



**Re-manufaCturing  
and Refurbishment**  
LArge Industrial equipMent



#### RENOVATION CURE

How the industry changes its behavior of sustainability.

#### THE DIGITAL TWIN

How virtual copies of machines reduce downtime to a minimum.

#### FIVE SOLUTIONS

Which RECLAIM solutions are almost ready for the market today.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°869884.



**Dear readers,**

If you had known that it is possible to significantly extend the lifespan of older industrial machines through digitalisation alone, you would have been surprised. We firmly believed this when we started our European research project 3.5 years ago. We are 22 companies, universities, and research institutes that have set ourselves the goal of jointly supporting industrial change with sustainable solutions and applications. After 3.5 years of the project, I am proud to say that we have succeeded.

Of course, it was not only about extending the lifetime of machines. Our developers and engineers have done an incredible job despite the difficult circumstances of an all-changing pandemic. In addition to 5 so-called Key Exploitable Results, i.e., developments that have a real potential to be used more widely in industry, I am also very proud of the work on standardisation. We succeeded in documenting all processes and developments in a certain set of rules so that other projects and developments can benefit from them easily and sustainably.

To give you a more detailed insight into our work and results, you will find facts, figures and informative articles on why refurbishment and the sustainable circular economy are a fundamental part of industrial change on the next 56 pages of this magazine. I hope you enjoy reading it.

**Dr. Michael Peschl**

# CONTENTS

<b>02</b>	<b>Editorial</b>   Project Coordinator Dr. Michael Peschl
<b>04</b>	<b>Demo Case Gorenje Group</b>   White Goods Slovenia
<b>06</b>	<b>Demo Case Fluchos</b>   Shoe Making Spain
<b>08</b>	<b>Demo Case Harms &amp; Wende</b>   Friction Welding Germany
<b>10</b>	<b>Demo Case Podium</b>   Wood Manufacturing Switzerland
<b>12</b>	<b>Demo Case Zorlutek</b>   Textiles Turkey
<b>14</b>	<b>About RECLAIM</b>
<b>16</b>	<b>Designing the Machines of the Future</b> Article
<b>20</b>	<b>Decision Support Framework</b> Solution
<b>24</b>	<b>Rejuvenation Cure for Old Production Equipment</b> Article
<b>28</b>	<b>Intelligent Health Management Prediction Toolkit</b> Solution
<b>32</b>	<b>Strategies for Seamless Adaption of People and Machines</b>   Article
<b>36</b>	<b>Legacy Machine Booster</b>   Solution
<b>40</b>	<b>Why Obsolete Machines Can No Longer Lead to Production Losses</b>   Article
<b>44</b>	<b>Replica Digital Twin</b>   Solution
<b>48</b>	<b>ICE Knowledge Discovery</b>   Solution
<b>52</b>	<b>Matrix Solution</b>   Demonstration Cases
<b>54</b>	<b>Partner and Results</b>

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# WHITE GOODS MANUFACTURER

ENAMELLING AND ROBOTICS



RETURN ON  
INVESTMENT

UP  
TO **5**  
YEARS



SLOVENIA

**gorenje**group

Robotic cells (RC) are a very important part of the manufacturing process at the Gorenje dishwasher factory. Dishwasher inox tubs are manufactured and isolated in robotic cells, where bending, punching, double bending, pressing, welding, and isolation processes are carried out mainly by robots.



# TARGETS AND KPIs



## SAFETY & ENVIRONMENT

INCREASED **HYDRAULIC TIGHTNESS** TO **90%**  
REDUCED **COOLING WATER** BY **10%**



## MAINTENANCE COST EFFECTIVENESS

DECREASED **COST** BY **50%**



## OPERATIONAL EFFECTIVENESS

INCREASED BY **7%**



## EQUIPMENT EFFECTIVENESS

INCREASED **10%**



## MATERIAL & RESOURCE EFFICIENCY

IMPROVED BY **10%**



## EXPECTED USEFUL LIFE

**15** YEARS **LIFETIME EXTENSION**



# FOOTWEAR MANUFACTURER

**SHOE MAKING**



**RETURN ON  
INVESTMENT**

**UP  
TO 2  
YEARS**



**SPAIN**



**Fluchos**

The Spanish footwear company Fluchos tested RECLAIM technology on their complete shoe manufacturing unit. The manufacturing unit includes five major shop floors: cutting, stock fitting, conforming, set up, and finishing departments. Automation levels are currently low.

# TARGETS AND KPIs



## SAFETY & ENVIRONMENT

REDUCTION OF INCIDENTS AND ACCIDENTS BY **10%**



## MAINTENANCE COST EFFECTIVENESS

REDUCTION IN COST BY **10%**



## OPERATIONAL EFFECTIVENESS

INCREASE IN EFFECTIVENESS BY **10%**



## EQUIPMENT EFFECTIVENESS

INCREASE IN EFFECTIVENESS BY **10%**



## MATERIAL & RESOURCE EFFICIENCY

MORE EFFICIENCY BY **10%**



## EXPECTED USEFUL LIFE

INCREASE IN LIFETIME BY **20%**





# FRICTION WELDING

WELDING



RETURN ON  
INVESTMENT

UP  
TO **5**  
YEARS



GERMANY



Friction welding machines are used for reliable joining of welded metal parts and for a variety of materials like steel, aluminium, ceramics, brass, and copper. RECLAIM partner Harms & Wende (HWH) specialised in the construction and development of such machines.

# TARGETS AND KPIs



## SAFETY & ENVIRONMENT

REDUCTION OF INCIDENTS AND ACCIDENTS **10%**

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## MAINTENANCE COST EFFECTIVENESS

REDUCTION IN COST **10%**

---



## OPERATIONAL EFFECTIVENESS

INCREASE IN EFFECTIVENESS **20%**

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## EQUIPMENT EFFECTIVENESS

INCREASE IN EFFECTIVENESS **10%**

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## MATERIAL & RESOURCE EFFICIENCY

MORE EFFICIENCY **10%**

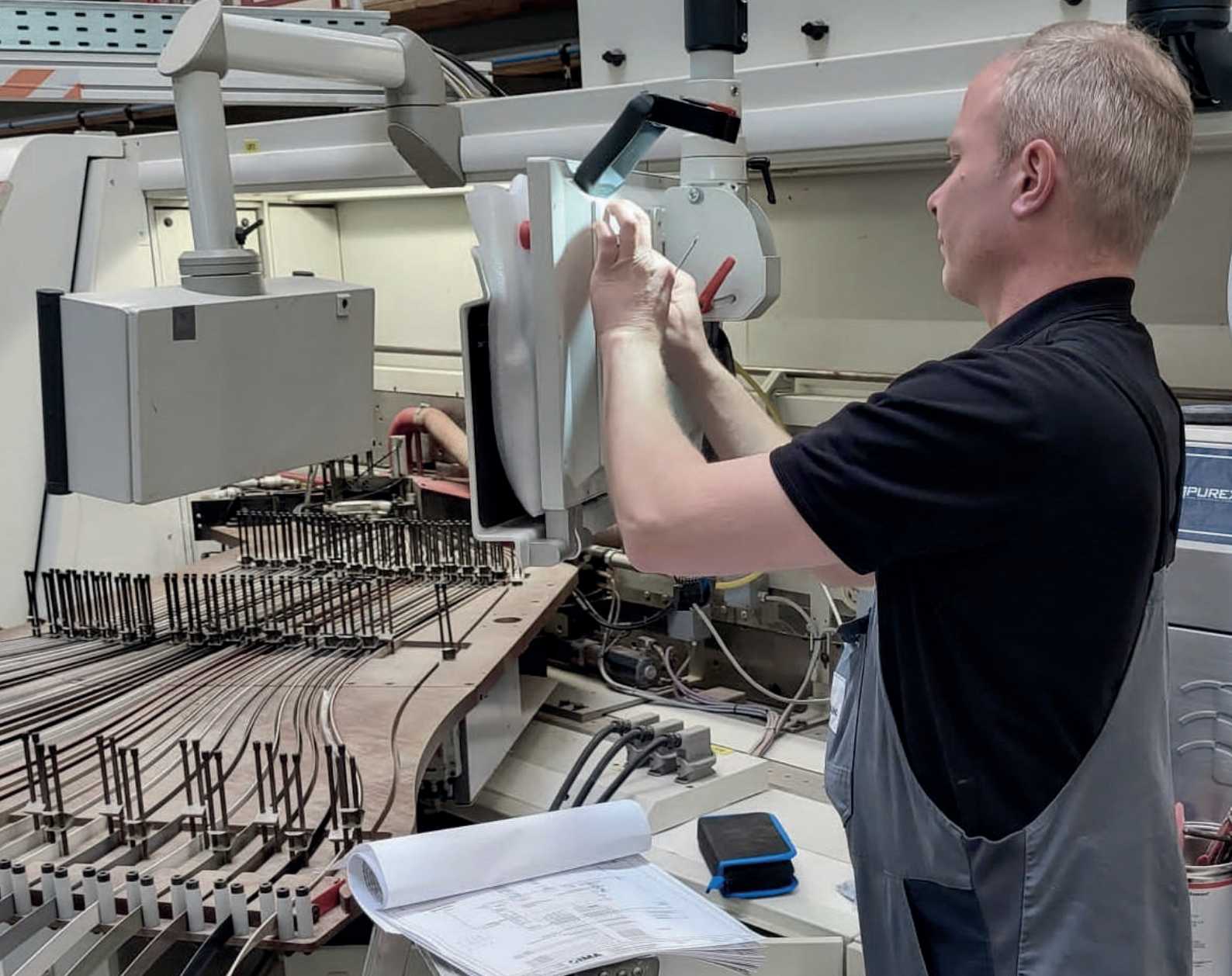
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## EXPECTED USEFUL LIFE

**10** YEARS LIFETIME EXTENSION





# WOODWORKING MANUFACTURER

**WOOD WORKING**



**RETURN ON  
INVESTMENT**

**UP  
TO 3  
YEARS**



**SWITZERLAND**



This high-end wooden kitchen production line covers 1800 m2 and is comprised of machines from several interconnected vendors. The machines work over one shift of 8.4 hours and their expected lifetime is 15 years.



