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IMBALLAGGI ECO-SOSTENIBILI

IS CRISIS OPPORTUNITY?

(starts on p. 38)

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AUTOMATION

Is Crisis Opportunity?

Constraints, limits and health barriers imposed by Covid-19 can and must accelerate the processes of metamorphosis and innovation (in progress or dormant), and that goes for the industrial automation sector as well. Our 42-page Dossier provides plant engineers, facility technical directors, maintenance managers and experts in mechatronics and IT with a set of resources, both theoretical but based on experience (by Eduardo Schumann) and practical (company case studies of technological solutions).
The goal of the Dossier is to indicate opportunities in the specific company area of "after sales." But does "after" even exist anymore? In our view, it no longer makes sense to refer to the industrial or commercial process in linear terms: gone are the days when there was a before, during and after. From now on, it's about "here and now."

Vincoli, limiti e barriere sanitarie create da Covid-19 possono o devono accelerare processi di metamorfosi ed innovazione (in atto o dormienti) anche nel settore dell'automazione industriale. In 42 pagine, il Dossier mette a disposizione di progettisti di impianti, direttori tecnici di stabilimento, responsabili della manutenzione, esperti di meccatronica e IT una serie di risorse teoriche ma basate sull'esperienza (a cura di Eduardo Schumann) e pratiche (casi aziendali di soluzioni tecnologiche).
L'obiettivo del Dossier è indicare opportunità in un'area azienda specifica, quella del cosiddetto 'post vendita'. Ma esiste ancora un 'post'? Riteniamo che non abbia più senso, oggi, riferirsi ad una linearità del processo industriale e commerciale: non ci sono più un prima, un durante ed un poi, ma un 'qui e ora'.

After sales and maintenance, a world to redesign

From a recent KPMG survey on After Sales services directed to member companies of Federmacchine, ideas arise for industry growth

ABSTRACT

Da una recente ricerca KPMG sul tema dei servizi After Sales presso le aziende aderenti a Federmacchine, alcuni spunti per la crescita del settore. L'attuale portafoglio servizi è improntato a quelli basici di assistenza. L'azione commerciale è prevalentemente reattiva. Vi sono importanti potenzialità di crescita della percentuale di conversione dei propri 'clienti macchine' in 'clienti customer service'. Solo le grandi imprese possiedono un'organizzazione con business unit dedicata al customer service. Il presidio territoriale logistico e tecnico è limitato. Gli investimenti sono focalizzati solo su Lifecycle Services. Limitati investimenti previsti, in particolare da parte del cluster dimensionale fra 50 e 100 milioni di fatturato. La quota di ricavi customer service sul totale dei ricavi è minore del benchmark.

"After Sales within the Italian Framework of Capital Goods" is the study conducted by KPMG presented in November 2019 at the Federmacchine manufacturer's association in Milan. Italian manufacturing companies, which represent an excellence in the production of capital goods, face the challenge of complementing the sale of primary commodities with a portfolio of services with added value. Involved in this is the development and consolidation of a brand new business model that calls for new processes, new organizational units and new enabling technologies.

This article examines the first part of the study dealing with the analysis; the synthesis, which also indicates operational paths, is available by contacting one of its authors, Andrea Bontempi, Partner at KPMG at abontempi@kpmg.it.

