SMART PACKAGING HUB
your food & beverage partners

MACHINE DIGITALIZATION: FROM DIGITAL TWIN TO BLOCKCHAIN

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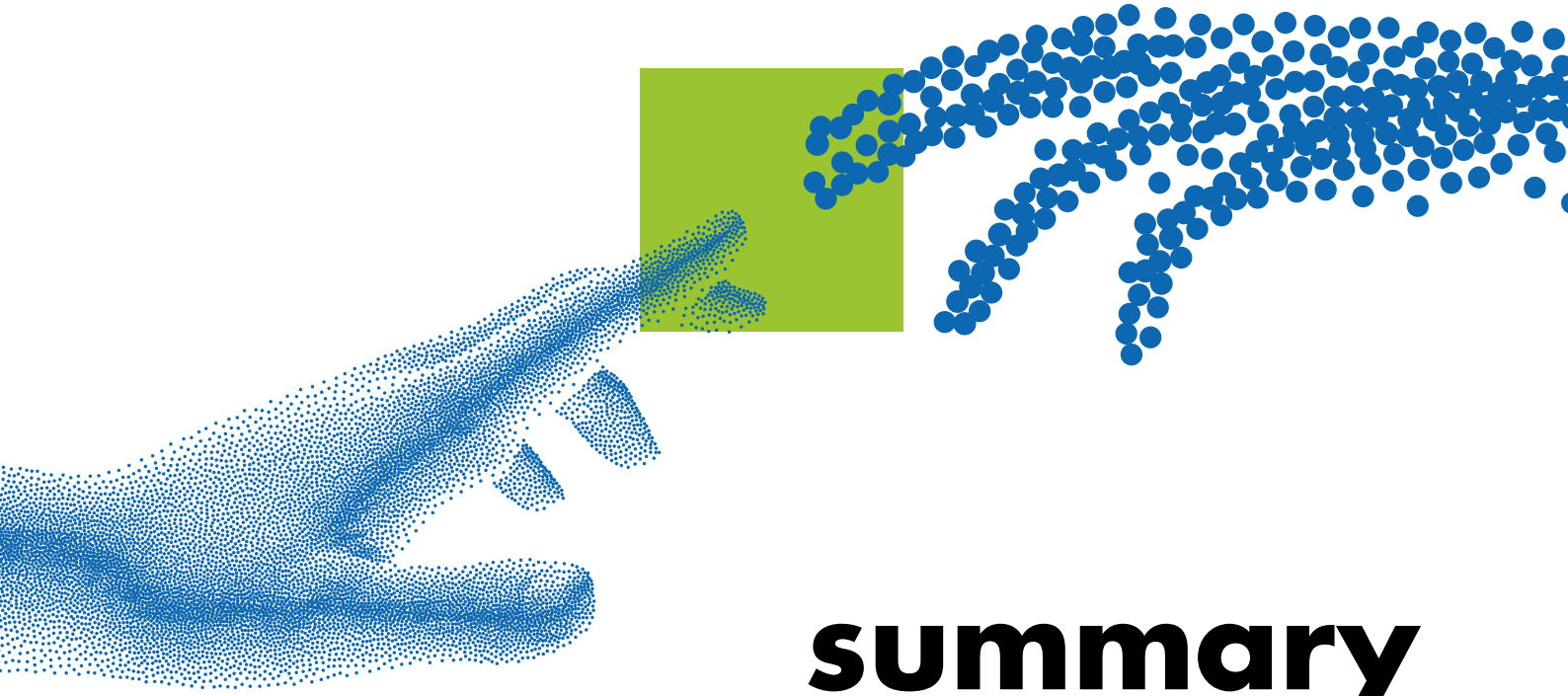
index



summary

Digitalization in the mechanical industry, also known as “4.0. Industry” is the inevitable evolution for any kind of business, when referring to interconnected machines, processes and people using new technologies.

In a 4.0 factory, data is expected to play an increasingly important role, involving crucial partnerships within real digital eco-systems.