# TARGETS AND KPIs



## SAFETY & ENVIRONMENT

INCREASE BY **30%**

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## MAINTENANCE COST EFFECTIVENESS

INCREASE BY **25%**

---



## OPERATIONAL EFFECTIVENESS

INCREASE BY **30%**

---



## EQUIPMENT EFFECTIVENESS

INCREASE BY **40%**

---



## MATERIAL & RESOURCE EFFICIENCY

MORE EFFICIENCY **10%**

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## EXPECTED USEFUL LIFE

**+6/8** YEARS

# TEXTILE MANUFACTURER

TEXTILES



RETURN ON  
INVESTMENT

UP  
TO **2**  
YEARS



TURKEY

## ZORLUTEKS

Zorluteks is an integrated producer of cotton home textiles such as curtains, roller blinds, bed linens, bed covers, and tablecloths. The machines are used to bleach raw cotton fabrics from different suppliers with a wide range of whiteness.



# TARGETS AND KPIs



## SAFETY & ENVIRONMENT

REDUCTION OF INCIDENTS AND ACCIDENTS BY **10%**

---



## MAINTENANCE COST EFFECTIVENESS

DECREASE COST BY **10%**

---



## OPERATIONAL EFFECTIVENESS

INCREASE BY **10%**

---



## EQUIPMENT EFFECTIVENESS

INCREASE BY **10%**

---



## MATERIAL & RESOURCE EFFICIENCY

INCREASE BY **10%**

---



## EXPECTED USEFUL LIFE

INCREASE BY **20%**



# ABOUT THE PROJECT

**MANUFACTURING IS A PILLAR OF INNOVATION AND GROWTH FOR EUROPE, REPRESENTING 15% TOTAL EMPLOYMENT AND 80% OF EXPORTS. MANUFACTURING IS QUALLY ESSENTIAL FOR THE PRODUCTION OF INNOVATIVE PRODUCTS AND SYSTEMS THAT AFFECT EVERY ONE OF US – TRANSPORTATION, HOUSEHOLD APPLIANCES, HEALTH PRODUCTS, JUST TO NAME A FEW.**

Well-functioning equipment is a key to industrial productivity. However, a significant share of machinery in the European production lines is approaching the end of their designed lifetime. These ageing machines can suffer unplanned downtime causing significant losses – in financial terms and of the resources in production when they fail. Simple disposal of the outdated machinery is costly and carries a large environmental footprint. New approaches are needed to ensure European manufacturing remains competitive and protects the environment.

Researchers and industry representatives from nine European countries formed RECLAIM with an ambitious goal to provide replicable solutions that could help European manufacturing sector meet these and future demands.

RECLAIM stands for RE-manufaCturing and Refurbishment LArge Industrial equipment.

This EU funded project intends to demonstrate strategies and technologies that enable the re-use of industrial equipment in old, renewed and new factories alike.

## SOLUTIONS

RECLAIM solutions aim to extend machinery lifetime while also improving productivity and performance. The project focused on harnessing digital analytics, the Internet of Things (IoT), and circular economy strategies to improve predictive maintenance and upgrade legacy machines responsibly and effectively.

Improving informed analysis and decision-making is a key objective.

RECLAIM will create a novel Decision Support Framework to assess the health status of machinery and propose methods, tools, or services for the appropriate lifetime extension strategy.

Developed solutions will be demonstrated and refined in real industrial environments to evaluate the lifecycle of the industrial equipment (machines, production lines, robotic system, etc.) and to implement recovery strategies.



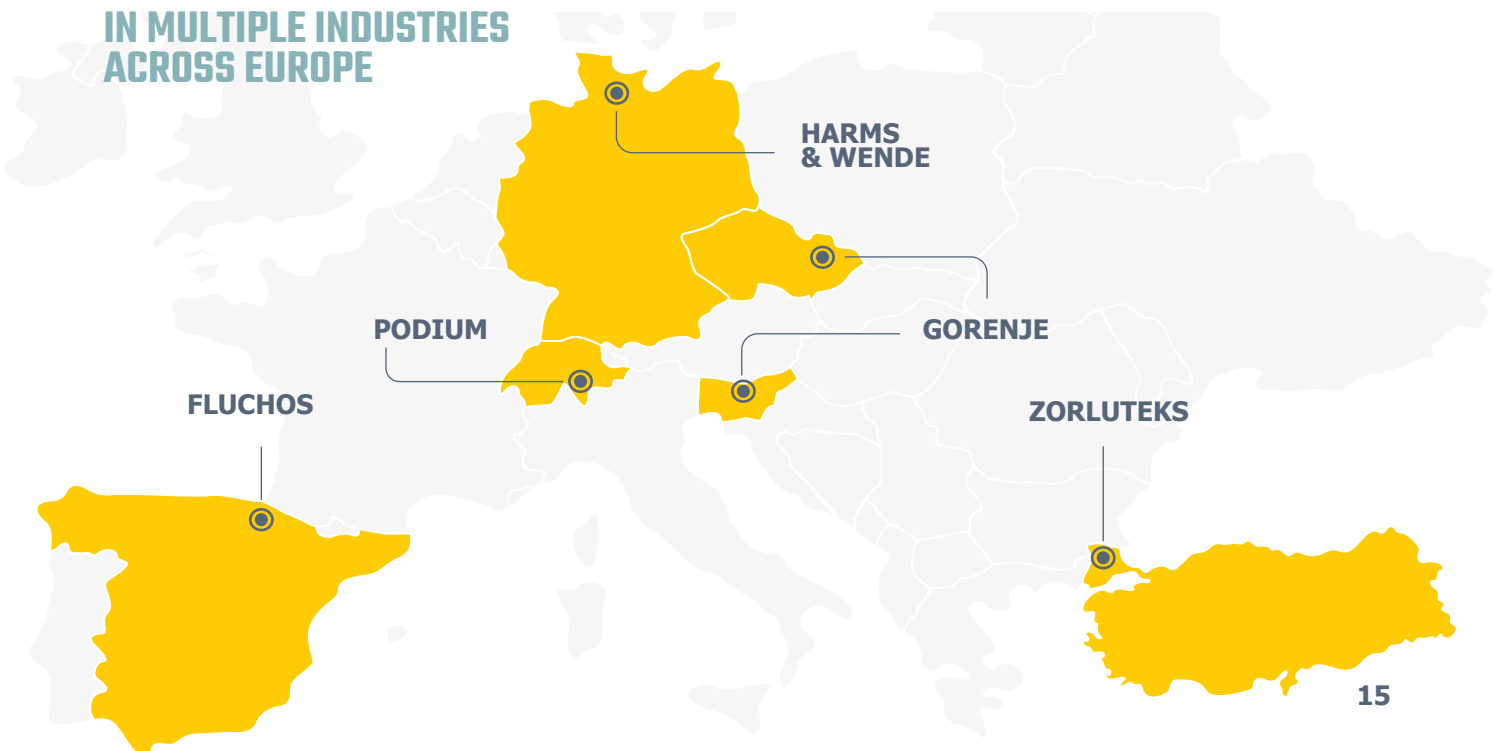
# RECLAIM'S CORE TECHNICAL ELEMENTS

## REFURBISHMENT AND RE-MANUFACTURING PROCESS



## DEMONSTRATION CASES

IN MULTIPLE INDUSTRIES  
ACROSS EUROPE





BY MARTIN GROLMS

# DESIGNING THE MACHINES OF THE FUTURE

## SUBSCRIPTION MODELS FOR INTELLIGENT MACHINES COULD LEAD TO A CIRCULAR ECONOMY

The interconnection of embedded production systems and dynamic processes of business and technology makes it possible to manufacture products more profitably, the so-called smart production. But intelligent linking of even old machines can do much more: it can save resources, avoid overproduction, prevent breakdowns and significantly extend maintenance intervals. This could be the first step towards an industrial circular economy as demonstrated in the EU project RECLAIM.

We all know that our current economic system, which is widely based on resource consumption, is destroying and polluting our planet. The Earth Overshoot Day (EOD) this year will be July 28, i.e. the calculated date on which humanity's resource consumption for the year exceeds Earth's capacity to regenerate. If we and future generations want to continue to live in prosperity, we have but one solution: avoid consuming more resources than will grow back. We must conserve resources and consistently reuse them. In short, we need a Circular Economy.

Concepts like repair and reuse sound reasonable – they would allow us to extend the useful life of products with the system. However, such an economic shift would be nothing less than the manufacturing revolution. Sure, in some areas, there are already promising approaches but industrial production in particular still generates huge quantities of waste. Production consumes an enormous part of the available energy and drinking water worldwide. And at the same time it emits the lion's share of carbon dioxide and other greenhouse gases.

Researchers around the world are addressing these challenges, technically, economically and socially. Some believe that production in the future has to be highly networked to meet these challenges. Industry 4.0, Smart Factory, Artificial Intelligence, we hear repeatedly. However, we are still a long way from that. There are pioneering companies, but the vast majority of factories use conventional machines that have often been in use for decades. And they still do reliable and accurate work, but with a traditional, resource-consuming environment.





