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CORDIS Results Pack on green manufacturing

A thematic collection of innovative EU-funded research results

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Towards smart and sustainable manufacturing practices

Research and Innovation

Contents

3

Digital platform targets zero-defect manufacturing

5

Harnessing data to deliver more sustainable manufacturing

7

Transforming industry with AI-powered quality control

9

The circular economy project keeping Europe's gears of industry turning

11

Integrating collaborative AI into manufacturing

13

Giving industrial machinery a new lease of life

Editorial

Towards smart and sustainable manufacturing practices

With its significant contributions to industrial leadership, technological innovation and employment opportunities, Europe's manufacturing sector occupies a central position to drive sustainability and digitalisation agendas across the region. This CORDIS Results Pack on Green Manufacturing highlights six EU-funded research projects contributing to waste reduction, improved product quality and optimised energy use, paving the way to a more sustainable industry.

Climate change is a significant threat to the security and prosperity of Europe, and the wider world. Addressing this challenge means finding solutions that can satisfy economic and social needs while minimising impact on the environment. Europe's manufacturing industry is responsible for a quarter of its business economy turnover, and is a significant contributor to the EU's greenhouse gas emissions. As such, transformative changes to manufacturing are central to the delivery of the European Green Deal, as well as the twin Green and Digital Transitions.

Among these transformations is **zero-defect manufacturing**, a strategy which aims to reduce waste, optimise energy usage and lead to higher-quality products. Using digital tools such as connected sensors, internet of things (IoT) devices and artificial intelligence (AI), companies can improve their position on the market and become more competitive.

In addition, support for **more sustainable manufacturing practices** can help the production of high-quality products, minimise environmental impact and foster a healthier and more sustainable manufacturing ecosystem overall.

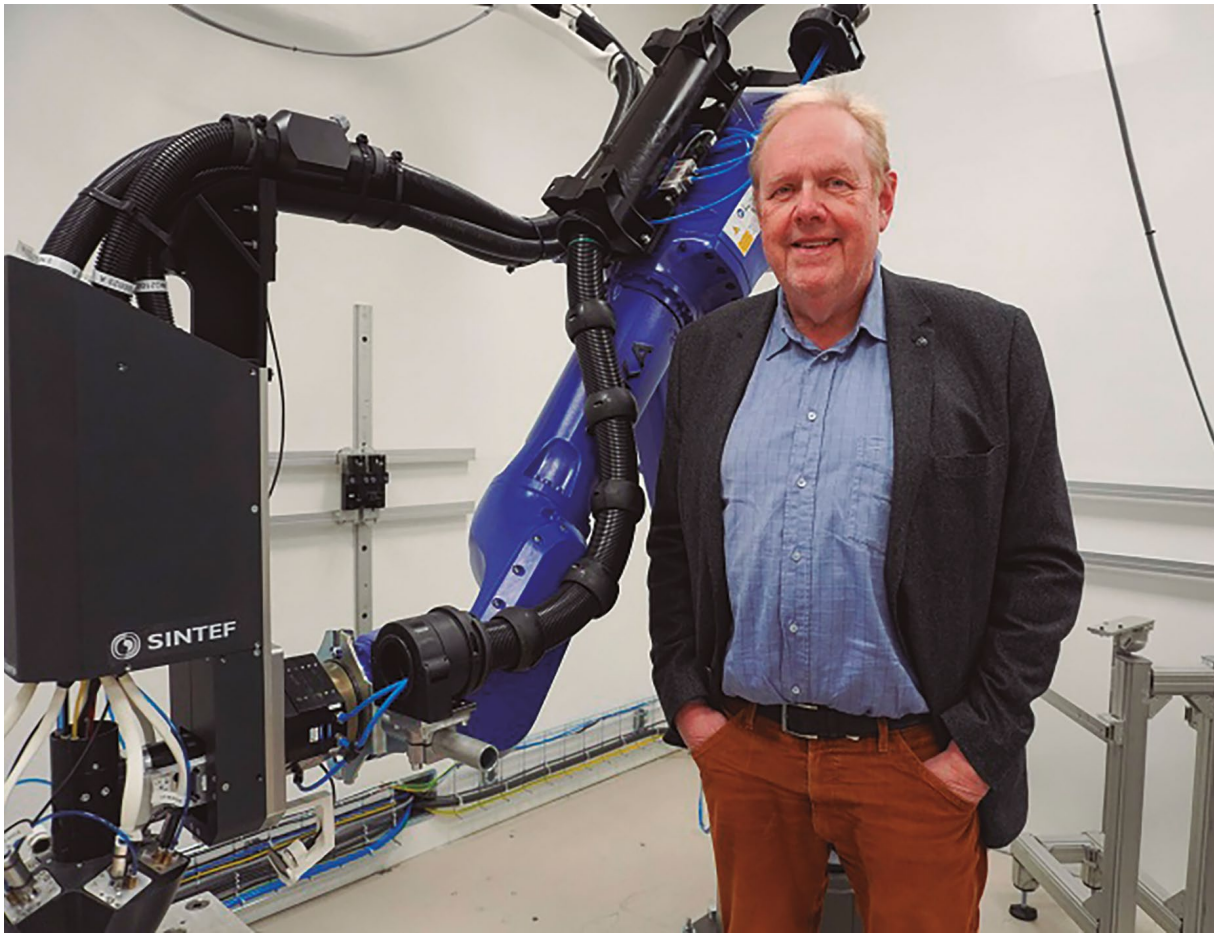
To accelerate the **transition to climate neutrality**, the Green Deal Industrial Plan is creating a more supportive environment for scaling up the EU's manufacturing capacity for net zero technologies.