Furthermore, boundaries between hardware, software and IT tend to be blurred in what is defined as Industrial Internet of Things (IIoT), while the expertise in planning and processing is shared in cloud.

An overview is set out below of what 4.0 Industry is, with some specific cases, issues and solutions offered by companies referred to the Smart Packaging Hub platform. The platform is a virtual meeting point where final users of food and beverage automatic packaging machines and lines can discuss with the manufacturers to find an answer to their need of production efficiency, configuration flexibility, safety and quality of products, traceability, calculation of the ROI, environmental sustainability and energy saving.

targets

HIGHLIGHTING
THE DIGITALIZATION FOOTPRINT WITHIN THE FACTORY (4.0 INDUSTRY)

ILLUSTRATING
THE MAIN FEATURES OF THE NEW INDUSTRIAL PARADIGM

INTRODUCING
THE VALUE OF THE SMART PACKAGING HUB AS A MEETING AND DISCUSSION POINT BETWEEN MACHINES

DESCRIBING
SOME SPECIFIC CASES WITH ISSUES AND SOLUTIONS, ALSO WITHIN A LONG-TERM PERSPECTIVE

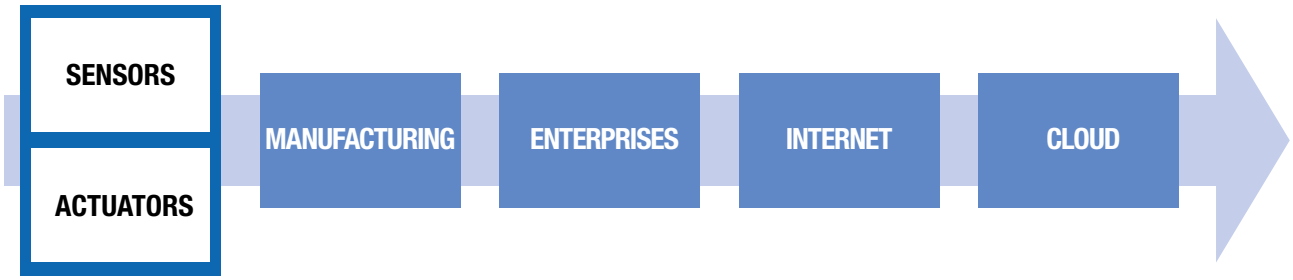
Digitalization: A One-Way-Road for Machinery Manufacturers and Users

In a factory, the connection of digital to the real world would increase the yield and create entirely new business patterns.

In particular, in the machine tool industry the digitalization pathway requires a huge amount of data collection: sensors connected with machine tools, like CNC machines, e.g., can collect data on vibrations, forces and temperature.

Data is sent to the cloud to be analysed and used to build a veritable digital twin of the actual machine or system, that is more accurate if based on a higher amount of available information. The results of tests carried out on a digital twin can, for example, help to plan machining processes, hence reducing waste and maximising efficiency and accuracy, as well as managing aimed and planned maintenance operations.

INTEGRATED CONNECTED ARCHITECTURE



Flow of data from a machine to the cloud in a fully digitized factory
(Source: FutureBridge Analysis)

A number of existing major technologies qualify the 4.0 evolution, such as the IIoT mentioned above.

They include control, planning and remote control functions of machines and production lines; advanced automation systems consisting of machines and equipment with a high adaptability, identification and interaction ability with other machines or people; the Industrial Analytics segment, that gathers all applications able to extract information from data, useful in company decision-making; and, again, wearable devices and the new man-machine interfaces (Advanced Human Machine Interface, HMI), additive manufacturing and, of course, cloud systems.