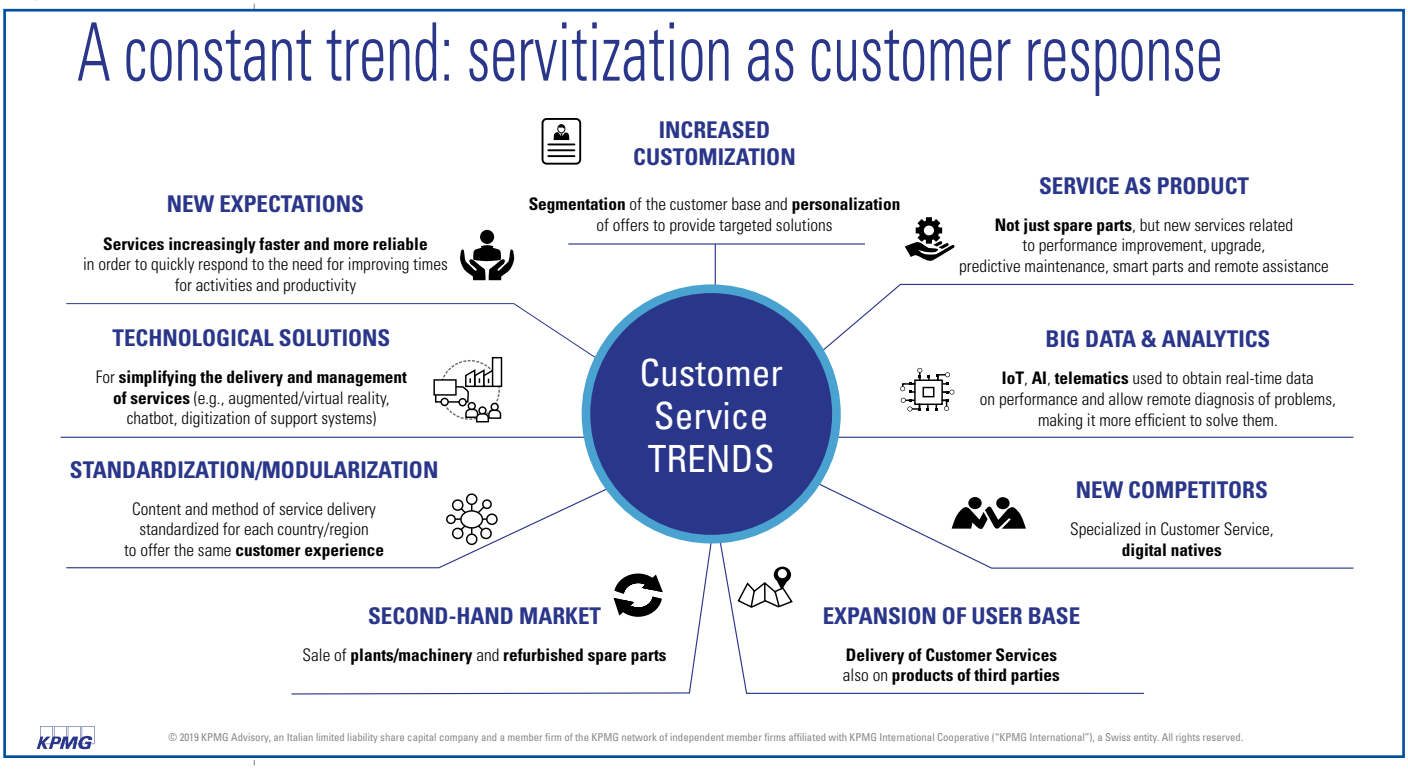
Era of the customer

These days, companies have to stay ahead of the game by adopting a *Customer-Driven* logic. This new era requires customized experience, transparent communication, efficient service delivery and added services. *Customer Experience* is the overall experience of customer during their entire relationship with the company. Creating a *Customer-Driven* business model often entails large-scale changes and transformation. Customer Service takes on a leading role since it adds services to the physical product and increases satisfaction and points of contact with the customer; *After Sales* evolves from a reactive to proactive logic in order to assist them make a profit. The study highlights how *Customer Service* offers higher margins, sales being equal, compared to the selling of physical goods, with the incidence on revenue increasing in proportion to company size. In *figure 1 (see following page)*, KPMG outlines eight tools for developing customization of services.

These eight tools include technological solutions that the report illustrates in the external devices for predictive maintenance: one, for example, are services focused on preventive maintenance through the diagnostics of vibrations and algorithms for monitoring conditions obtained by sensors attached to the machines. There are even some cases of companies and start-ups created with the sole purpose of researching advanced algorithms for analyzing the vibrations and parameters of the machines that can 'read' data arriving

FEDERMACCHINE numbers 5,150 companies and 194,000 employees, for an overall turnover in 2018 of 49.2 billion euro.

Figure 1



directly from the sensors on board customers' machines. Specialized staff is unnecessary, as reporting can be managed from any electronic device, fixed or portable, and the service is integrated with each company IT system.

The example given allows us to understand how some innovations, including recourse only to specialization in big data and artificial intelligence, can create a predictive maintenance system that generates plant efficiency without specific knowledge of the machines.

"Another example," points out Andrea Bontempi, one of the Dossier's authors, "is the fact that KPMG itself is seeking to join ranks with companies in the capital goods sector by launching a campaign for aggregating companies that need and want to react to the limitations imposed by Covid-19 and find solutions designed to provide remote assistance to customers. Many companies in the sector find themselves in the unfortunate situation of having orders in their portfolio and plants ready that cannot be installed at the customer due to limitations on travel by technicians. The idea is therefore to use augmented reality tools that enable remote services for installation and technical assistance through a *leading edge* software platform that would be accessed free of charge."

Upcoming scenario

The growing need to demonstrate to customers that they are a sustainable company, along with the necessity to optimize CAPEX and OPEX on an ongoing basis, will favor *Second Hand Market* and *Refurbishing services.* Servitization and customization of the physical product will increasingly lead to the decomposition of products into functional modules produced with standardized components.

Servitization is stimulated by the availability of data and their applied intelligence. Those who have the data will win, even if they come from sectors outside capital goods.

Figure 2

Classification of services proposed in the survey

	DESCRIPTION	ACTIVITIES	ENABLERS
ACADEMY	**Services dedicated to training and increasing the specific knowledge** of customer personnel, and the ability to use, manage and operate the machines	• **E-learning** • **Interactive manuals** • **AR/VR training**	• *Study of advanced AR/VR tools* • *Use of access-based web platforms with digital content*
LIFE CYCLE SERVICES	**Services to support machine operation** (spare parts and technical assistance) aimed at guaranteeing **the expected production performance** provided over the entire life cycle of the product, in either a reactive or preventive form	• **Spare parts** • **24H Assistance** • **Maintenance plans**	• *Efficient worldwide logistics structure* • *Technical presence on territory* • *IoT competencies*
LIFE BOOSTING SERVICES	Services dedicated to **upgrading and increasing the original operating functions** of the machine/plant and to the adaptation to renewed standards or different specifications of the end product	• **Consulting** • **Changeover** • **Upgrade**	• *Commercial proactivity* • *Presence on market, oversight of machinery installed, and knowledge of conduct during its use*
BUSINESS/ PREFORMANCE SERVICES	Services oriented to **guaranteeing the customer the certainty of attaining determined levels of efficiency/productivity as agreed**	• **Product servitization** • **Warranty extension** • **Financial services**	• *Change of internal business model* • *Adaptation of organizational structure*