Meanwhile, **advanced technological solutions** such as AI systems, virtual and augmented reality systems, smart sensors and collaborative robotics are being implemented by the Horizon 2020 European Factories of the Future initiative, a EUR 1.15 billion public-private partnership for advanced manufacturing research and innovation. The work continues under Horizon Europe as Made in Europe.

With support from the EU, the European manufacturing industry is positioning itself to lead in the 21st century as a more flexible, sustainable and resilient sector, delivering both the material goods needed by the world, and a sustainable, climate-neutral future.

Digital platform targets zero-defect manufacturing

By detecting potential problems early in the manufacturing process, software designed by the EU-funded DAT4.ZERO project can boost production efficiency and open the door to the production of quality products from recycled materials.



Improving quality and minimising defects and costs are essential for ensuring European industries stay competitive in the global marketplace. "Manufacturers are increasingly applying digitalisation in order to measure and control production processes better," notes DAT4.ZERO project coordinator Odd Myklebust from SINTEF Manufacturing in Norway. "At the same time, these tools can enable human workers to more fully contribute their skills."

Building on this concept, the DAT4.ZERO project developed a digital software platform to help industry progress with the zero-defect manufacturing approach. The platform contains a collection of tools applicable across a range of sectors and designed to detect and address potential defects early in the production process. Identifying problems as early as possible ensures fewer problems down the line.

Real-time adjustments

The centrepiece of this software is the project's digitally enhanced quality management (DQM) system. This combines smart sensors and large data sets in order to monitor process parameters, such as temperature and vibration, during machining operations.

The goal was to achieve a zero-defect extrusion process.

The project has five different pilots. "We wanted to ensure that our DQM system could be used across a range of sectors," explains Myklebust. German automotive parts manufacturer BENTELER hosted one of the demonstrations. The factory uses information about incoming material to adjust and control the downstream process in real time, taking account of any potential deviations and non-conformities.

"This factory extrudes aluminium parts, which then have to be bent the right way," adds Myklebust. "Slight deviations during machining can lead to problems later. The goal was to achieve a zero-defect extrusion process."

The five pilot projects all reported production improvements. Accurate measurements and analysis of input material, along with better tracking of production processes, help to ensure that quick and accurate adjustments could be made in real time.