THE DIGITAL TRANSFORMATION PATHWAY OF ITALIAN COMPANIES: MARKET DATA

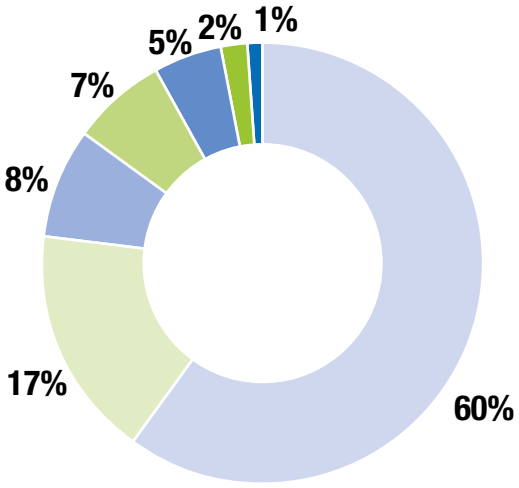
The "Engineering and digitalization of Companies' Processes" report by CNI (Italian National Council of Engineers), published in May 2023, stated that, while in Italy in 2020 investment in technologies connected with 4.0 Industry amounted to 4 billion Euro, in 2022 the amount exceeded 7 billion Euro, with a 14% increase as against 2021.

In fact, the Italian industrial system, though mainly made up of smaller businesses, is apparently ready to take up the challenge of modernisation through process digitalization. Just to give an example, Italy is the second European country, behind Germany, for the number of installed robots (more than 14,000).

The largest portion of the Italian enterprise investment covers automation and remote control instruments through data collection and transfer.

Investments in Industrial Analytics technology are increasing, while the bigger increase concerns Cloud computing, advanced automation and man-machine interfaces.

% distribution of the value of investments in applications and services for Industry 4.0, year 2020
Source: elaboration Centro Studi CNI on data from Osservatori.net digital innovation Politecnico di Milano



Investments in applications
Industry 4.0

60% IoT
17% Industrial Analytics
8% Cloud Manufacturing
7% Consultancy and Training
5% Advanced automation
2% Additive manufacturing
1% Advances Human Machine Interface

GOVERNMENT FACILITIES FOR 4.0 INDUSTRY: LAW PROVISIONS

The 2023 budget law (Law N° 197/2022) confirmed the financing of measures proposed by the 4.0 Transitional Plan. The objective remains to promote the development of 4.0 manufacturing.

For the tax credit in respect of capital investment in equipment, the relevant regulation is the Budget Law (article 1, paragraph 44, Law 234/2021), integrated by the Decree on Aid (DL 50/2022) and the 'thousand extensions' decree. In order to claim the Transition 4.0 tax credit on capital investment in new, technologically advanced equipment (both tangible, mentioned in Annex A, and intangible, mentioned in Annex B) the decree grants time until 30th November 2023, provided that the purchase order has been accepted by the seller within 2022, against a minimum payment of 20% of the acquisition cost.

The 2020 budget law also introduced a new regulation on tax credit for investment in R&D, environmental transition, 4.0 technological innovation and other similar activities to support business competitiveness. This tax decree was extended in 2021 and 2022.

The regulations on facilities for 4.0 Industry are rather complicated: for a detailed overview, you can visit the Chamber of Deputies website.

Transforming the Whole Production Chain: from Cloud to Line up to the Machine

Today's digital factories look very different from factories of around ten years ago. In fact, the effective implementation of 4.0 solutions obtains very interesting results: McKinsey, for example, estimates a 30-50% reduction of downtime, 10-30% increase of production, 15-30% higher labour productivity and even 85% more accurate business forecasts.

Digitalization involves the whole business, from management to production and logistics: in fact, products, production techniques and processes, all together, build a sort of "operating system" where the exchange of data among all players and along the whole chain, from sensors to the cloud is fundamental.

Furthermore, 4.0 Industry allows for new business pattern and innovation opportunities, hence creating more flexible, agile, resilient and sustainable value chains.

PROVIDING MACHINES WITH SENSORS TO ENABLE THE DATA STRATEGY: IIOT AND BIG DATA ANALYTICS

The Internet of Things is a set of technologies to optimize the collection of data from a great number of sources: products, factory systems, vehicles, etc. Data, made available through such techniques as machine learning, is used to extract information useful to make decisions at different levels.