## REUSE AND REFURBISHMENT OF OLD MACHINES

If we are to save resources, increase energy efficiency and move towards sustainability, then all production equipment and process steps must be seamlessly connected and synchronised.

Which is a problem: "Most machines cannot simply be equipped with sensors and used in a digitalised environment," explains Dr. Michael Peschl, Head of Research and Development at Harms & Wende. The Hamburg-based company is an industrial supplier for automated and manual welding technology and is leading the RECLAIM project.

RECLAIM stands for RE-manufaCturing and Refurbishment Large Industrial equipMent. This EU-funded project seeks to demonstrate strategies and technologies that enable the re-use of industrial equipment in old, refurbished and new factories alike. Researchers and industry representatives from nine European countries formed RECLAIM with an ambitious goal to provide replicable solutions that could help the European manufacturing sector meet these and future demands.

"Harms & Wende has two main objectives within the RECLAIM project," Michael Peschl says. "Firstly, how far can we get with reuse and refurbishment, retrofit and revamp? Where are the limits?" New re-use and refurbishment approaches are needed to ensure European manufacturing remains competitive and protects the environment, according to the researcher. Several companies have successfully retrofitted existing machines with smart sensors as part of RECLAIM. The aim is to integrate them into the control and regulation network of their plants, highly as well as partially automated. "Secondly, we want to find out how machines will have to be designed in the future to meet the requirements of a circular economy," he adds.

These are not merely technical or mechanical issue. It is not just about separating materials and fully recycling them, even though this is still important to do. The point is: The fewer resources an economy needs, the easier it will be to move away from resource-intensive production and consumption models, towards a sustainable, low carbon and zero waste economy.

Peschl and his RECLAIM colleagues want to reduce the demand for resources as much as possible. Therefore, they are seeking for ways to postpone maintenance intervals as much as possible, for instance. They are developing flexible machine concepts that can be used more widely, and they are considering whether it might not make more sense to rent machines instead of buying them.

For this, they need data, so-called big data: about machines, production, materials, machine operators and the entire production environment. In addition, they need details about schedules, areas of product application, end-user behaviour and so on. And they can't process all this information without Artificial Intelligence.



# INDUSTRY 4.0 AUDIT

To determine the digitalisation potential of production facilities Maurice Herben, Program Director Fraunhofer Project Center at the University of Twente, Netherlands, and his colleagues from the Fraunhofer Institute for Production Technology IPT developed an Industry 4.0 Audit. The comprehensive Industry 4.0 Audit pledges to provide companies with an insightful bird's eye view of the current digitalization status, as well as a research-backed, data-driven blueprint for future success.

The audit starts with an on-site Quick Scan to understand the company's specific needs, goals, and expected challenges in order to scope a tailored audit approach. It includes on-site talks with the company's leaders and employees. Using the information from the quick scan, the Fraunhofer experts will develop a custom audit plan.

The main Industry 4.0 Audit takes up to two weeks of in-house workshops with various stakeholders. It comprises a current state analysis, a benchmark and gap analysis and finally a roadmap development.

The company receives a detailed report and a customised action plan by Maurice Herben and coworkers. If desired, they provide implementation support and workshops.

"The key customer benefit of our audit is that many companies don't even know what is possible with digital transformation", says Herben. "For individual areas, we have various experts who are familiar with the latest trends and technological developments in smart industry, such as adaptive production or analytics in production, Digital Twin or subscription models. They know the specific benefits, opportunities and challenges."

Recently, the Dutch Smart Industry Hub "Innovatiecluster Drachten" (ICD) applied the 4.0 Audit to develop an action plan for introducing a completely paperless production. "It actually sounds like a lot less work than it really is", Herben recalls. The ICD companies Quadient, Variass Ventura Systems, NTS Norma and Photonis s have spent two years successfully working on solutions for paperless production. The results go beyond instructions for operating machines on iPads. Thus, the new comprehensive solution calls for an innovative IT infrastructure that, linked to the production process, can respond to the latest consumer needs.







# MACHINE AS A SERVICE (MAAS)

According to the Fraunhofer Project Center, analytics in production and Digital Twins enable new business models – with an extended scope or a consistently sustainable orientation. Of course, this requires transforming the current production processes. Moreover, if companies are willing not only to rethink their production but also their financing principles, subscription models could be the next big step: Companies such as MAN, Siemens, Philipps, Caterpillar and Saint Gobain have already implemented the subscription instead of purchase trend. More and more companies simply want to use machines and tools; access to such a service is more important than the acquisition. For many companies, this is a question of availability, flexibility, variety of options, and sustainability.

The increasing digitalisation of processes and products raise great hopes among manufacturing companies in the form of the resulting value creation potential. Due to the mounting possibilities of digitization, special potential is possible in the reinterpretation of industrial subscription models possible. Traditional distribution models have resulted in significant overproduction and waste – and associated costs for manufacturers and customers. Subscriptions could avoid this. Subscription models offer increased performance and aligned interests of manufacturer and customer. Furthermore, machine users enjoy benefits, including: enhanced dynamics linked to productivity and quality, comprehensive maintenance and repair services, cost transparency and lower usage costs as well as simplified re-procurement.

“Subscription models have not yet become established,” explains Michael Peschl. “But the advantages are obvious. We have to create trust and acceptance. That’s exactly what we’ve started to do with RECLAIM.” Now Peschl and his colleagues demand adjusted European tax depreciation options to support subscription approaches that facilitate the circular economy.

However, the RECLAIM project has successfully drawn on the idea on refurbishment and remanufacturing based on big data analytics, machine learning, predictive analytics, and optimization models using deep learning techniques and digital twin models. Stakeholders were able to make informed decisions about whether to remanufacture, upgrade, or repair heavy machinery that is nearing the end of its life cycle.

“Harms & Wende could substantially improve the welding technology within the RECLAIM project,” says Peschl before proudly presenting the results. “So far, we’ve reduced incidents by 50 %, reduced maintenance costs by 50 % as well, and extended the service life of our systems by eight years.” As soon as the RECLAIM project partners implement the knowledge gained and the fundamental findings on the design requirements of the circular economy, further improvements are very likely in the very near future. ■



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**IT ALL COMES DOWN TO THE  
RIGHT TERM.  
NOT EVERY LIFE-SUPPORTING  
MEASURE OF A MACHINE  
MAKES SENSE.”**

**Nikolaos Kolokas**, Research Associate CERTH

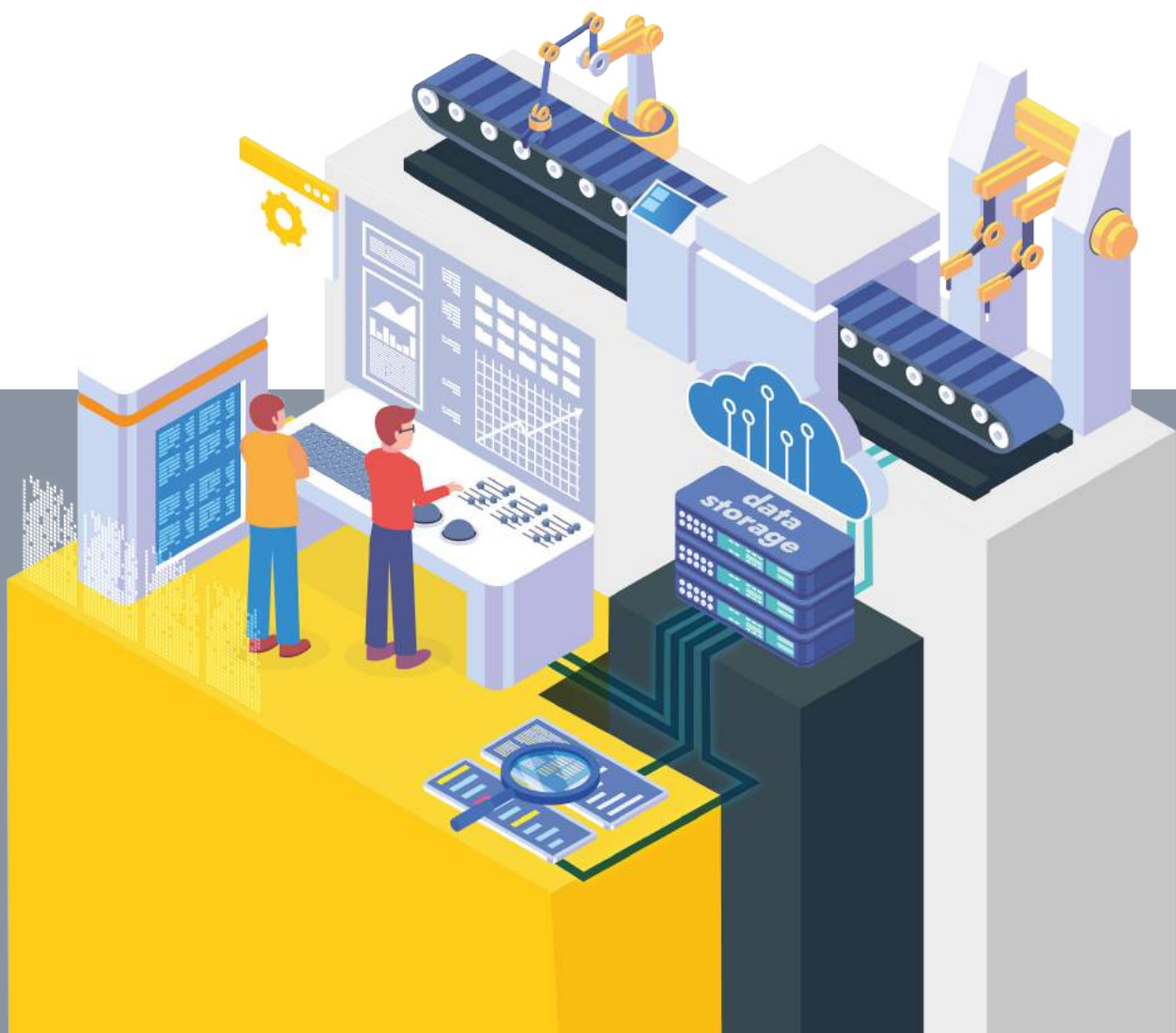
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ASTON U, UPORTO



# DECISION SUPPORT FRAMEWORK

## FOR EFFICIENT LIFETIME EXTENSION OF INDUSTRIAL EQUIPMENT

This flexible Decision Support Framework is used for planning the recovery of industrial equipment during its life cycle. It proposes a timetable for optimal retrofitting for relevant machines and components, taking into account the economic, environmental, and quality effects of extending the lifetime of machinery, the return on investment by avoiding the cost of replacing machinery, and the efficiency of materials and resources. It is based on the analysis of heterogeneous real-time industrial data, both raw and processed by sub-services (past downtime, degradation levels, failure probabilities, production efficiency), while considering manually defined specifications (failure metrics, cost elements, etc.).