This has led to less material waste and more efficient energy consumption. Fersa, a Spanish manufacturer of bearings, was able to achieve a 10 % reduction in the number of parts scrapped due to defects. And the Italian medical device manufacturer ENKI achieved projected annual savings of EUR 290 000, driven primarily by reductions in production time and raw material consumption, as well as fewer revisions and reworks.

Reuse, recycle, remanufacture

A key objective now is to bring this software to market and extend digital benefits to more industrial processes. The project team has also focused on training activities to generate interest and knowledge within industry and to ensure familiarity with digitalisation.

These activities have ranged from basic supplier management processes to solution-oriented training sessions for different manufacturing processes such as CNC machining and lathing.

"One thing that will be very important in the future is remanufacturing," says Myklebust. "This involves using old parts to create new products. This is a bigger challenge than simply using new material, as the quality of raw material needs to be stable and assured."

This is where Myklebust believes the DAT4.ZERO project can make a significant impact. The DQM system can be used to assure quality and uniformity in high-level manufacturing, for example automotive parts. "We can really achieve added value here," he remarks. "Our aim is to push our project results in this direction, to close the loop and achieve the circular production of quality products."

PROJECT
DAT4.ZERO – Data Reliability and Digitally-enhanced Quality Management for Zero-Defect Manufacturing in Smart Factories and Ecosystems

COORDINATED BY
SINTEF in Norway

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/958363

PROJECT WEBSITE
dat4zero.eu

Harnessing data to deliver more sustainable manufacturing

The EU-funded i4Q project's easy-to-use tools are helping to deliver zero-defect manufacturing by continuously collecting and analysing data along factory production lines.

Manufacturers are continuously redesigning and adjusting their production lines to produce goods specific to clients' requirements, and to ensure optimal use of resources. However, not all factories are able to make full use of all the data being generated, due in part to technical complexity and cost.

"A key aim of the i4Q project was to develop tools capable of capturing and managing factory data," explains project coordinator Georgia Apostolou from the Centre for Research & Technology Hellas (CERTH) in Greece. "We wanted to develop simulation and optimisation tools that create an integrated approach to zero-defect manufacturing."

Digital tools

The i4Q project worked with manufacturers to identify and understand key production processes, and to pinpoint where production line problems occurred. This led to the development of user-friendly tools based on five key data issues: sensing where problems occur; communication of these problems in real time; computer analysis and simulation; data storage; and optimisation.

"Each manufacturer has its own problems," says Apostolou. "By applying internet of things (IoT)-based reliable industrial data services and AI, we wanted to create tools that would be easy to use and adaptable to specific challenges."

A suite of 22 tools was created, each of which can be tailored to the needs of specific manufacturers. The tools cover the data life cycle, from collection and storage through to analysis and distribution. Web-based software tools to help manufacturers visualise information were also developed, with a key emphasis on user-friendliness.

Real-world trials

The suite of tools was installed, tested and validated in six factory production lines. These factories produce industrial metal equipment, specialised wood equipment, white goods, metal machining tools, ceramics and plastics. The trials provided invaluable feedback, helping the production team to make improvements as the project advanced.

Moving towards greener manufacturing with less waste is essential.

"Take the ceramics manufacturer, as an example," adds Apostolou. "The production process involves shaping clay into plates, putting them through an oven, and applying a liquid glazing material. A common problem is that sometimes too much liquid is applied to each plate. This creates an uneven surface that doesn't look appealing, leading to wastage."

An inability to predict, monitor and verify glazing in real time can lead to hundreds of plates having to be destroyed, costing the manufacturer time, material and money. To counter this, the i4Q project installed sensors at critical stages of the production line. Data was analysed in real time, and alerts sent to machine operators if a potential error was detected. This enabled production to be immediately paused and to optimise the process.

Power of big data to reduce waste

The i4Q team is currently commercialising several of the more advanced data tools through the creation of project-related start-ups – such as CDXi solutions – and marketplaces, such as the i4FS platform. This enables project partners to promote their tools and connect with potential customers.

"Some industrial project partners also want to continue using the tools beyond project completion, and have identified the need for extra features, something that we are currently working on," says Apostolou.