Just to give an example, within the industry, we talk about the Smart Supply Chain,

with sensors especially programmed to manage the inventory and generate an automatic alarm that activates an order for the stocks, before reaching the minimum level that would require the restocking of inventories. Another issue concerns the Smart Logistics, with reference to traceability of the supply chain, protection of the brand and monitoring of the cold chain as well as the fleet management.

In a Smart Factory, every physical object has a counterpart in the digital world (Cyber-Physical Systems) to enable: checking the production progress, more safety at work, implementing preventive and predictive maintenance, a higher quality control, a more efficient waste management, and so on.

FROM DATA TO INTELLIGENT SIMULATION: DIGITAL TWINS AS ACCELERATORS TO DIGITAL TRANSFORMATION

Until around twenty years ago, when we began to speak about digital twins, one had to test an industrial product in the form of a physical prototype, the construction of which provided designers the opportunity to better understand the system and its behaviour. In case of difficulties and the consequent need to modify something, one had to go back to a 2D project, in order to build a new 3D prototype, resulting in a costly and time-consuming process.

Today, thanks to digital tools, one can virtually create both projects and prototypes, thus simulating, in a shorter time and with lower costs, the impact of changes on the project, using scenarios, environmental conditions and numerous variables, all beneficial to a shorter product development process and a shorter time-to-market.

Nowadays, digital twins integrate all modern intelligence technologies, including Big Data, Artificial Intelligence, machine learning and the IoT, used for a predictive analysis of all kinds of systems or equipment.

Protecting the Production

Cybersecurity is crucial to systems that are closely connected: cyber-attacks are increasingly frequent and sophisticated, causing not so trivial problems, since industrial plants operate for as long as 20 or 30 years, whereas safety provisions require continuous updating.

Simple components, integrated in various intelligent devices, together with management and software updating defects or errors, made them vulnerable to possible attacks on the web: hence, IoT platforms risk becoming the target of increasingly sophisticated cyber-attacks.

This situation requires specific technologies to ensure the IoT security, such as, for example, segmentation of the net and checking access and privileges of single users, as well as a policy to manage and protect various devices so as to build a convergent SOC (Security Operation Centre) aiming to integrate the security of both OT and IT universes.

From a regulatory perspective, since May 2018, companies operating on the European IoT market shall comply with the GDPR; the data protection issue has to be tackled right from the design stage (Privacy by Design).

In June 2019, the Cybersecurity act entered into force; its guidelines cover the entire life cycle of IoT solutions.

Furthermore, the cybersecurity technical committee (ETSI European Telecommunications Standards Institute) released the information security standard for the IoT market, including 13 rules to ensure the security in connected devices, to make them compliant with the GDPR and offer guidelines for future certifications in the industry.

CYBERSECURITY AND 4.0 INDUSTRY

In a factory, the Industrial Cybersecurity includes all the means applicable to factory automation and intended to make all control systems, especially PLC, SCADA and HMI immune to attacks.

Machines, HMI, PLC, and switches with different features are often added or replaced at different moments in time with no track of such activities in time.

Currently, many companies only act once they have suffered damage.

The first effective countermeasure against a cyber-attack is the analysis of the automation infrastructure in order to understand to which extent every single machine, production area or plant may become a potential target. It is also necessary to understand what would be the consequence. By doing this, one can prioritize actions on the infrastructure, as a countermeasure based on the severity of possible consequences.

The application of the IEC 62443 international standard is fundamental to safeguard industrial devices. The standard covers the entire lifespan of industrial automation control systems, from analysis of its vulnerability to the implementation and maintenance of safety measures.

FROM SUPPLY CHAIN TO QUALITY CONTROL: THE ROLE OF THE BLOCKCHAIN IN PRESERVING DATA

As regards 4.0 Industry, the blockchain can be applied in various areas: from the decentralisation of processes and business models, to the capacity to register tamper-proof records of the history of each industrial asset or product, from process synchronisation, e.g.in logistics, to automation of processes.