# DECISION SUPPORT FRAMEWORK FOR OPTIMAL LIFETIME EXTENSION STRATEGIES IN MANUFACTURING (E.G. REFURBISHING, REMANUFACTURING), (DSF CORE + SERVICES) BASED ON ANALYTICS OF HETEROGENOUS REALTIME INDUSTRIAL DATA, BOTH RAW AND PROCESSED BY SUBSERVICES.

## INNOVATIVE ASPECT

Health-based recovery planning at both machine and component level while considering economic and environmental effects flexible recovery decision support framework (DSF) to assist the machinery operators and machinery manufacturers in making efficient end-of-life decisions at different service-life periods.

## TARGET AND MARKET SIZE

Manufacturers / producers of parts. The clinical decision support systems market size was valued at USD 4.48 billion (=> 4483 Million €) in 2021 and is estimated to expand at a compound annual growth rate (CAGR) of 10.4% from 2022 to 2030. source: grandviewresearch: clinical decision support system market.

## BENEFITS

Machinery lifetime extension, return on investment by avoiding machinery replacement cost, material & resource efficiency.

## PRICE

To be decided for each sub-service separately by the respective owner. For the DSF Core the royalty price will be agreed, starting from 2000€ for non-academic license, whereas academic licenses may be available even for free.

## REQUIRED INVESTMENT/ FUNDING

Further training of models by data scientists on the customer side. Final integrations among software and hardware components is required. Marketing/advertisement.

## COMPETITORS

Other research institutions, but no particular ones known as of now.

## TECHNOLOGICAL READINESS LEVEL

7

## TIME TO MARKET

1-2 YEARS

✓ +2 YEARS

+5 YEARS

+10 YEARS





**A PILOT LINE IN WHICH THE DECISION SUPPORT FRAMEWORK IS INTEGRATED IS ZORLUTEKS TEXTILE MANUFACTURER. FROM THE SIMULATIONS IT HAS BEEN CONCLUDED THAT THE FAST AND ECONOMIC PREVENTIVE MAINTENANCE STRATEGIES, WHICH USUALLY MAY HAPPEN IN PARALLEL TO PRODUCTION, CONSIDERABLY HELP TO IMPROVE THE KEY PERFORMANCE INDICATORS OF THE INDUSTRY, SINCE THEY PREVENT NUMEROUS FAILURES AND THEIR RESPECTIVE BAD CONSEQUENCES. THE TRAINED MODELS WILL BE RUNNING ALSO AUTOMATICALLY AND PERIODICALLY TO PRODUCE REAL-TIME RECOMMENDATIONS BASED ON THE REAL-TIME CONDITION OF THE PRODUCTION LINE, EXPRESSED BY PILOT DATA AND REAL-TIME OUTPUT OF THE VARIOUS ALGORITHMS OF THE SYSTEM.**





BY BJORN LOHMANN

# REJUVENATION CURE FOR OLD PRODUCTION EQUIPMENT

**‘REPAIR CAFÉS’ ARE ON THE RISE AS A WAY TO REPAIR OLD THINGS INSTEAD OF REPLACING THEM. THIS IS SUSTAINABLE AND SAVES MONEY. THE SAME DEVELOPMENT IS TAKING PLACE IN INDUSTRY: IF WE SUCCEED IN MAXIMISING THE LIFESPAN OF MANUFACTURING EQUIPMENT, THE ENVIRONMENT AND COMPANIES WILL BENEFIT EQUALLY.**

Until a few years ago, anyone who found their home appliances no longer working were faced with only one option; buying a replacement. However for more than a decade the repair café movement has helped people repair their old machines by working with expert volunteers. This saves people money and feeds into the idea of a circular economy in which raw materials can be reused repeatedly.

It’s a concept that offers hope for Europe’s manufacturing industry, where many large production plants are approaching their natural end of life. Replacing the old equipment too early is an unnecessary expense, while replacing it too late would result in production losses and chaos. Ecologically and economically, it would make the most sense to optimally use or even extend the service life of a machine.





## OLD MACHINES WITH NEW STRENGTHS

Solving this can be achieved through a combination of sensor technology, data sets and digital tools that provide an informed decision-making framework explains Melanie Gralow from the Steinbeis Europa Zentrum, an organisation for innovation consulting and research funding based in Karlsruhe, Germany. To do this, she says, one analyses what the current running times of a plant are, what faults occur, and what risk components exist. "Based on that, you can then make predictions and extend the time a machine is in operation."

Algorithms and programmes to make predictions about the remaining life of machines to extend their life expectancy and to modernise the plants are being developed by experts in the EU research programme RECLAIM, for example. First, those involved in the project look at specific use cases. However, the solutions for this must be designed flexibly so they can be transferred to other industries and other production systems. "The parameters used have a certain degree of flexibility - i.e. which parameters are used or from which parameters values are read in," Gralow describes. In addition, new standards could emerge from projects like RECLAIM and facilitate broad applicability as industry standards.

## TECHNICAL SOLUTIONS OFTEN ALREADY EXIST

Fundamental questions need to be clarified such as how sensor technology and data acquisition can be combined to monitor the machines in real time, and how software and algorithms can then access and evaluate this data. Another is what role can machine learning and 'digital twins' (a complete software model of the physical plant) play. Only when these steps are clear can the optimisation of the respective plant begin.

Often, no new technical methods need to be developed for this. "We see that the market is lagging behind what is possible," says Jesus De La Quintana of Tecnalia, an applied research centre in the Basque Country, Spain. One task, he says, is to inform potential customers about such solutions and to demonstrate the possibilities. Companies today often don't even think about making an old plant fit for a second life instead of replacing it. "We're not talking about an evolution here, but a revolution," he says.

But technology is not everything. Often, employees with many years of experience know the tricks of the trade to keep an old production line running as smoothly as possible and with the best quality. When these experts leave a company, one machine or another can quickly become unusable. "So sustainability and efficiency don't just mean digitalisation. They also mean storing knowledge digitally," De La Quintana emphasises.



## ARE MACHINES AS A SERVICE THE ANSWER?

Taking this approach further, a new business model emerges: 'machines as a service' where production facilities lease their machines to customers. The Hamburg-based company Harms & Wende has gained some early experience with this. The company produces friction welding machines and, in the course of the RECLAIM project, has also started to lease its products, including maintenance. Maximising the service life of the equipment has thus become an integral part of the revenue model.

On the hardware side, Harms & Wende has redesigned the machines so that they can be used in a modular and scalable way. Online sensors monitor the condition of the system and give an early warning if potential problems are on the horizon. A special interface enables maintenance personnel to interact with the system conveniently, even via remote maintenance. The provider can even import software updates so that machines that have been in operation for a long time can also participate in technical developments. The new business model has already found its first customer. If all developments go as hoped, Harms & Wende expects to halve operating costs and extend the life of the plant by eight years.

De La Quintana sees great potential in this model: "Things often change very suddenly, and that can make it risky for a company to spend money on big equipment." Leased manufacturing machines would therefore make it easier to venture into a business field. It also increases the likelihood that rental companies will design their machines in such a way that they can be adapted to technological developments. Those who only sell equipment, on the other hand, might appreciate it when it becomes obsolete and the customer has to buy a new modern machine.





## SUCCESSFUL CASE STUDIES AS A STARTING POINT

Friction welding will certainly not be the only business area in which increased attention will be paid in future to the use of durable machines and the extension of the service life of existing equipment. The EU project alone has already produced four more case studies, from wood processing to shoe manufacturing. "The variety of possible applications in industry is promising," says Gralow. The case studies so far, she says, are just the core to start with specific examples. "That's when you first notice what challenges you encounter and where the limits of the technology are." Thanks to the successfully overcome challenges of the case studies, she is optimistic: "The approach can definitely be transferred to other sectors in the manufacturing industry."

■





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THE HEALTH CONDITION OF A  
LARGE INDUSTRIAL MACHINE  
CAN HARDLY BE SEEN FROM  
THE OUTSIDE.  
DIGITAL MONITORING IS  
WORTH ITS WEIGHT IN GOLD.”