KPMG

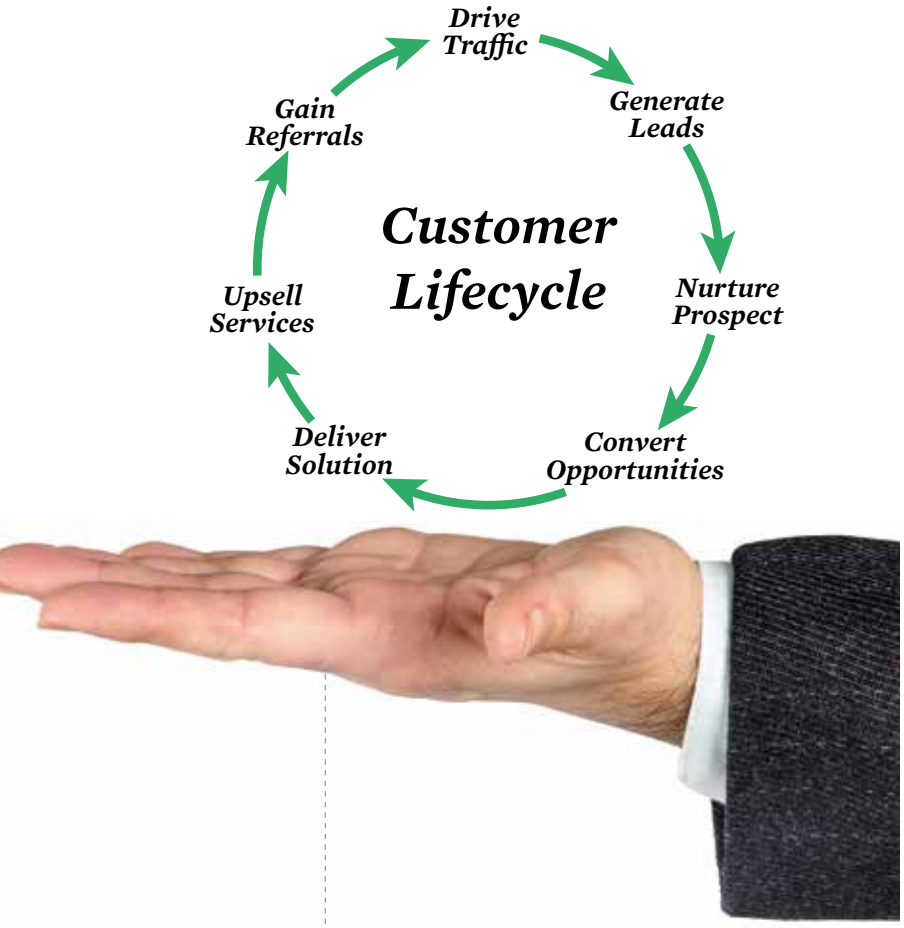
Classification of services

The survey of companies who are members of the 11 associations under the umbrella of Federmacchine (including Ucima, Acimall, Acimga, Amaplast, i.e., those more engaged in the production and management of goods for packaging and ready-to-fill packaging) adopted a classification of services *(figure 2)*.

Survey results

Basic *After Sales* services are provided across all clusters of the companies interviewed with an average of over 90%: they include training, spare parts, customer and technical assistance. Regarding additional services, only maintenance plans have a good coverage with an average of 60%; however, less than 20% of the companies sold over 10 maintenance plans in 2018. The warranty extension service is highly present only in the larger companies.

There is a clear concentration of basic services, especially *Lifecycle Services*; among the services of *Academy*, the companies mainly provide basic training at the expense of more advanced services such as *E-learning and AR/VR*. In the *Lifecycle services*, there is a definite growth (among the large companies) of additional services such as the warranty extension and preventive maintenance plans. However, maintenance plans with predictive analytics and 24-hour assistance are not being acted upon, with exception of the large companies. *Life Boosting* services are not well represented in the portfolio of companies: there is a recurrence of only *Upgrading* and *Revamping*, on average managed by 35% of companies. As for *Business Performance Services*, only the large companies, about 32%, state that they have started up servitization planning, an indication of how the market is not ready yet to modify its buying behavior.



Communications and sales area

Another analysis of the study concerns the commercial approach. The low frequency of commercial initiatives underlines the reactive organization of the *After Sales* area. The type of program companies most commonly pursue is maintenance plans and customized plants, especially the larger companies. The communication of services takes an approach that favors a direct contact with the customer, through visits or during trade fairs, compared to other means available, e.g., brochures, newsletters and magazines. This validates a commercial logic centered on the physical presence of the customer and the territory.

Indicators of potential

It appears that only 30% of the sample operates in the *Customer Service* area with over 75% of the customers: about 60% of cases are clientele with a stable, enduring relationship; most problems in service delivery have to do with the availability of materials and the lack of operative personnel.

In relation to the size of the company, there appears to be a transition from *After Sales* managed with technical personnel, or company functions, towards the creation of a dedicated *Business Unit* with its own profit and loss account. The *Customer Service* teams are made up of especially maintenance technicians, in proof of operations-oriented organizations. The logistics network organization is based on a central warehouse, particularly for smaller companies.

Technical operations performed by third parties are uncommon, with the large companies disinclined towards *Outsourcing* with respect to the smaller companies. The response time for maintenance requests in most cases average two days. Longer, instead, are the times for spare parts shipment, which in many cases exceed one week. The survey notes how the companies frequently offer *Lifecycle* type services in the warranty without valorizing them in a fee-based service. Less than 30% of the sample performs tele-diagnostics or tele-assistance operations for a fee. The intentions for future investments indicate that the companies will primarily focus on *Academy* and *Lifecycle* services, in particular on predictive maintenance plans.

Profitability

The incidence of turnover generated by *Customer Service* services with respect to the total turnover is on average 13%, less than an average value of 20%, thus with considerable prospects for growth. It appears that there is a larger incidence of the turnover of services in the large companies, especially in those with a turnover of 100+ million euros. The revenue from *Customer Service* mainly comes from spare parts, without distinctions among size clusters of companies. ■

Plants and maintenance: how I wish they were

While waiting for the Internet of things to become a reality, machines for the food industry are required to be reliable and easy to maintain with controlled costs

ABSTRACT

C'è una disconnessione tra quello che i fornitori di impianti offrono e quello che le aziende di produzione di beni di consumo chiedono. C'è bisogno di macchine affidabili e semplici da mantenere, che durino nel tempo, anche se vengono usate in condizioni estreme. Per quanto riguarda la manutenzione bisogna puntare ad alta affidabilità, facile manutenibilità e basso costo di manutenzione totale. Inoltre, serve uno specifico strumento che identifichi i componenti e i materiali di consumo comuni, in modo che siano sempre tenuti a magazzino.

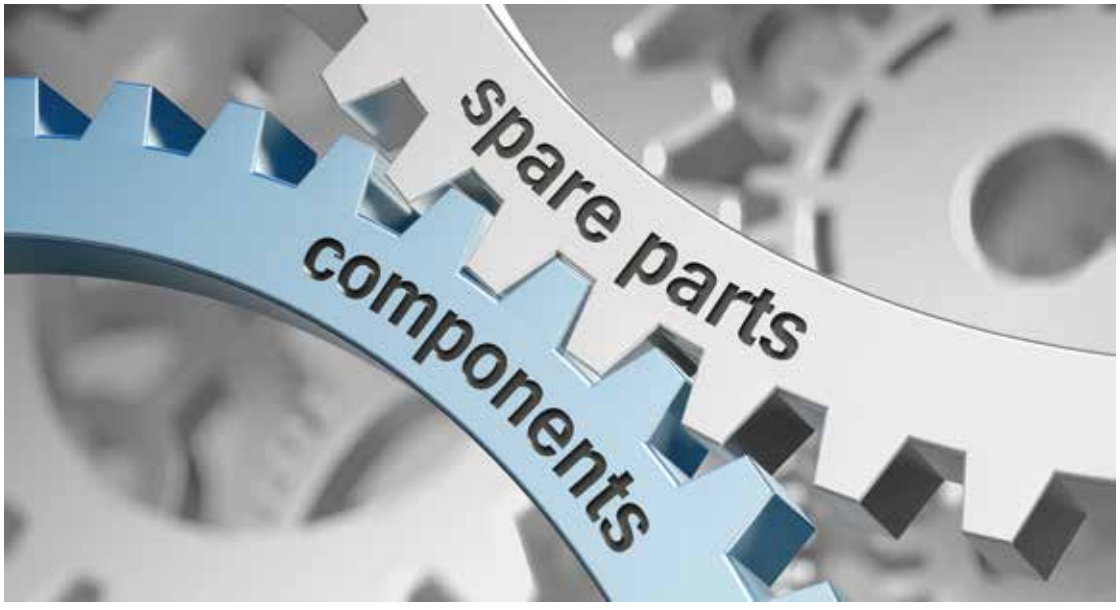
Eduardo Schumann is responsible for the maintenance of the food (and non food) production and packaging plants at different companies in the world. We took advantage of his experience to understand what a company expects from its partners today for the supply and maintenance of its plants.