For example, in terms of traceability, the blockchain allows to analyse the impact of project changes, to avoid manual recording of supplier details, to de-materialize claims and guarantees, to prevent the fraudulent use of any controlled origin certificates.

The blockchain is also applied in recording of product maintenance stages and in ensuring the reliability of IoT devices, mainly certifying their identity and authentication.

The blockchain-shared registry makes the system more resilient, while getting rid of the single point of failure and ensuring data accountability even in case of a catastrophe or a security investigation by the authority in charge, or an inspection by any other regulatory authority

Digitalization in Industrial Packaging: Role and Support of the Smart Packaging Hub

The Smart Packaging Hub initiative grew from the idea of five manufacturers of machinery and solutions for the food & beverage packaging industry; they wanted to build a platform as a virtual meeting and exchange opportunity for machine users to discover practical solutions and face the market challenge through the advantage of digitalization.

Today, the Hub includes five companies: Baumer, Cama, Clevertech, Tosa and ZACMI. Users can look for innovative technology made available by the member companies to support them on innovation, digitalization pathways as well as to applying the 4.0 Industry Guidelines. All of it is based on "Made in Italy" technology, mainly to ensure maximum flexibility in the customisation of installations and solutions.

By the way, the Hub offers the opportunity to experience advanced robotic solutions, IIoT, advanced software to analyse data and optimize production and energy performance, virtual machine models (digital twins).

SOME ACCOMPLISHED PROJECTS

Cama Group is a long-term supplier of 4.0 Industry solutions, for example the digital twin of an installation for maintenance operators to follow it on their tablet screen.

They are actively doing R&D in this field as well as on predictive maintenance

strategies. Cama Group goes for the implementation of solutions reaching a fair compromise between general features, required in economies of scale, and specific features. The aim is user- friendly solutions, extremely reliable and economically viable.

For an important Italian customer, Clevertech built a depalletizing system for reams with automatic feeding and detection of the ream position on layers, through a system that reads the QR printed on reams. Such information is needed for the robot to carry out an accurate pick-up operation.

The INTEGRA software system made all of this possible. Developed by Clevertech, it can correctly interface the depalletizing system (PLC automation) and the customer's ERP system. The software relies on sensors embedded in the installation to identify processed products (RFID and bar code readers). The result is a fully automatized system, able to detect the product loaded on the machine, receive data from the central unit, send the required amount of product to the warehouse, while managing the routing of a product from the depalletizing system up to its entrance to the warehouse. From an economic point of view, the return on investment of depalletizing systems for reams with automatic feeding to the carton former is estimated in three years, bearing in mind that the installation site is in Europe [1]. This kind of automation allows managing consumables by means of AGV, hence further reducing operation costs.

In close cooperation with the n.1 multinational Company in PC and HC products and for their Japanese logisitic site, Clevertech has implemented a mixed palletisation system to load pallets with different items (more than 25 different packages/cartons/bundles to be loaded on the same pallet) based on the shipment order and establish a specific sequence of product loading to pallet accordingly the secondary packaging robustness, directly in

connection with Customer ERP and- seamless design to be integrated with automatic truck loading operation

For a leading multinational company in the soft drinks industry, Tosa developed T-HYPOTHALAMUS, an advanced cloud-based data monitoring solution. The system aims to reduce machine downtime, optimising wrapping cycles and limiting consumption, T-HYPOTHALAMUS allows storing and analysing in cloud all the machine's production and performance parameters, while monitoring the use of energy and materials. Through an extremely user-friendly dashboard, the operator can understand whether the machines are working at best; in the negative case, he can act on any parameters that need improvement.

For an important Italian mineral water producer, that required a stricter control of energy use and a higher quality of bundles, Baumer designed the GreenTech Tunnel®, a latest generation thermo-shrinking tunnel. Equipped with as many as nine sensors to control temperature and air flows, it controls the thermo-shrinking operation on an appropriate panel, optimising operation and ensuring high quality bundles. The implementation of the system, reduced energy consumption by over 20%, making the best of the thermo-shrinking operation and cutting heat waste.