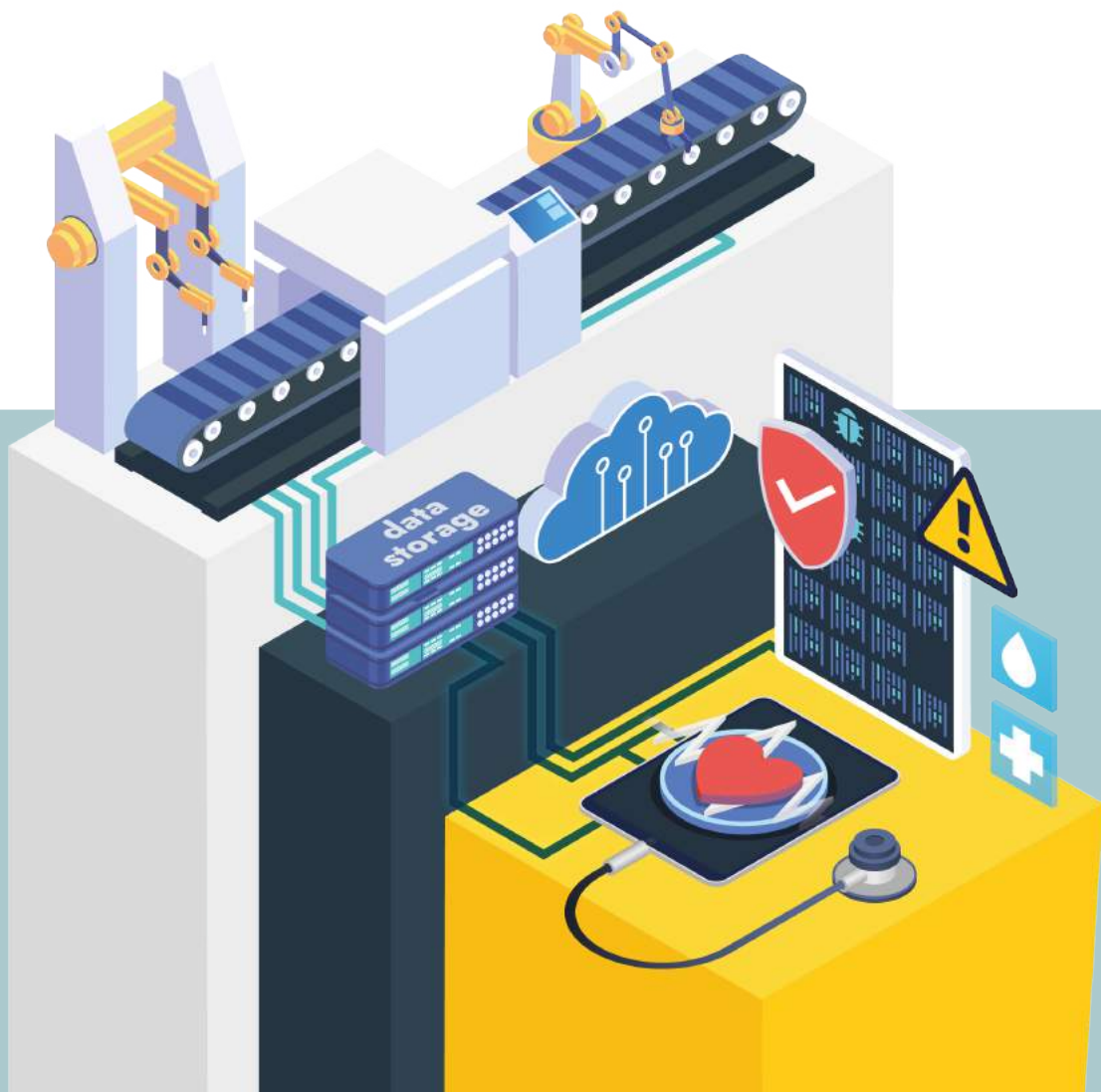
Dietmar Zettel, Development Manager HWH



# INTELLIGENT HEALTH MANAGEMENT PREDICTION TOOLKIT

## FOR MANUFACTURING MACHINES

Everyone knows about a well - functioning health system for people. But one for industrial machines? This is exactly what we are talking about when we talk about the INTELLIGENT HEALTH MANAGEMENT PREDICTION TOOL - KIT. A digital solution consisting of hardware devices like sensors and a newly developed software solution. These two components make it possible to generate valuable data about the condition and functioning of the corresponding machine. The information generated provides information about necessary adjustments or other value - preserving maintenance measures. This not only enables error - free and more efficient production, but also leads to a very sustainable use of the machine.



**A TOOL-BOX COMBINATION OF SENSORS AND INTELLIGENCE THAT CAN BE EASILY TAILORED TO THE SPECIFIC CASE AND CUSTOMER, AND THEN WILL ENGINEER THE COLLECTED DATA FROM MACHINES (CURRENTLY FRICTION WELDING MACHINES) TO PROVIDE AT LEAST THREE OUTPUTS:**

- Understanding the performance and use of the actual machine so customer complaints could be quickly responded and solved.
- Adding value to customer providing feedback for better performance and predictive maintenance.
- Diagnose the machine prior to a cost-effective refurbishment to be put again in the market for a new customer, and extend its life span.

### INNOVATIVE ASPECT

Novel business model for manufacturing machines (Performance oriented feedback and service to the customer), baseline for maintenance planning, based on health diagnosis and prediction of sensor-retrieved data from the machine directly. Opportunity for machine leasing as part of the business model.

### TARGET AND MARKET SIZE

Medium and large production companies (e.g. white goods, automotive sector (Tier1 suppliers, OEM manufacturers))  
Approx. 5-10 Mio. €, including new and update of legacy machines.

### BENEFITS

15-20 % reduction of breakdown time.  
Production efficiency (due to optimised maintenance) and reduction of cost per part.

### COMPETITORS

None known in same domain, simple dashboards for process monitoring available, but not to the extent of the developed toolkit.

### PRICE

10.000€–15.000€ per Licence/machine

### TECHNOLOGICAL READINESS LEVEL

7

### TIME TO MARKET



**1-2 YEARS**

**+2 YEARS**

**+5 YEARS**

**+10 YEARS**



THE KER IS INTEGRATED IN THE HWH PILOT WHICH REPRESENTS A FRICTION WELDING MACHINE. THE MACHINE WAS USED BY A CUSTOMER TO WELD COMPONENTS OF THE AIRCRAFT'S TURBINE ENGINE AND WAS IN OPERATION FOR A PERIOD OF 10 YEARS. THIS MACHINE DOES NOT MEET TODAY'S REQUIREMENTS E.G., ADAPTABILITY TO DIFFERENT WELDING TASKS, INCREASED CYCLE TIMES, OPERATOR GUIDANCE BY HMI, SAFETY, QUALITY CONTROL, DEGREE OF AUTOMATISATION, ETC. TO GET THE MACHINE OPERATIONAL AGAIN AND TO ENABLE IT FOR PREDICTIVE MAINTENANCE IT REQUIRES REMANUFACTURING AND UPGRADING AS WELL AS EQUIPMENT STATE AND CONDITION MONITORING.



# STRATEGIES FOR SEAMLESS ADAPTATION OF PEOPLE AND MACHINES

**THE EMERGENCE OF INDUSTRY 4.0 MARKS A SIGNIFICANT SHIFT AS BUSINESSES SEAMLESSLY INTEGRATE INTERNET OF THINGS (IOT), MACHINE LEARNING, AND EXTENDED REALITY (XR) INTO THEIR OPERATIONAL LANDSCAPE. THIS TECHNOLOGICAL CONVERGENCE IS RESHAPING INDUSTRIES, ENABLING A NEW ERA OF EFFICIENCY, PRODUCTIVITY, AND INNOVATION.**

As the wave of Industry 4.0 gains momentum across Europe, both people and machines are learning to adapt, and there are some early lessons that can help these businesses make the most of this digital transformation.

As companies adopt Industry 4.0 technologies for their processes to increase their efficiency and competitiveness, business leaders may feel lost on how to best ensure success.

Fortunately some strategies are already emerging that companies can implement for employees, single machines, or even for entire manufacturing lines.



# REFURBISHMENT VS REMANUFACTURING

Gone already is the idea that adopting Industry 4.0 means throwing old equipment away. Existing industrial equipment can be used by adding new technologies such as smart robotic and sensing systems, including IoT, digital twins and Extended Reality (XR) applications.

This opens two opportunities for businesses; they can either refurbish their machines, or create new 'remanufacturing' possibilities. For Dr Michael Peschl, Head of Research and Development at the German company Harms & Wende GmbH & Co. KG,

"Refurbishment means restoring an old product and bringing it up to date, in order to maintain reliability or extend service life, while remanufacturing targets on using parts of discarded products in a new product with the same function."

Part of his work involves coordinating an EU-funded project called RECLAIM, which is developing strategies to refurbish and remanufacture this industrial equipment. These strategies include digital analytics, the Internet of Things (IoT) and circular economy strategies. The project wants these strategies to help businesses predict possible machine failures, create optimisation plans, and create cost models.

Since 2019 the four-year project has also worked with leading manufacturers to demonstrate these strategies. For example, the project worked with the Slovenian appliance manufacturer gorenje to modernise and refurbish their white enameling line. They expect this to reduce emission bs by 10%, decrease maintenance costs by 30%, and increase their machines' lifetime by 15 years.

Dr Peschl says that alongside using physical and statistical methods to monitor machines as a whole, businesses should also make sure there's enough data generated to monitor their components and processes. In other words, equipment needs sensors, IoT networks and algorithms to be re-used successfully. Once these components are in place, it's then crucial to have a clear vision on the goal of equipment re-use. Based on the target, a proper method then needs to be derived.