The i4Q team believes that harnessing the power of big data will help industrial manufacturers to reduce waste, improve product quality, optimise energy use and achieve more sustainable production. Ensuring the tools are easy to use will be critical for encouraging their widespread adoption among businesses looking to upgrade their production lines.

"Moving towards greener manufacturing with less waste is essential," remarks Apostolou. "Innovations from the i4Q project will keep shaping the smart manufacturing field. These advancements are expected to lead to fully integrated, defect-free production environments, enhancing competitiveness and sustainability in the manufacturing sector. By showing the benefits of working with data, we hope to get more companies on board."

PROJECT
i4Q – Industrial Data Services for Quality Control in Smart Manufacturing

COORDINATED BY
Centre for Research & Technology Hellas (CERTH) in Greece

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/958205

PROJECT WEBSITE
i4q-project.eu

Transforming industry with AI-powered quality control

Zero-defect manufacturing can help European industry stay competitive. AI-powered tools and methods developed by the EU-funded InterQ project improve product quality and efficiency.

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As more manufacturers embrace Industry 4.0 principles, they are encountering issues such as limited data and insights on product quality, unreliable monitoring systems and poor data exchange across the supply chain. The InterQ project was conceived to address this, particularly in the aerospace, wind power and automotive sectors, where product quality and safety is paramount, and even minor defects can lead to significant negative outputs.

"The primary objective was to achieve zero-defect manufacturing through the measurement, prediction and control of product and process quality," explains InterQ project coordinator Jose Luis Lanzagorta, manufacturing processes researcher at Spanish technology centre IDEKO. "While enhancing safety, promoting sustainability by reducing waste and energy consumption, and driving technological advancement."

InterQ put together a consortium of 25 research institutions and industry partners across 11 European countries. Their goal was to transform processes and promote innovation in manufacturing quality by introducing tools powered by artificial intelligence (AI), providing manufacturers with meaningful and reliable data.

Machine intelligence

The project employed a new generation of digital technologies and AI-driven applications that included: digital twins; virtual sensors; AI decision support systems; data fusion; and distributed ledger technology. These were used in three key areas: data-driven optimisation; AI-powered inspection; and a collaborative quality ecosystem.

For the first, InterQ transformed raw data into actionable insights, such as predicting equipment failures, optimising production and ensuring product quality. By leveraging AI, the project was able to replace destructive testing for quality assessment and complement non-destructive inspection methods such as ultrasound, eddy currents and vision systems, cutting time and material costs. Finally, InterQ built a trusted framework to foster data sharing and quality assurance across the supply chain.

Each approach was tested in three pilots across the aerospace, wind power and automotive sectors, with significant success. In the aerospace demonstrator at ITP Aero in Spain, InterQ tools prevented various critical and costly parts from being scrapped in the aerospace pilot, leading to savings of approximately EUR 265 000 (with projected savings of EUR 1.7 million over the next four years). Meanwhile, the Spanish wind turbine design centre Gamesa Gearbox saw the efficiency of non-destructive inspection increase by a remarkable 80 %.

Delivering tangible results

By the end of the project in October 2023, InterQ had developed a comprehensive quality control software suite that can be adopted by any manufacturer. It enables predictive maintenance, optimised production processes and ensured product quality through enhanced inspection methods.

This also included the development of a sensorised tool holder that can identify surface defects made during the machining process, and an optical sensor for surface quality control to review completed parts, both of which highlighted the project's ability to deliver tangible solutions for manufacturers. Additionally, the suite facilitated easy data sharing across the supply chain, which created collaboration and trust among partners.

"What initially seemed like a daunting challenge gradually evolved into tangible and real solutions," adds Lanzagorta. "And these have yielded significant advantages in crucial sectors of European manufacturing."

Meanwhile, InterQ made a scientific impact, resulting in 17 publications in top journals and global conferences in the field. Additionally, industry partners have engaged in over 30 events, further promoting the project's findings.

What initially seemed like a daunting challenge gradually evolved into tangible and real solutions.