Lastly, ZACMI has implemented a project to integrate the machines within a company's information system, to supervise the governance of production lots, format changes and machine washing. The main issues they had to face concerned changes of the production plan, synchronisation of the production process, management of unused product and containers.

They overcame the obstacles networking the machines with the customer's MES, from which they receive information to manage the starting, ending and washing procedures.

This development resulted in fewer actions to be carried out by the operator, shorter format change times and a quicker container and product rejection time arising from the format change. In particular, used containers fell from 300/400 to 50/60, while the format change took 1 hour instead of 3 and a half hours, previously necessary to carry out the operation. Product rejection fell from 200/250 L/hour to approximately 50 L/hour. Lastly, this solution ensures a continuously sanitized machine, ready for the next product to be processed.

OBSTACLES ENCOUNTERED AND STRATEGIES TO OVERCOME THEM

According to Cama Group, to unlock the real potential of Industry 4.0 technologies, a mixed IT/OT computer scientist culture must spread. One of the reasons hindering businesses from enlarging the range of application in this direction, is the difficulty in finding on the market professionals skilled in both the technology fields, since Industry 4.0 technologies requires a mix of both.

Cybersecurity is a subject still slightly covered, though companies are getting increasingly aware of it. Cama Group has been offering since several years a wide range of HW/SW protection solutions.

Clevertech highlights the challenge to make its rather complex systems as user-friendly as possible for the final user. To this aim, touch screens as intuitive as possible are implemented with a continuous effort to simplify the process. In fact, Clevertech is mainly committed to extreme user-friendly approach. For example, at Interpack 2023 it has been presented a new type of panel with a tutorial video to help operators carry out maintenance task.

On the other hand, Tosa addressed a difficult challenge: they designed and managed a data-monitoring platform like T-HYPOTHALAMUS, dedicated

to assessing and analysing data in cloud by means of a Big Data Analysis software, AI and machine learning to process data.

In fact, the development and the necessary attention to details in managing the platform demand a strong commitment. Furthermore, customers are often worried about a system that can allow access to sensitive data about production, however T-HYPOTHALAMUS has been developed complying with strict cybersecurity standards, protecting the customer's privacy. Without Tosa's knowledge, one would be unable to understand production data collected by the system.

While analysing data from Tosa machines, customers can access real-time automated monitoring systems that autonomously help the operator to carry out preventive maintenance operations. At the same time, analysing such data Tosa can continuously improve the system while developing increasingly detailed analysis patterns useful in identifying possible improvements in the production process.

A major difficulty encountered by Baumer, related to the GreenTech Tunnel®, concerned the adjustment of the bulkheads in the tunnel, during the format change operation when shifting from 0.5 litres to a 1litre bottle.

In order to obtain a perfect thermo-shrinking for each single product and reduce energy consumption, they installed sensors to adjust the bulkheads autonomously to the tunnel by simply clicking on the operator's panel, during the automatic format change. A complex operation that, however, gave the customer the opportunity to optimise the production with any formats and not just with the main 1 litre format, as was the case in the past.

Lastly, ZACMI points out that each single customer needs a specific customization and an extensive technical support in development to insert the machines in a digital context and let them operate effectively. These digital

contexts can vary a lot and are always linked to the customer's business sector. Considering the variety of applications, ZACMI prepared some unified interfaces containing data and procedures the machines may need in order to be part of a customer management framework.

FUTURE PROSPECTS

For the future, Cama Group intends to develop some HMI solutions to make machine programming, configuration, and customization easier. They are developing new proprietary robotic solutions, and they are optimising their machines to be more efficient, simple, less energy consumer. As a whole, since the success of Industry 4.0 depends on the growth of various players within the ecosystem, say producers, clients, suppliers, who should strengthen their skills and strategic choices, they are studying new markets contracts, e.g., providing for a kind of subscription with a set of updates. Of course, all that will imply a re-organisation of the functions of the client company as well as the supplier one.