The interfacing of legacy equipment is also a major challenge. They often lack a proper interface for data collection. Even if there are standards existing such as OPC UA, MQTT or others, legacy equipment often cannot deal with them explains Peschl:

"In such cases, interfaces need to be implemented without influencing the functionality of the component negatively."

Fortunately some solutions exist for this such as the Asset Administration Shell, he says. This is the digital representation of an asset (such as a machine), consisting of submodels that contain all the information and functions of that asset.







## EMPOWERING THE WORKFORCE

Another challenge lies with the mindset of workers, operators and other responsible people in manufacturing. "It is important to develop an Industry 4.0 strategy keeping them in the loop," said Peschl.

An example of this can be seen in the Greece-based Teaching Factory Competence Center, which offers consulting, training and technical services to help companies upgrade and expand their business activities.

For Konstantina Salagianni from the Teaching Factory,

"Training and upskilling of personnel is one of the most important factors that affects the adaptation to advanced technologies."

Companies that want to incorporate or extend the digitalisation concept, can promote the training of employees so as to familiarise them with the advanced technologies and acquire the necessary skills and competences. By fostering training, employees are more confident in handling advanced equipment, as well as more creative, identifying potential applications of Industry 4.0 technologies in their workplace.

This can involve integrating collaborative and mobile robots with sensory systems and virtual/augmented reality (XR) set-ups to help operators perform tasks, while ensuring workplace safety.

Dr Makris is project coordinator of the University of Patras in Greece and also the head of Robotics, Automation and Virtual Reality, at the university's Laboratory for Manufacturing Systems and Automation (LMS). According to him, "Virtual reality applications may represent the industrial environment in a virtual one, with

true-to-scale objects and interactions similar to the real world."

For example, machinery operators can practice on new procedures and engineers can evaluate the different workplace layout designs for performance and ergonomics, he explains.

"A management decision on the introduction of Industry 4.0 technology can only be successfully implemented when the people responsible for the operation of machines and manufacturing lines are convinced of the technology and are familiar with the targets of the strategy."

In this area the MASTER project aims to improve the XR ecosystem for training robotics in manufacturing, by providing an open XR platform, accompanied with high quality training material.

The project's XR platform means that people can safely and effectively teach and learn how to work in Industry 4.0. For example, the platform can allow non-experts and non-programmers to remotely program industrial robots, explore real time visualisation of safety zones and robot behaviour information and warning notifications, and learn how to use 'gaze-based' interactions (interacting with XR objects as indicated by the user's eyes).

"The platform integrates key functionalities like creating safe robotic environments, programming flexible robotic applications, including advanced interaction mechanisms based on eye tracking. Focusing on the upskilling of people that are going to work along with these new technologies, companies promote the development of favorable conditions, ensuring a seamless transition to the Industry 4.0 era."



## BUILDING BRIDGES OF TRUST

Beyond machines and technology, companies have to confront the human factor; acceptance of cutting edge technologies by their operators, engineers, and managers.

Reluctance to embrace these innovations over traditional methods is often observed, and the lack of skills and knowledge, seems to be one main reason. Poorly designed systems, usually performed by people that are not experts or familiar with these technologies, lead to difficulties in adaptation to Industry 4.0, consuming resources and affecting productivity.

Salagianni says that the Teaching Factory saw firsthand that the first step to transforming existing industries is bridging the gap between academia and industry.

“Enabling the knowledge sharing between industrial companies and researchers, upskilling the employees, and exploiting research results through industrial pilots will lead to creating added value to products and services of manufacturing companies.”

Companies may also ask for consultancy by technology experts, aiming to create a complete and wisely designed plan of transitioning to Industry 4.0, facilitating a seamless transformation says Peschl: “It is wise to work with consultants or with partners who are already familiar with Industry 4.0. Also, research projects on national or European level are a good opportunity to get in touch with I4.0 technology and with potential partners.”

Raising awareness among employees of different hierarchy levels, and familiarizing them with the advanced technologies, are some of the first steps for successful integration of Industry 4.0 technologies, adds Salagianni: “In the context of operational excellence, managers may create favorable conditions and motivate employees, facilitating training and workshops, towards continuous improvement and upskilling. Additionally, they may actively participate in technology-related events, getting informed about the state of the art technologies and the potential applications that may fit to their needs.”

Enriching the broader ecosystem, companies can actively engage in research endeavors, positioning themselves as pioneers in the adoption and experimentation of cutting-edge technologies. By spearheading industrial pilots for futuristic innovations, they assume the role of early testers and integrators. Furthermore, these companies assume the pivotal responsibility of fostering seamless communication channels between academia and industry. In doing so, they emerge as vital architects, shaping a future for the manufacturing industry that is both productive and sustainable. ■







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**DIGITAL PREDICTIONS ALLOW  
MACHINES TO BE MAINTAINED  
MORE EFFICIENTLY AND  
MAINTENANCE CAN EVEN BE  
PLANNED.”**

**George Bogdos**, Co-Founder FINT

Other Partner: ADV, TECNALIA, CTCR

# LEGACY MACHINE BOOSTER

The Legacy machine booster, which consists of an adaptive network of sensors and close-to-machine intelligence and is capable of digitising old/legacy machinery while keeping knowledge and expertise of artisans in-house, radically improves production related to economic, environmental, quality, and social aspects by enhancing the diagnostics of the machines sensing intelligence through actual digital retrofitting.





**THE LEGACY MACHINE BOOSTER IS A COMBINATION OF ADAPTIVE SMART SENSORIAL NETWORK (HARDWARE) AND REAL TIME SITUATION MONITORING. ADDING SENSING CAPABILITIES TO HIGHLY SPECIALISED MACHINE EQUIPMENT AND TAILOR THE MONITORING TO THOSE MACHINES IN ORDER TO ACHIEVE LIFETIME EXTENSION.**

### INNOVATIVE ASPECT

Combination of adaptive smart sensorial network (hardware), real time situation monitoring.  
Adding sensing capabilities to highly specialised machine equipment and tailor the monitoring to those machines in order to achieve lifetime extension.

### TARGET AND MARKET SIZE

The customers can be the various industry players, which want to upgrade/enhance/modernise their production line. In particular factories with similar machinery to the pilots of the RECLAIM project. It is a market that is still growing. Including the maintenance contracts it can reach tens of millions.

### BENEFITS

15-20 % reduction of breakdown time. Production efficiency (due to optimised maintenance) and reduction of cost per part.

### PRICE

Price will comprise both consultancy services (analysed initial scenario and propose retrofitting actions) and implementation of new devices + cloud services—price will then include an initial fee for the consultancy and a license for the cloud-based service.

### REQUIRED INVESTMENT/ FUNDING

Marketing, stocking. The value is something negotiable, if starting really small it can range between 50k to 100k.

### COMPETITORS

Both SMEs and large multinational companies.

### TECHNOLOGICAL READINESS LEVEL

7

### TIME TO MARKET



1-2 YEARS

+2 YEARS

+5 YEARS

+10 YEARS



**THE SO-CALLED LEGACY MACHINE BOOSTER WITH THE DIGITAL RETROFITTING SOLUTION WAS USED, AMONG OTHERS, AT OUR SPANISH DEMO SITE PARTNER FLUCHOS IN ARNEDEO. THE SHOE MANUFACTURER'S SOLE AND HEEL GLUER IS AN OLDER MACHINE THAT PREVIOUSLY DID NOT PRODUCE ANY DIGITAL DATA ABOUT THE MACHINE'S CONDITION. THANKS TO THE IMPLEMENTATION, FAULTS AND THE NEED FOR MAINTENANCE CAN NOW BE DETECTED AT AN EARLY STAGE AND THE SERVICE LIFE OF THE SPECIAL PRODUCTION CAN BE SIGNIFICANTLY EXTENDED.**





BY KHATIA SHAMANAUNI

# WHY OBSOLETE MACHINES CAN NO LONGER LEAD TO PRODUCTION LOSSES

**EVERYTHING HAS ITS OWN LIFE CYCLE, FROM BIRTH TO DEATH. SO DO MACHINES. WHEN THEY REACH THE END OF THEIR DESIGNED LIFE, THEY SHOULD BE REPLACED. BUT SOME COMPANIES PROVED THAT OUTDATED EQUIPMENT COULD START A BRAND-NEW LIFE CYCLE AND PERFORM EVEN BETTER.**

It may sound unrealistic to many that out-of-date machinery in factories can be refurbished and brought back to life without the need to replace it with expensive modern equipment.

It's widely believed that almost every factory loses between 5% and 20% of their productivity due to downtime, resulting in losses of millions of Euros. And this happens when obsolete machines can save resources and prevent significant production losses after upgrading.

"To be honest, it sounded unbelievable that after refurbishing old machines, we would be able to save money," says Asia Savino, executive assistant at Podium – a high-end wooden kitchen producer in Switzerland. She recalls the time when she first heard about the refurbishment. "Today, I realise that it's possible and we made it," she says. Once unthinkable has become reality for Gorenje too, manufacturer of high quality domestic

appliances. Majda Meza from R&D Gorenje, describes the refurbishment process of robot cells in dishwasher production as a great opportunity that came at just the right time. "We are able to renew the most critical equipment, reduce maintenance costs and increase effectiveness," Meza says.

Outdated machines represent an acute problem for companies. In most cases, they not only consume much more energy, but machine failures also cost more time and materials. Replacing them might be even more challenging. Modern industrial equipment often requires huge financial investments.

Refurbishment has become a cost-effective solution for some businesses. RECLAIM, a European Union-funded project, offers an opportunity to restore old industrial equipment, improve efficiency, and lower costs and carbon footprints.