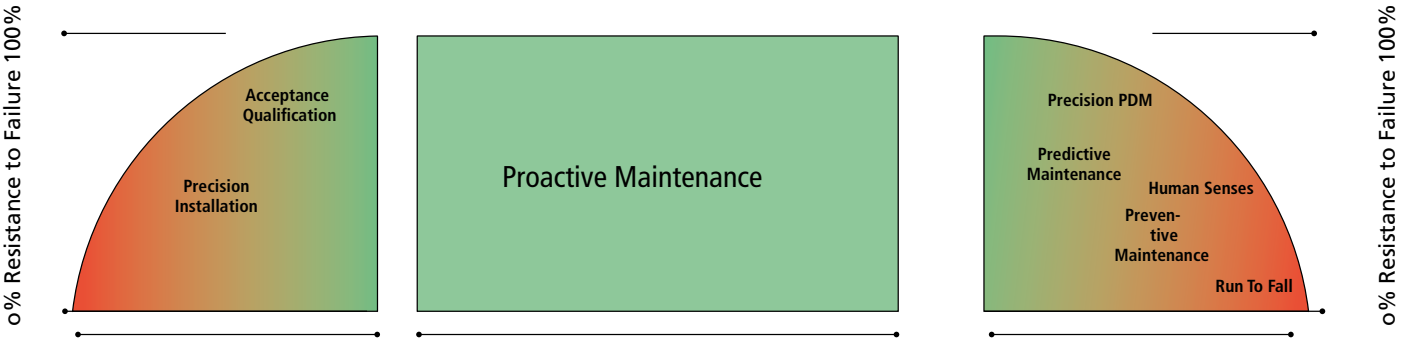
How are the management parameters changing in medium and large food companies?

From the point of view of the final product, we must focus on quality so that it meets all the requirements: it must be correctly labelled, it must not contain foreign bodies... in short, it must not represent a risk to the final consumer and therefore not lead to withdrawal or recall procedures. This means having a sound production process, but also the installation of some accessory components (X-rays, metal detector, label reader...) on the packaging lines, which were not so common a few years ago.

From the point of view of production, all routines must be standardised and controlled, and procedures for the safety of workers must

by Eduardo Schumann, Improving efficiency consultant.





INCEPTION TO INSTALLATION
H Interval
ASSET DEVELOPMENT

1. Inception
2. Pre-feasibility
3. Preliminary Design
4. Detailed Feasibility
5. Failure Mode Effects Analysis
6. Detailed Design
7. Purchase for purpose
8. Construction
9. Installation
10. Operational
11. Performance
12. Commissioning
13. Torque to specification
14. Alignment and balancing
15. Competency based learning

INCEPTION TO POTENTIAL FAILURE
I-P Interval
NORMAL OPERATING HOURS

1. Human Capital Management
2. Asset Condition information
3. Computer Maintenance Management system
4. Criticality Analysis
5. Reliability Centred Maintenance
6. Failure Mode Effects Analysis
7. PM Optimisation
8. MRO-Spares Management
9. Planning and Scheduling
10. Preventive Maintenance
11. Autonomous Maintenance

POTENTIAL FAILURE TO FUNCTIONAL FAILURE
P-F Interval

1. Motor Testing
2. Vibration Analysis
3. Ultrasound testing
4. Oil Analysis
5. Infrared Thermal Imaging
6. Time Based restoration or replacement
7. Vibration to touch
8. Audible Noise
9. Hot to Touch/Smell
10. Visible looseness
11. Functional Failure
12. Catastrophic Failure

be strengthened. Systems, plants and pipes must minimise performance losses.

From the point of view of maintenance, it is necessary to have machines that guarantee reliability and maintainability. Using acronyms I hope they have a high MTBF (Mean Time Between Failures) and a low MTTR (Mean Time To Repair), i.e. short failure repair times (MTTR) that occur after long operating times since the last repair was made (MTBF). We have worked hard to minimize failures by continuously monitoring the operation of the plants through the online Condition Base Monitoring (CBM) system. This system is important because it helps to identify the initial stages of a failure and reduce the randomness of problems, thus giving us time to plan and organize an intervention, instead of just reacting. Once we reach this 'sustainable' stage, we can achieve more targeted orders. If we have the time, we can arrange e-auctions for spare parts and services. Of course, all this must be done with the costs in mind.

What tools do the food industries have available to test and validate the quality of scheduled maintenance?

We currently adopt precision maintenance at most of our production sites to avoid failures due to misalignment, vibration and wear, ensuring the relevant components are set to established tolerances. Such tools and techniques can be used not only to identify the early stages of a problem in an equipment, but also to test new or refurbished machines. One of the responsibilities of a machine manufacturer is to ensure that the equipment has been installed correctly. In the next step, it is the responsibility of the maintenance team to work with suppliers, identify critical aspects, check them after installation and then set up maintenance routines to ensure that these components remain within tolerances.

Is the technical know-how of the maintenance and service teams of food companies today sufficient to effectively test

the operations carried out and the proposals made by technology manufacturers?