Clevertech aims in particular at implementing to employ the development of integrated systems between automation and management. The FMCG manufacturing industry is driven by marketing strategies that develop new products to exploit new market opportunities. Hence, we should make the product change management as automated as possible, because the downtime to change a format puts increasing pressure on costs.

The centralised control of production lines began a few decades ago with the aim of monitoring the efficiency of single machines in a production line and of increasing their performance.

Today, a continuous evolution is bringing production planning near the market demand, while increasingly integrating the production line into the system of storage and preparation of orders; the digital transformation

appears inevitable to reach this target. Lastly, Tosa will further develop T-HYPOTHALAMUS, aiming to improve the customer service.

Today, the system already makes machines signal any faults, autonomously and effectively to the operator, while even anticipating possible future anomalies. Furthermore, through its operating interface, the machine autonomously sends out a request of spare parts needed to ensure a perfect function, without the involvement of the operator. On the other hand, he can access machine data and its analysis by means of the most common devices (PC, mobile phone, tablet), even remotely from any place.

Tosa plans to invest in enlarging the scope of the system, making it even more accessible and practical, hence making the machines as autonomous as possible, limiting the intervention of an operator and reducing maintenance costs.

Over the next two years, Baumer will digitize as big a portion of the production process as possible to ensure better control and a higher quality of packaging, while implementing systems to control both the packaging and the workflow.

Besides the production area, Baumer will also work to improve their customer support service. Recently, they developed Baumer Prime, a digital e-commerce platform that they supply to customers to display a 3D model of their machine with all its components. In this way, they can remotely direct the operator, in a safe and quick way, to detect the component to be replaced in case of breakdown.

In addition, customers can order the component needed, just clicking a button, and receive it in a very short time. Within the next two years, Baumer intends to improve Baumer Prime further in order to offer customers the all-round control of the machine.

Lastly, in the near future, ZACMI will focus on the development of MES to

measure the performance of the machines in order to ensure their efficiency (no rejects, reduced consumption and green solutions). Later on, they will enable improved control of the operation of machines, while at the same time minimizing the customer's effort, according to a general principle of sustainability.

[1] In detail, in a logistical system, assembling a mixed pallet requires many resources with a low general efficiency connected with the availability and handling of product to be palletised together on the same pallet. Operators often have to manage 15-20 kg per item in safety during an 8-hour shift. Considering a traditional 24/7 operating regime, quite usual in logistics, we can estimate at least 200.000 Euro/year in cost of direct labour and 50-100.000 Euro in cost of land use, storage of items and handling of storage pallets in the area where the mixed pallet is recomposed. Bearing this scenario in mind, a low efficiency rate in terms of pallets/hour, and possible human errors, supposing a performance of 50-60 pallets/hour, the estimated return of investment is actually not more than 3 years (site of installation in Europe).

Final Key Points

- Digitalization is inevitable to stay competitive in the industry, in an increasingly global and challenging environment
- It means integrating one or several technologies from the sensor to the cloud
- Data is at the heart of 4.0 Industry, with the embedded information, as a starting point to improve performance and to make better-informed strategic decisions
- Smart Packaging Hub is a virtual web storefront where 5 leading packaging companies in the Food & Beverage segment meet and guide customers in their digitalization process
- Automation, integration and a user-friendly approach are the bottom-line of today's project as well as of future development prospects.

Conclusions

Pierre Nanterme, at that time, Accenture CEO, said, "Digitalization is the main reason why, since 2000, over fifty per cent of companies have disappeared from the Fortune Global 500 list".

From product development to production, from packing to distribution, the integrated combination of digital technologies available on the market, thanks to experienced and skilled partners like those that are part of the Smart Packaging Hub, allow companies to tackle the challenge of an increasingly competitive market and ensure the resilience needed to face crisis and changes under a global scenario.

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