## PREVIOUSLY UNIMAGINABLE, IT IS NOW REAL

Podium is among those companies that are in the final stages of refurbishing their equipment. For example, the wooden kitchen manufacturer purchased a drilling machine in 2005. But after 17 years and more complex requests from customers the machine's poor performance became a concern for the company. Refurbishment allowed them to both maintain the old machine and improve it significantly.

"The machine has been improved in two ways: the first is a mechanical component - previously, the process was manually carried out, now it is fully automated. For the software part, refurbishment provides us with the opportunity to connect our very old machine to unique software", says Asia Savino.

Although the refurbishment process at Podium is still underway, the company has already prevented significant production losses.

Due to a mechanical problem, the drilling machine previously couldn't deal with particularly small wooden pieces. Sometimes these pieces fell on the floor, and they had to throw them away, and create new ones. "It was a waste of materials and a waste of time too", says Asia.

Podium no longer has to deal with this kind of problem after refurbishing the machine.

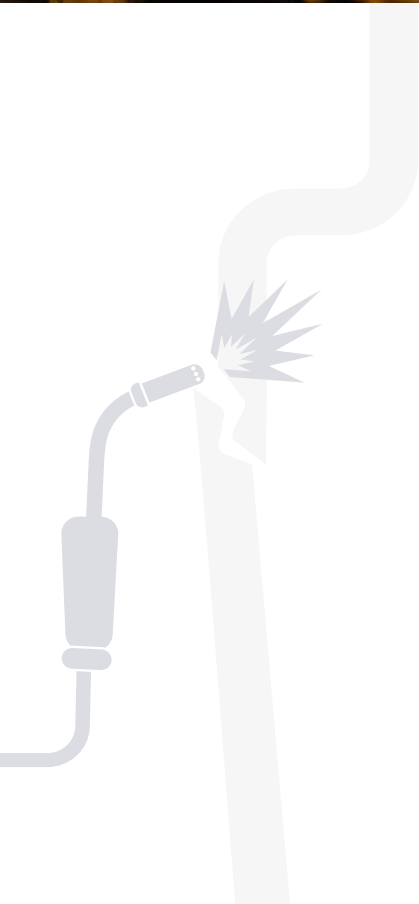
The company replaced the wheels that transport the wood pieces from the start point of the machine to the inside part where operations take place.

In addition, a guide of the machine has been modified since it was no longer adaptable. "We have adapted this guide to the new equipment so that they can be automatically inserted into the pieces instead of manual insertion", says Asia. As a result, Podium managed to increase productivity by reducing production time.

Also, if an unexpected stop was occurring and the company's operator was unable to solve the problem for any reason, it was usually necessary to bring the supplier to the factory. This person no longer has to come to the site to fix the problem. After refurbishment they can do it remotely.

"It may seem simple, but in reality, it's a huge advantage for us. We spend less money," says Asia.

Without refurbishment, Podium would have had to purchase a brand-new machine, which could cost more than half a million Euro. Whenever a company purchases a new machine, they have to train their operators and the new equipment needs technicians. All of these involve additional expenses, which have been avoided at Podium through refurbishment. →





## THE RIGHT OPPORTUNITY AT THE RIGHT MOMENT

Obsolete machinery served as a headwind for Gorenje too, a manufacturer of high-quality domestic appliances. "We were very concerned about the renewal of various equipment in our factory," says Majda Meza from Gorenje, in Slovenia.

Robotic cells are crucial to the production of dishwasher inox tubs at Gorenje dishwasher factory. But most of the equipment dates back to 1994. Some of them experienced operation failures and unexpected shutdowns as they approached the end of their designed life. Aside from that, spare parts were practically unavailable due to the machines' age.

"As a result of the RECLAIM project, robot cells equipment will be refurbished with an extended lifetime of 15 years. Furthermore, overall effectiveness will increase, with less maintenance and production costs. It will improve the product quality and reduce environmental impact", says Majda Meza.

Gorenje has already modernized and renewed most of its obsolete robots. By upgrading programmable logic controllers (PLC), data can now be monitored and collected. Additionally, spot and seam welding machines and control systems have been renewed. The welding machines and hydraulic aggregates were equipped with new sensors for predictive maintenance. Another significant improvement among many is establishing the capture and recycling of cooling water.

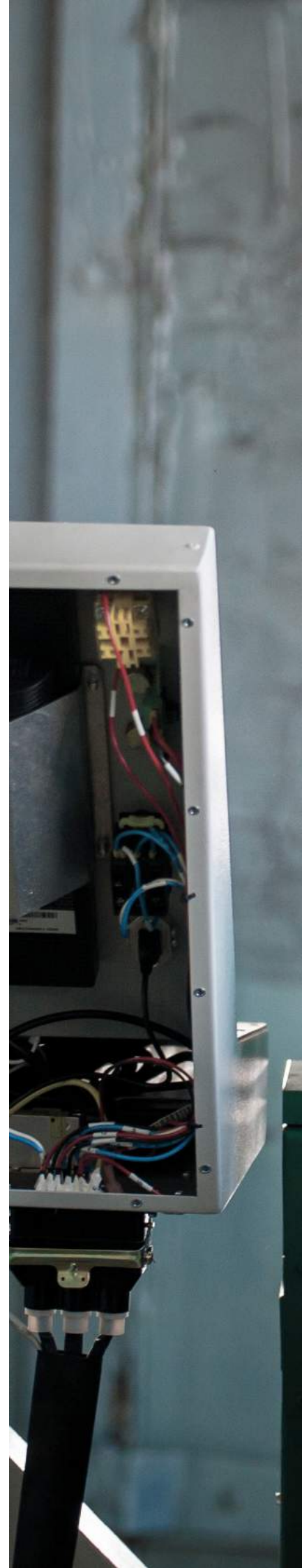
"We will be able to handle certain problems more easily because we will be able to help ourselves with data that we did not have before", says Meza.

The Gorenje production expert adds that the company releases a new generation every five years and without proper equipment it is impossible to manufacture new products and keep up with the growing demand.

"It would have been impossible for us to remain competitive in the market with such old technological equipment. The cost of downtime and the unavailability of spare parts would have become an unmanageable problem, and productivity would have dropped significantly. Even more serious problem would have been our inability to produce tubs for new projects using this type of obsolete equipment", says Meza.

At Gorenje, 80% of the refurbishment has already been completed. Without the option to upgrade, the company would likely have had to invest in a new production line for dishwasher tubs and gradually stop the existing one. "That would have required a substantial financial investment." – says Majda Meza.

Machine obsolescence in the manufacturing industry no longer means that companies should replace them with expensive new equipment. The experience of various companies shows that businesses can preserve valuable resources by refurbishing obsolete machines instead of discarding them. ■









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**TIME IS A VALUABLE  
RESOURCE.  
A MACHINE THAT DOES NOT  
RUN COSTS MONEY.”**

**Gianluca Prato**, Computer Scientists LINKS

Other Partner: UPORTO, TTS

# REPLICA DIGITAL TWIN

## RECLAIM OPTIMISATION AND SIMULATION COOPERATION IN DIGITAL TWIN FAULT DIAGNOSTICS AND MAINTENANCE STRATEGY SOFTWARE

With the REPLICA DIGITAL TWIN system it is possible to avoid the situation of standstill as far as possible. In plain language, this means that thanks to the digital copy of the physical machine, we can first simulate the maintenance work. With the digital twin, data from the original machine can be transferred by means of sensors. Through the digital evaluation, maintenance errors and other unclear interventions in the process are avoided. The downtime of the machine is reduced to a minimum.





## THE RECLAIM OPTIMISATION AND SIMULATION COOPERATION IN DIGITAL TWIN (REPLICA) IS A SYSTEM FOR MACHINERY FAULT DIAGNOSIS AND PREDICTIVE MAINTENANCE, IMPLEMENTING:

- The simulation environment integrating heterogeneous simulation tools;
- Algorithms for fault diagnosis, remaining useful life prediction, and maintenance.

### INNOVATIVE ASPECT

Combination of simulation environment and predictive maintenance.

### TARGET AND MARKET SIZE

Any industrial sector, not sector-specific.  
Market size unknown

### BENEFITS

- Performing proper maintenance planning;
- Optimising the production throughput;
- Reducing the production lines stoppages.
- Have all results in one interface—One-stop-shop —> no need for change between softwares.
- Both sensor data and simulated data can serve as an input.
- Allows change of set-up in machines.

### COMPETITORS

None known.

### TECHNOLOGICAL READINESS LEVEL

7

### TIME TO MARKET

1-2 YEARS

✓ +2 YEARS

+5 YEARS

+10 YEARS



THE MAIN APPLICATION OF OUR SOLUTION TOOK PLACE IN CADENAZZO, SWITZERLAND, AT THE DEMO SITE PARTNER PODIUM. HERE, THE SOLUTION WAS INSTALLED ON ONE OF THE LARGEST MACHINES, THE SO-CALLED GLUING MACHINE. SENSORS MEASURED THE AMOUNT OF GLUE OR TEMPERATURES, AMONG OTHER THINGS.





“

**THE MANUAL EVALUATION  
OF DIFFERENT DATA FROM  
DIFFERENT SOURCES COSTS  
TIME AND IS PRONE TO  
ERRORS.”**

**Oscar Garcia Perales**, Operations Director ICE

# ICE KNOWLEDGE DISCOVERY

A business intelligence tool, working as a data sink (storage of data), but with extended functionalities, such as a powerful built-in GUI. Both dashboards and plotting of data can be created in numerous way, giving the user the choice of how to visualize their data. The tool offers the opportunity to link it to advanced calculations/algorithms e.g. Machine Learning that are performed on top of the data stored. It also provides the means, with the help of the customer, to connect several types of data pipelines directly from sensors, machines or databases.