Not necessarily. We can test a defined performance, but technology keeps improving and we don't get everywhere. This risks having new lines that are less performing than expected. We are trying to work with some suppliers to combine our knowledge and get the best. We want to help them help us. As far as maintenance is concerned, we look for high reliability, easy maintainability and low total maintenance cost. In addition, a specific tool is needed to identify common components and consumables so that they are always kept in stock. This simple step would have an impact on maintainability, reducing MTTR since suitable spare parts would be available immediately.

Many technology suppliers offer web platforms for the purchase of spare parts or the execution of maintenance operations. Do you think this service is enough?

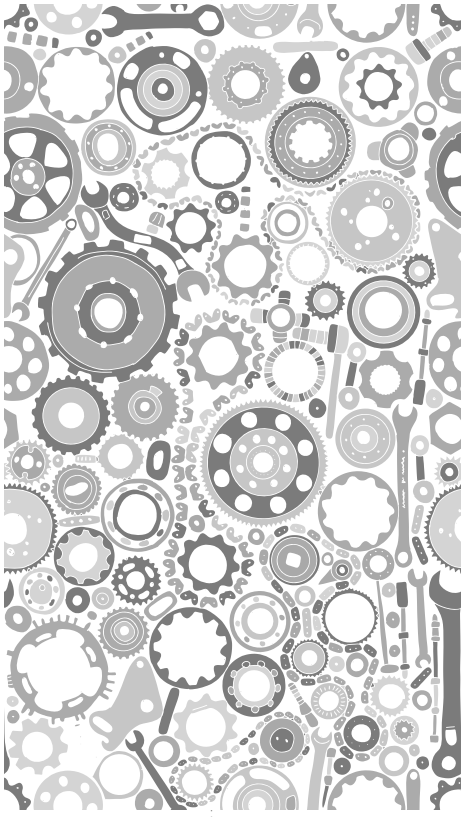
We use online catalogues for pre-agreed contracts with suppliers. In some cases this is enough, in others we need something else. Usually we look for spare parts with greater reliability, and we need to be able to identify the best ones, which last longer, and thus save money. This may seem a paradox, but in reality spare parts normally represent only a fraction of the cost. To get the job done, you need a downtime, people to do it... So paying more for a part that lasts longer means, in most cases, saving money. What we need to focus on is the total cost.

Overall, do you think that the machine suppliers meet your needs?

I believe there is a disconnection between what plant suppliers offer and what consumer goods companies demand. We need reliable, easy-to-maintain machines that will last over time, even if they are used under extreme conditions. I'm not saying the plants aren't working well, but they should be improved. Today producers have needs never experienced in the past: standards are stricter, consumer expectations are higher, the brand must not be compromised by problems concerning the quality of the product...

Finally, in your opinion, will Industry 4.0, the Internet of Things, really become the paradigm for changing the way service and maintenance are made?

Yes, at least partially. As far as I'm concerned I'm using e-auctions a lot: this helps us to save money for what we can get with the right features and that we don't need urgently. As far as remote assistance is concerned, we still have a long way to go: we are much more likely to use physical assistance.



I think we are generally a long way from this being fully realised. The Internet itself doesn't work in every industrial site in the world. The CBM system I mentioned is a step in this direction but there is still a lot to do. Let's think about 3D printing: we could also remotely identify a problem with a machine, but in any case we are not yet ready to print the spare part where the machines are installed, because 3D printing works for plastic, but not for metal and cannot be used on an industrial scale. In short, something is being done but the road to the Internet of things is not so short in my opinion. *(by Elena Consonni)*

Stepping up digital management of service and parts

Cavanna sets out to reduce costs of these two service areas by adopting smart technologies

ABSTRACT

Cavanna ha sviluppato servizi basati sulla connessione remota e su Cavanna Supporto App che permettono di dare assistenza al tecnico manutentore del cliente e di ridurre i costi degli interventi. Le indicazioni vengono fornite avvalendosi della realtà aumentata in tempo reale dalla sede. A supporto dei tecnici del cliente, sono stati messi a punto anche dei video "how to do" per aumentare la comprensione e favorire la ripetibilità dei principali interventi periodici e programmati sui componenti più importanti delle macchine.

With 60 years experience on the market of high and medium speed flowpack packaging lines, Cavanna is making constant innovations in the after-sales area. The company began the process of digitizing parts six years ago; an important step was the investment in an automated

vertical storage system to allow a build-up of stocks to the advantage of user costs. Recently, Cavanna has activated the new 'e-spare' platform that enables users to identify the needed spare parts via the web or a dedicated app. The process starts with the QR Code applied to the functional units of the machines; thanks to the spare parts app, the relevant unit is identified, the 3D technical drawing is opened, the part is identified and the order is placed based on availability and price approval.

"Cavanna has installed a total of 6,000 lines and stand-alone machines in the world," says Antonio Marangon, who claims 20 years of detailed experience and is now service manager of Cavanna Group. *"Of these, 4,500 are running, but there may be even more. This is*

machinery that requires substantial investments in components, warehouse management, spare parts service and revamping. This latest action will make it possible, also through application of electronic systems, to extend the average life of lines and plants."

Focus on after-sales

With 800 active customers, the customer service area is becoming ever more important: over the last five years, its contribution to total revenues has grown on average 10% per year (for parts, modifications, technical assistance on an increasing number of machines installed and

in operation). Through the expansion in services, the company will be able to establish a joint collaboration for the whole OPEX period with positive effects for the machine manufacturer and the user alike.

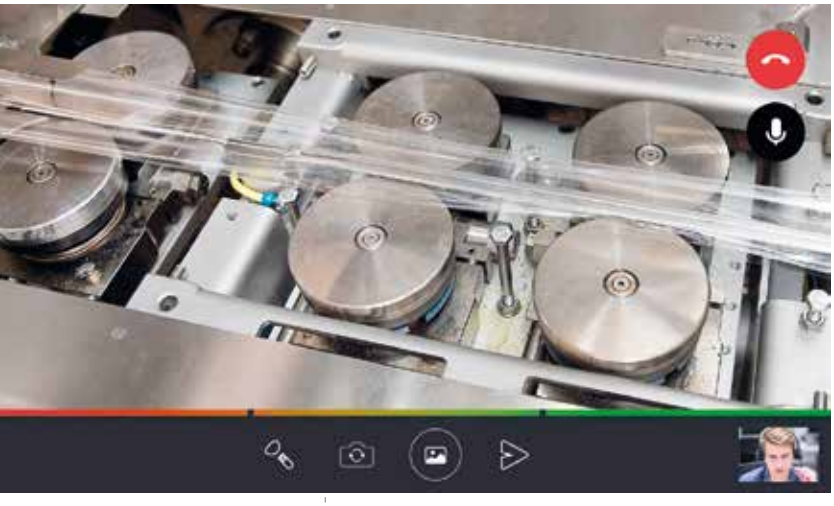
"By developing the service area, we can offer 'guarantees' on the machine's efficiency," points out Marangon. *"With the user's commitment to observe the predictive maintenance program with low costs, the manufacturer ensures performance."*

Since 2014, Cavanna has seen a rapid development from preventive to predictive maintenance, and now towards proactive maintenance. Current efforts are being directed to implementation of the Industry 4.0 paradigm.