Transforming manufacturing

In preventing defects, reducing waste and increasing efficiency, InterQ has demonstrated the potential of AI to revolutionise manufacturing and drive economic growth. Furthermore, the project focused on developing new manufacturing skills through project knowledge creation and sharing as well as providing training for personnel.

PROJECT
InterQ – Interlinked Process, Product and Data Quality framework for Zero-Defect Manufacturing

COORDINATED BY
IDEKO in Spain

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/958357

PROJECT WEBSITE
interq-project.eu

The circular economy project keeping Europe's gears of industry turning

Digital tools developed by the EU-funded LEVEL-UP project can increase the working life of machinery in industries such as woodworking, aeronautics and toolmaking, helping European manufacturers modernise and cutting waste.

© AIMEN

Modernising manufacturing lines can mean functional equipment gets discarded, creating unnecessary waste. Small and medium-sized enterprises (SMEs) often lack the resources and knowledge needed to tackle both digitalisation and sustainable practices. The absence of standardisation and common terminology related to the circular economy has magnified these challenges.

To address this, LEVEL-UP aimed to establish a standard framework for applying circular economy principles to extend the

lifespan of industry assets. The project developed 10 circularity protocols, and an integrated advanced digital platform which measures every step of the manufacturing process so that it can be optimised. This enables SMEs to adopt a more sustainable approach to resource use, tackle overconsumption and significantly reduce their carbon footprint.

Project coordinator Roi Méndez, from the AIMEN Technology Centre in Spain, outlines their mission statement: "LEVEL-UP's vision was specifically designed to focus on the modernisation and digital transformation of product manufacturing, encompassing every stage of the life cycle and value chain."

LEVEL-UP's vision was specifically designed to focus on the modernisation and digital transformation of product manufacturing, encompassing every stage of the life cycle and value chain."

Scalable and sustainable

LEVEL-UP's scalable digital platform allows users to optimise equipment use, simplify maintenance tasks and manage data, making it easier for smaller companies to adopt digital solutions. They also explored the potential of 3D-printing critical metal components to keep machines in service, avoiding the need for costly replacements and minimising downtime and waste.

To achieve these goals, the project outlined 12 objectives, grouped into key areas: Digitalisation; Knowledge Management; Digital Twins; Inspection of Components; and End-of-Life Strategies. Once development was completed, the platform was rolled out at seven demo sites across Europe, each involving outdated large industrial equipment from different sectors with distinct requirements and business models. The pilots included manufacturers across Europe including machine tool producers, woodworking machines, and members of the automotive, railway and aeronautics industries.

Levelling up to the challenge

As with many digital transformation projects, LEVEL-UP faced some hurdles. Implementing digital tools often requires access to historical production data, which some companies were initially hesitant to share. And there was also initial scepticism towards using 3D-printing for critical components. However, successful demonstrations and training initiatives helped overcome these concerns.

Most interestingly, the initiative also highlighted the need for better communication between research institutions and industry: the project found researchers often develop complex solutions, while manufacturers need practical and user-friendly tools.

Nonetheless, the project has been a great success. LEVEL-UP's approach has been shown to extend the lifespan of large machinery by 5 to 10 years, reduce energy and resource use by over 10 % and increase the Material Circularity Indicator by over 20 %.

In addition, all 10 circularity protocols have been defined and published, helping to standardise circular economy practices and contributing to CEN-CENELEC Workshop Agreement 18106 Circularity Protocols for extending the useful Life of Large Industrial Equipment, released in April 2024. This ensures consistency across various industries and facilitates the broader adoption of sustainable methods.

The future of industry

LEVEL-UP's innovative approach to integrating circular economy principles and advanced digital technologies offers European industry an opportunity to extend the lifetime of industrial equipment, maximising return on investment and enhancing sustainability.

Its legacy lies in its comprehensive approach providing valuable tools and methodologies that can be adopted by companies of all sizes – promoting a more competitive European manufacturing sector.