**A BUSINESS INTELLIGENCE TOOL, WORKING AS A DATASINK (STORAGE OF DATA), BUT WITH EXTENDED FUNCTIONALITIES: IN-BUILT GUI. CREATION OF DASHBOARDS, PLOTTING OF DATA. GIVING THE USER THE CHOICE OF HOW TO VISUALISE THE DATA. OFFERS OPPORTUNITY TO LINK IT TO ADVANCED CALCULATIONS/ALGORITHMS E.G. MACHINE LEARNING.**

### **BENEFITS**

- Decision-making support (Significant help to decision-makers).
- Helps to understand data and underlying patterns.
- Compared to QLIK Sense (competing software): Visualisation and possible performance differences in automated pattern detection.

### **TARGET AND MARKET SIZE**

Any company producing vast amounts of data. Not sector-specific, can be used by any company. Can be further tailored to specific sectors if needed. Both applicable to large and small enterprises. (B2B mainly) Business Intelligence Tools Market: market size unknown. To be checked.

### **INNOVATIVE ASPECT**

Automated pattern discovery (of input data) and visual representation in multiple ways, without «telling the tool what to look for».

### **PRICE**

Similar price to competitor. Unique advantage in terms of performance targeted.

### **REQUIRED INVESTMENT/ FUNDING**

No further investments foreseen, other than market research/expenditures

### **COMPETITORS**

QLIK (company) QLIK\_Sense (Software), biggest competitor.

### **TECHNOLOGICAL READINESS LEVEL**

6

### **TIME TO MARKET**



**1-2 YEARS**

**+2 YEARS**

**+5 YEARS**

**+10 YEARS**



**WISH TO MAKE THE MOST OF THEIR DATA BUT STRUGGLE WITH EXTRACTING THE MOST RELEVANT INFORMATION FOR DECISION MAKING. ICE KNOWLEDGE DISCO VERY HAS HELPED IN CHARACTERISING THE DIFFERENT MACHINES VIA SENSORS AND MANUFACTURING INDICATORS.**



# THE INTEGRATION

## WHICH SOLUTION IN WHICH DEMO SITE?

After more than 3.5 years of research, development, implementation, and testing, almost all the planned applications have been implemented and are already being used by the 5 industrial partners. The following matrix should give you an overview of which digital solution is used by which industry partner.

Despite the various unexpected challenges, such as the COVID pandemic, the result clearly shows that the planned scaling and diversity of the developed applications could already be adapted to the different requirements in the project phase. The aim is to continue scaling the already developed and tested solutions after the end of the European funding in order to make them accessible to as many industrial sectors as possible.

### IMPLEMENTED DIGITAL SOLUTIONS

#### FRICION WELDING | HARMS & WENDE

**DECISION SUPPORT FRAMEWORK  
(DSF) FOR OPTIMAL LIFETIME-  
EXTENSION STRATEGIES**

**DIGITAL RETROFITTING  
INFRASTRUCTURE**

**DRYICE DATABASE AND  
ANALYTICS**

**GATEWAY FOR DATA  
COMMUNICATION**

**AR GLASSES FOR IN-SITU  
REPAIR**

**PROGNOSTIC AND HEALTH  
MANAGEMENT TOOLKIT**

#### WHITE GOODS MANUFACTURER | GORENJE GROUP

**TEMPERATURE AND HUMIDITY  
SENSORS**

**HW AND SW UPGRADE OF  
THE ROBOTS**

**THE RELIABILITY MODEL  
OF ROBOTIC CELL A**

**PREDICTIVE MAINTENANCE  
ALGORITHMS**

**CAMERA VISION SYSTEM**

**DEGRADATION MODEL  
DEVELOPMENT**

**TEXTILE MANUFACTURER | ZORLUTEKS**

**DECISION SUPPORT FRAMEWORK  
(DSF) FOR OPTIMAL LIFETIME-  
EXTENSION STRATEGIES**

**IN-SITU REPAIR DATA ANALYTICS  
FOR SITUATIONAL AWARENESS**

**FAULT DIAGNOSIS AND  
PREDICTIVE MAINTENANCE  
SIMULATION ENGINE USING  
DIGITAL TWIN**

**ADAPTIVE SMART SENSORIAL  
NETWORK AND DIGITAL  
RETROFITTING INFRASTRUCTURE**

**PROGNOSTIC AND HEALTH  
MANAGEMENT TOOLKIT**

**COST MODELLING AND FINANCIAL  
ANALYSIS TOOLKIT**

**FOOTWEAR MANUFACTURER | FLUCHOS**

**REAL-TIME-PROCESS/  
ELECTRICITY**

**DYNAMIC BAYES MODEL  
(HIDDEN MARKOV MODEL)**

**ANOMALY DETECTION**

**MACHINERY OP. PROFILING**

**AUGMENTED REALITY**

**DRYICE**

**WOODWORKING MANUFACTURER | PODIUM**

**DIGITAL TWIN MODEL**

**DEGRADATION MODEL**

**GATEWAY AND OPC-UA**

**FAULT DIAGNOSIS**

**SMART CAMERA FOR  
DETECTION OF WOOD TILES**



## OUR PARTNERS

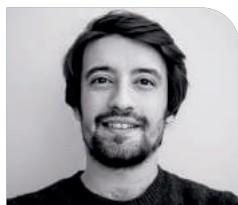
We are very pleased about your interest in the RECLAIM project and the extraordinary developments and technical solutions that have arisen through the excellent cooperation and collaboration of all the partners involved.

As the coordinator, I can look back on a highly successful project. Over our four - year cooperation, many events have unfolded, and numerous challenges had to be overcome. In addition to the technological advancements and pilot activities illustrated in this magazine, I would also like to highlight other successful results and activities. For instance, after numerous but invaluable meetings, we managed to document our methods and processes that led us to these solutions in a document called the 'RECLAIM standardization,' thanks to our partner UNI from Milan.

I would also like to mention the highly engaging hackathons at the University of Porto. Engineering students from Portugal engaged with the approaches and solutions of our project in three rounds and made significant contributions to the success of various developments through their input. The academic passion and dedication of Aston University should also be emphasized. Through their papers, posters, and conferences, they have disseminated the project and presented it to the public in the best possible light.

We must also recognize the support of Steinbeis Innovation for their assistance in general project management, SUPSI for their extensive efforts in machine lifecycle analysis, and finally ESCI for their excellent communication of RECLAIM activities and results to the wider public. Thanks to the professional and always cooperative support of the European Health and Digital Executive Agency, RECLAIM has successfully reached the finish line. I would like to express my gratitude to everyone who has accompanied us on this exciting and undoubtedly challenging journey over the past four years.

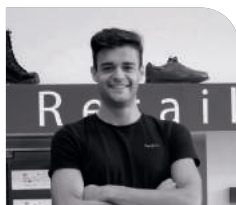
**Yours sincerely,  
Dr Michael Peschl (HWH)**



**ADRIANO FERRARO**  
UNI



**ALEXANDER  
MAISURADZE**  
HWH



**ALFONSO PASCUAL**  
CTCR



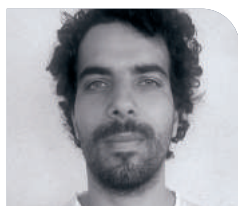
**MELANIE GRALOW**  
SEZ



**ANTONIO SAENZ**  
FLUCHOS



**CRISTINA DI MARIA**  
UNI



**ELISEU PEREIRA**  
UPORTO



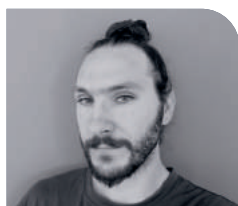
**ELENA MOCCHIO**  
UNI



**FELIX BRÜGGMANN**  
HWH



**FLORIÁN DAMIÁN**  
CTCR



**CHRYSOVALANTIS  
CHATZIMAGKAS**  
FINT



**MAËVA PRATLONG**  
SEZ



**GIL GONÇALVES**  
UPORTO



**DUŠAN MESNER**  
GORENJE



**YUCHUN XU**  
ASTON U



**GABRIEL LAZARIDIS**  
FINT



**JAVIER CORTÉS**  
CTCR



**LUCREZIA  
QUARATO**  
SCM



**NIKOLAOS  
TRIANAFILLIDIS**  
FINT



**SIMON KOTNIK**  
GORENJE



**SAÚL IÑIGUEZ**  
CTCR



**MAJDA MEŽA**  
GORENJE



**ANTONIO AVAI**  
TTS



**JESÚS DE LA  
QUINTANA**  
TECNALIA



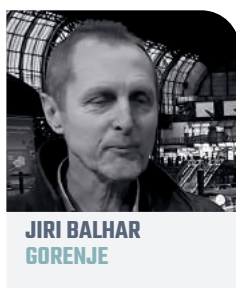
**ASIA SAVINO**  
PODIUM



**SILVIA MENATO**  
SUPSI



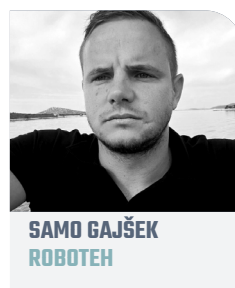
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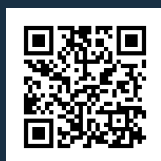
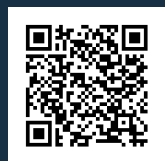
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