The biggest customers have a greater preparation when it comes to digitization and are pushing towards predictive maintenance by analyzing the data on machine efficiency. The SMEs, on the other hand, still prefer preventive maintenance, but the situation is shifting: gradually, even this category of companies is becoming equipped to adopt the Industry 4.0 paradigm and opening up to proac-

TCO IN BRIEF

Total Cost of Ownership (TCO) indicates the total costs of managing a plant and should be considered on two levels: the first is CApital EXpenditur-CAPEX (cost of investment and start-up of a new plant), and OPerating EXpense-OPEX (the overall costs inevitably generated during the lifecycle of the plant and which the machine supplier can become a partner in reducing these costs).



tive maintenance. It's a spontaneous evolution, with the demand generated by clients.

Evolution at Cavanna

Today most maintenance operations are performed by the technician who goes in person to the line at the customer's plant. Cavanna has recently developed services based on remote connection and the Cavanna Support App which provide assistance to the customer's maintenance technician, resulting in a reduction in maintenance costs. The indications are provided via augmented reality in real time from the headquarters. As a support to the customer's technicians, "how-to" videos have been produced to increase understanding and encourage the repeatability of the main regular and programmed maintenance procedures on the major machine components.

Cost analysis

Until a few years ago, only a limited number of companies used CAPEX and OPEX for purchases; today that number is growing. Cavanna's team of engineers can help the customer understand how to correctly process CAPEX and OPEX according to the type of machinery, customer's product and other variables that characterize its production. The role of the manufacturer is also to design, along with the user, lines and machines that respond to certain requisites of CAPEX and OPEX, which obviously differ according to the case. For example, by means of simulators, it is possible to demonstrate how the addition of a buffer increases CAPEX, yet how it reduces the OPEX in as little as a couple of years.

"From an OPEX viewpoint, there can be substantial reductions in costs for users," assures the Cavanna service manager. *"However, a purchase made on the basis of the two TCO parameters, CAPEX and OPEX, is not a spontaneous process or that widespread; the customer must always be guided."* ■

EVOLUTION IN TECHNICAL ASSISTANCE

Maintenance is a process that starts with what is defined as 'reactive'.
Over the years, manufacturers developed preventive, then predictive maintenance to arrive at today's proactive maintenance.
This evolution presumes the transition from services focused on the product to those focused on the customer's business.
Preventive maintenance is meant as the set of precautionary maintenance operations on the lines which are regularly programmed.
Predictive maintenance, an evolution of preventive maintenance, analyzes the current and actual conditions of a plant and requires a remote connection between the user and manufacturer of the plant in order to share big data regarding efficiency, hours operated, format changes and alarms.
This enables prompt action to be carried out on the causes and maintenance performed only where strictly necessary.
Also referred to as enhancement, proactive maintenance entails an operation that modifies an aspect so that the problem does not repeat.
This type of maintenance provides useful experience for an improvement of the lines to be designed in the future.

Online spare parts: reduced time and costs

ABSTRACT

Per ridurre tempi e costi di riordino, Sertek trasforma i progetti e gli esecutivi tridimensionali dei ricambi in interfaccia immediata per i compratori che consultano i siti di vendita on line: si tratta di X-Pare 3D, un'applicazione web per la creazione di cataloghi ricambi interattivi che utilizza come base i 3D senza informazioni 'delicate' di progettazione né possibilità di reverse-engineering. Del componente si vede tutto quello che si vuole mostrare a 360 gradi. Il sistema si adatta al tipo di sistema operativo, di macchina fissa, portatile o on board, alla modalità touch screen.

The quality of the spare parts sales service is crucial for the growth of automatic machine manufacturers to reduce time and costs for users of automatic lines: Sertek, specialized since 1980 in technical and consulting services for technical documentation and software development, is able to transform projects and three-dimensional spare parts working drawings into an immediate interface for buyers who consult online sales sites.

"We have developed X-Pare 3D, a web application for the creation of interactive spare parts catalogues that uses 3D as a basis without 'sensitive' design information or reverse-engineering possibilities. In this way we are able to integrate 3D files in e-commerce quickly and cost-effectively – explains Tiziano Mazzanti – The solution protects against the acquisition of sensitive details by third parties, but above all it offers an intuitive and adaptable way to the needs of those who sell and those who buy: spare parts catalogues become interactive".

You can decide what you want to show of the component, all round. The system adapts, in addition to the type of operating system and the type of fixed, portable or on-board machine, to the possible need for the touch screen mode; there is also the option of separating the components of the spare part on the screen, a useful function to check the exact correspondence to the purchasing need, dispelling any possible doubt.

Sertek's solution is intended to be man-friendly, but above all it reduces time and costs for manufacturers and users of spare parts. ■

Green plants: prevention is better than repair

Right from the design stage, there are measures to avoid plant breakdowns. Only in this way can maintenance be turned from cost into investment

ABSTRACT

L'approccio 'run to failure', ovvero quello di attendere la rottura e riparare, è solo apparentemente il più economico: in realtà, più si investe in prevenzione delle rotture, più i costi di gestione degli impianti si abbassano. In questo senso, la manutenzione non è un costo, ma è un investimento, perché la profittabilità di una macchina dipende anche dalla facilità con cui può essere manutenuta.