"Thanks to the collaboration of our partners, and the commitment of the end users, LEVEL-UP has had very satisfactory results that will hopefully help translate to a higher return on investment for manufacturers," concludes Méndez.

PROJECT
LEVEL-UP - Protocols and Strategies for extending the useful Life of major capital investments and Large Industrial Equipment

COORDINATED BY
AIMEN Technology Centre in Spain

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/869991

PROJECT WEBSITE
levelup-project.aimen.es

Integrating collaborative AI into manufacturing

By integrating cutting-edge artificial intelligence into production line processes, the EU-funded OPTIMAI project was able to improve efficiency, sustainability and innovation in manufacturing, helping European companies stay competitive.

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The manufacturing industry makes a significant contribution to the EU economy. It delivers 80 % of all EU exports and employs one in five European citizens. In order to stay competitive, there is a growing demand for zero-defect manufacturing, particularly where precision and safety are critical.

Integration and optimisation

The primary goal of OPTIMAI was to harness the capabilities of artificial intelligence (AI) to eliminate errors in manufacturing. Through advanced monitoring and inspection, the project aimed to optimise production lines and deliver high-quality, reliable products.

The project, hosted by the Centre for Research & Technology Hellas (CERTH) in Greece, focused on several key areas: human-machine collaboration; smart automation; computer vision; AI-assisted process optimisation; and quality control. It was envisioned that integrating these new technologies would create smarter, more adaptable production lines – improving productivity and helping reduce waste and energy consumption.

"Defective parts mean waste of resources and waste of energy – therefore minimising waste will make industry more competitive," explains project coordinator Nikolaos Dimitriou, an information technology researcher at CERTH. "We wanted to take the most advanced AI and apply that to manufacturing, to make production better and more efficient, and to predict and forecast defects."

Real-world application

OPTIMAI partnered with three manufacturers from diverse sectors across Europe, each with unique challenges. Focusing on concrete objectives that were tailored to the needs of the three pilots, research began with in-depth studies to understand the specific needs and challenges of the factories involved. A reference architecture was developed to outline the necessary software and hardware components for each factory.

Defective parts mean waste of resources and waste of energy – therefore minimising waste will make industry more competitive.

In each case, it achieved tangible results. For Microchip Technology in the United Kingdom, a closed-loop AI system was developed to automate glue dispensing on printed circuit boards. This monitored glue quantity, adjusted pressure in real time and ensured consistent quality, minimising defects.

Machine vision powered by AI was implemented for real-time identification of defects in antennas made by Televés in Spain. This enabled the automated rejection of faulty products before they entered the production line, significantly improving efficiency.

Finally, an AI-driven system for optimising the calibration of elevator valve blocks was created for Kleemann in Greece. This not only improved passenger comfort and energy efficiency, but also reduced noise levels, leading to a more pleasant elevator experience.

Human-in-the-loop methodology

While AI offers immense potential for industry, "OPTIMAI recognised that human expertise was invaluable in enhancing AI's performance," says Dimitriou. This meant a collaborative approach was essential in many processes, including AI model training, where human experts provided insights and labelling data on defective samples, verification and refinement of AI solutions by human workers, and task optimisation where humans and AI worked together to identify optimal solutions.

The methodology also helped to emphasise a trust and acceptance of AI technology among the workforce, while equipping them with the skills and expertise needed to thrive in an increasingly AI-driven industrial landscape.

The project expected initial resistance from factory staff to the new technology, but the 'human-in-the-loop' approach meant that the level of interest and engagement from employees was unprecedented. Workers were eager to participate in the project, demonstrating a real willingness to learn about, adapt to and upskill for the changes brought about by AI integration.

"The majority of staff wanted to be involved," adds Dimitriou. "They were interested in finding out what we were developing and what AI can do well. It was a very nice example of how humans and AI can coexist successfully."

OPTIMAI's success lies in this collaborative approach leveraging the strengths of both AI and human expertise. As AI technology continues to evolve, learnings and outcomes from the project will be invaluable in shaping more efficient, sustainable and future-proof manufacturing within the EU.