"I think maintenance does not mean fixing a machine that has broken down; it means preventing this from happening": this is how Eduardo Schumann, improving efficiency consultant for food and non food manufactures around the world, described his approach to the activity. "This is a fundamental difference in my opinion," he points out, "because if you fix something that's broken, you can't avoid reduction in production, waste of energy, loss of product... The approach must be different."

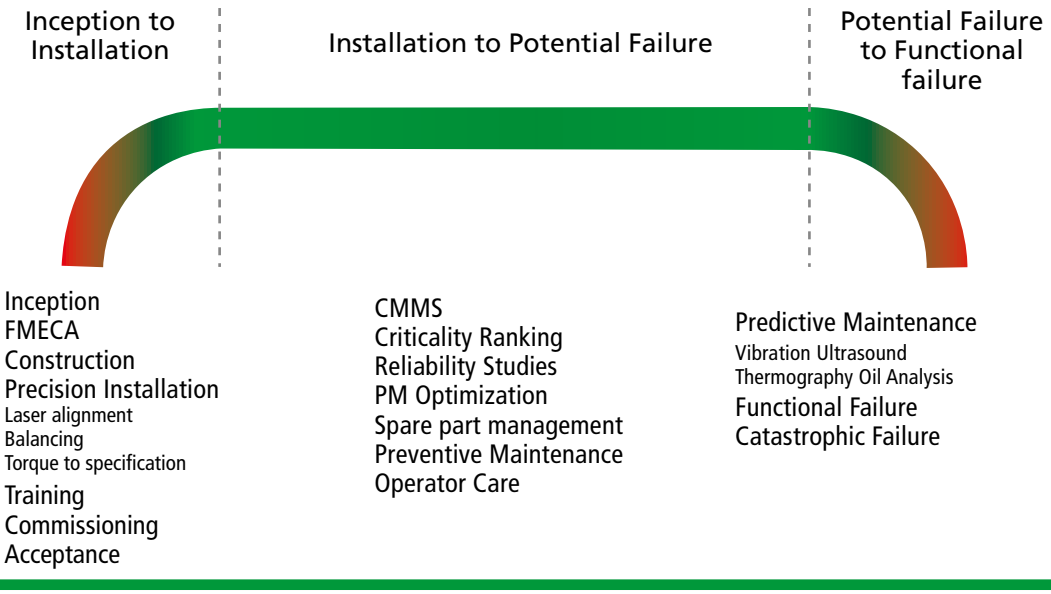
Working in prevention means taking measures to improve the availability of a plant, which depends on two factors: reliability and maintainability. To achieve this result, the joint commitment of the plant supplier and of the user is required.

What is a sustainable line?

A reliable system is a system reluctant to

PREVENTION

How the tools that make maintenance a preventive activity should be arranged throughout the life span of a plant.



break. The indicator that expresses this characteristic is the MTBF (Mean Time Between Failures), which is the expected time interval between failures for a system in operation. It can be calculated as an arithmetic mean between the failure times. The higher this value, the higher the reliability of the plant. The user's goal is to have tools with a high reliability index available. How is this possible?

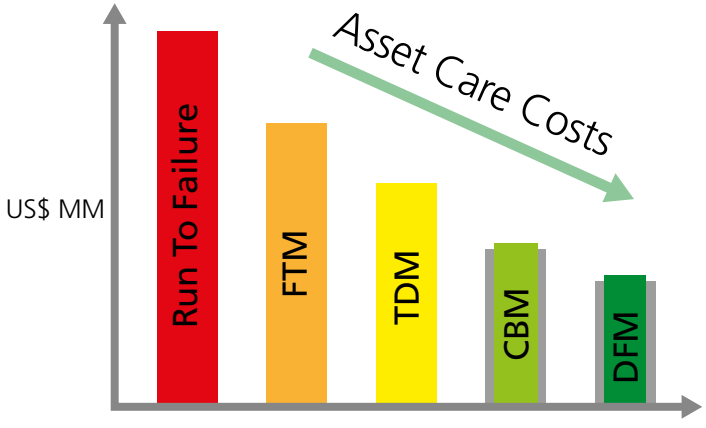
"Today," explains Schumann, "there are tools that have a positive effect on this parameter: first of all, we need to study the failure modes. Many manufacturers do this, but with a view to selling parts later. It is also useful to identify the critical points of a line or equipment with tools such as FMEA (Failure Mode and Effect Analysis) and FMECA (Failure Modes, Effects and Criticality Analysis)."

Smart spare parts

"Work must be done on the construction aspects: ceramic coatings are available that give excellent results in preventing breakage and in general new materials that are better and less subject to wear: these must be requested from suppliers. Let's imagine we have spare parts that cost 100 euros and last one year and others that cost 200 euros, but last 3, which are the cheapest? The second, of course, and as a maintenance manager, these are the ones I have to ask for, because what interests me is not the lower initial cost, but a lower Total Cost of Ownership. The whole system must be as economical as possible. Another trick is to work according to the principles of precision engineering in the design and building of a machine: for example, when it comes to installing a new machine, it must be tested first to check whether all the alignments are correct."
Total Cost of Ownership (TCO) is the sum of the costs to be incurred for the operation of a plant, from its purchase to its operational management and maintenance operations. According to Eduardo Schumann, this is the parameter to be used when choosing among different proposals for plants with the same objective.

HOW MUCH DOES YOUR APPROACH COST?

The overall cost of different ways of conceiving maintenance



Key

***Run To Failure**: wait for it to break and fix*

***Asset Care Cost:** cost of plant maintenance*

***Asset Care Approaches**: way of managing maintenance*

***FTM:** Fixed Time Maintenance-Scheduled maintenance*

***TDM:** Technology Delivery & Maintenance-Maintenance contracts*

***CBM:** Condition-Based Maintenance-Maintenance when the need arises*

***DFM:** Design for Maintenance-Design according to subsequent maintenance*

"All parts - Schumann points out - must be easy to access, and parts with the same function must be interchangeable"

Reduce intervention times

The other pillar of availability is maintainability, which is measured through the Mean Time To Recovery (MTTR). This parameter indicates how quickly a machine can be restored in the event of a failure. The lower this value, the better for availability. "Preference – he continues – must be given to machines designed to facilitate maintenance, for example, with openings for inspections without stopping production. If employees realize that a part is about to break, they can replace it before it does, reducing downtime. To avoid incorrect positioning of spare parts during replacement it is useful that the system is designed according to Poka Yoke principles." This expression, which could be translated as 'foolproof', expresses a Japanese concept and implies that a device is designed in such a way that an operation can only be performed in one way, forcing the user to perform it correctly.