PROJECT
OPTIMAI – Optimizing Manufacturing Processes through Artificial Intelligence and Virtualization

COORDINATED BY
Centre for Research & Technology Hellas (CERTH) in Greece

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/958264

PROJECT WEBSITE
optimai.eu

Giving industrial machinery a new lease of life

Applying digital innovations could help manufacturers to extend the life of their machinery, saving them money and reducing waste.

Well-functioning equipment is critical to industrial productivity, and replacing ageing machinery can entail a huge investment. This situation often presents manufacturers with a dilemma – whether to continue with outdated machinery that can break down, or to carry out a costly replacement.

The problem is that disposing of old machinery is not only expensive – it also carries a large environmental footprint. A more cost-efficient and environmentally friendly solution would be to give such machinery a second life, through the development of new technologies and methods that can self-assess, repair and encourage the reuse of industrial machinery wherever possible.

Making machinery more sustainable

This was the aim of the RECLAIM project, which brought together 22 partners including five end users. These manufacturers, active in the fields of friction welding, shoemaking, furniture making, and textiles and dishwasher manufacturing, use machinery to produce their products that are often years or even decades old.

"This project was about finding ways of making this machinery more sustainable," explains RECLAIM project coordinator Michael Peschl from Harms & Wende in Germany.

"This involves installing predictive maintenance, to make machinery more modular so that it is easier to exchange parts, and thinking about new business models such as the leasing of machinery."

In order to improve productivity and performance, the project team investigated the use of digital analytics, the internet of things (IoT) and sensors, in order to detect any problems before they occur. These solutions were then developed and trialled in real industrial environments.

Smart production line digital solutions

All five end users installed smart digital solutions in their production lines, providing them with valuable data concerning the state and productivity of their machines. "We tried to find a balance between helping manufacturers with their daily problems, and also looking at more strategic aspects of maintenance," says Peschl.

These solutions included an online decision support framework. This system gathers data about the machinery's performance, sourced from sensors. These sensors can be tailored to specific needs, to better understand machine performance and encourage predictive maintenance.

Another technological innovation combines sensors with real-time situation monitoring, in order to extend the lifetime of the machinery. "This was about improving machinery already in place wherever possible," adds Peschl.

The project team also developed a digital twin, enabling manufacturers to simulate their production lines digitally, to identify any unforeseen problems or maintenance needs. Machine learning was also used to develop a business intelligence tool, helping manufacturers to make informed decisions about their production line investments..

Bringing digital tools to market

Impacts of the installed RECLAIM technologies were then measured against key performance indicators (KPIs), identified by the five end users before the start of the project. Each end user focused on areas they felt were especially important for their business, for example productivity.

"The shoemaking manufacturer in our consortium always had an issue with membranes in their machinery," explains Peschl. "These were breaking without warning, resulting in days of repair."

The manufacturer now uses a digital degradation model that simulates when the membrane is likely to break, and has installed sensors to detect issues in real time.

All end users achieved their KPIs and were very happy with the results.

"All end users achieved their KPIs and were very happy with the results," notes Peschl. "We have successfully brought one of our tools to market, and partners in the consortium are getting close to commercialising other innovations.""

PROJECT
RECLAIM – RE-manufaCturing and Refurbishment of LArge Industrial equipMent

COORDINATED BY
Harms & Wende in Germany

FUNDED UNDER
Horizon 2020-LEIT-ADVMANU

CORDIS FACTSHEET
cordis.europa.eu/project/id/869884

PROJECT WEBSITE
reclaim-project.eu

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RESULTS PACK ON ENERGY-INTENSIVE INDUSTRIES

Energy-intensive industry (EII) sectors need to reduce their carbon footprint and accelerate the transition to climate neutrality by providing affordable and effective clean technology solutions. This new CORDIS Results Pack focuses on 12 Horizon 2020 research projects, funded within the SPIRE partnership, that demonstrate technological pathways for decarbonisation, efficiency and circularity in EIIs.

Check out the Pack here:
cordis.europa.eu/article/id/450530

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