Choose standard parts

The management of spare parts is an essential element in determining the maintainability of a machine. "All parts – Schumann points out – must be easy to access, and parts with the same function must be interchangeable. For example, there are too many different pumps, with different connection systems and therefore I can not use the spare pump of a machine on a different device. This complicates the maintenance of a line and increases its costs. All these criticalities should be addressed with the supplier in the design phase of a new plant, because it is very difficult to change the setting of an already built machine." The approach described above can be applied throughout the entire operating cycle of a plant.

On the starting line

At the time of installation, a detailed analysis of possible failure modes must be carried out and the tools for a precise installation (laser alignment, balancing, torsion specification) must be adopted.

The first start-up must be guided and accompanied by appropriate training of those responsible for operating and maintaining the system: "If these measures are not taken," says Schumann, "it must be taken into account that the plant has not been designed and installed to operate to the best of its ability."

Predicting the future is possible

Even after installation, during the operation of the plant, there are some tools you must equipped with before the potential failure: "For example – he explains – it is very useful to have computerized management and maintenance systems available: they are used to critically analyse the machine, defining which parts can break more or less easily. Reliability studies must be carried out, spare

parts management optimised and preventive maintenance carried out. Employees must be provided with all the information necessary for maintenance. And they don't have to be generic, but very detailed: how the machine is built, what spare parts are needed, how to position them, how they should work... This is the only way to carry out preventive maintenance. It goes without saying that the operator must take the utmost care in the management of the plant, doing everything he can to make it work in the best possible way."

Don't get ahead of the times!

When the time of a failure is approaching, you can still take preventive measures by carrying out analyses of the condition of the machine: ultrasound tests, vibration tests, lubricant analysis...

"For example, 85% of bearing failures – recalls Schumann – result from poor lubrication, the remaining 15% are due to all other possible causes. This means that even just by ensuring proper lubrication, the risk of failures is significantly reduced."

Unfortunately, all these measures represent a cost for the user, but according to Eduardo Schumann they are only apparently so: "The 'run to failure' approach, i.e. to wait for the failure and repair – he concludes – is only apparently the cheapest: in reality, the more you invest in failure prevention, the lower the cost of running the plant. In this sense in my opinion maintenance is not a cost, but an investment, because the profitability of a machine also depends on the ease with which it can be maintained". *(by Elena Consonni)* ■

IMA launches “Stay Connect!”

The platform that enhances collaborative and sharing technologies

ABSTRACT

Stay Connect! è la piattaforma lanciata da IMA che, all’interno di un unico touchpoint, potenzia e rende facilmente accessibile l’intera gamma di prodotti digitali creati dal Gruppo. Oltre al supporto rappresentato dalle CONNECTED MACHINES per monitorare da remoto lo stato di salute degli impianti, la piattaforma offre prodotti per l’assistenza tecnica, la realtà aumentata e virtuale, le applicazioni per la digital documentation, i training nelle loro diverse declinazioni.

RemoteFAT
Webinar systems for Factory Acceptance Test; FAT on machines and packaging lines carried out remotely through streaming platforms.

Collaboration, Sharing Experiences, and Digital Working are the keywords that feature Stay Connect!, the digital platform launched by IMA to enhance and offer all the Group’s digital products on a single touchpoint.

Besides the valuable support of the CONNECTED MACHINES to monitor the health status of the equipment, the platform offers product for the technical assistance, Augmented and Virtual Reality, applications for digital documentation as well as training in their different types. All of this on a single platform to facilitate partners and customers, and ensure an interaction never before achieved with machines and systems.

Augmented Reality
The Group has accelerated the process to implement new platforms for the technical assistance, such the Augmented Reality for remote assistance in case of malfunctioning on the machines.

“We are launching Stay Connect! in a particular delicate moment” says Massimo Ferioli, Director of the Organization and Coordinator of the IMA Digital initiative “and this platform is the clear message we want to give to our customers and partners: we do not stop, but rather, we accelerate, indeed”.

“We carry on our innovation activities. We are always fully active and in force, despite today’s uncertain environment, to support customers in the management of installed machines and in solving technical problems. In this, the products developed as part of the IMA Digital initiative are helping us a lot, allowing us to be active and reactive today. “Thanks to the strong drive for digital innovation that has been guiding the Group for years” Ferioli explains, “we are able to confirm the timelines and deliveries of the machineries and ongoing projects”.

Remote fat & virtual meeting

Thanks to the digital products developed and present today, the Group is able to offer the possibility to carry out FAT on machines and packaging lines remotely through streaming platforms, guaranteeing customers full efficiency and compliance with delivery deadlines on ongoing projects.

In support of the Remote FAT there are the numerous Buddy, digital assistants distributed

within the production plants. Equipped with trolley monitors, they create a virtual bridge between the workshop and the technical departments, guaranteeing operators direct access to digital documentation bypassing the need to go physically to the different technical departments. This is a flexible, smart and sustainable tool, which drastically reduces costs and times associated with this activity.

In the same way, IMA has also encouraged the use of web platforms to carry out online meetings and video conferences.

Customer care & connected field force

Technical assistance in its full efficiency. Just recently, the Group has accelerated the completion of the release of new platforms and services dedicated to technical support, such as Augmented Reality for remote assistance in case of breakdowns and problems related to the installed base. The aim, also because of what is happening at this time, is to achieve a comprehensive industrialization and market uptake as soon as possible. Thanks to the Connected Field Force APP and technologies such as AR, where it is possible to act on the machine remotely, the Group's partners can be guided in the step-by-step resolution of problems or malfunctions that have occurred on the systems. The Group then focused its efforts on continuous improvements in the relationship with the customer during the After Market phase: the IMA Service Portal, is the tool created to improve communication and manage documentation or spare parts request, technical interventions or whatever service connected to customer assistance.

Virtual training

All the technologies regarding training facilities arise from a strong desire to industrialize and distribute our products. For a long time, IMA has worked on different types of training to meet customers' needs, and in complex contexts that see a high turnover rate of operators. Among the technologies used, not only traditional e-learning courses, but also Virtual Reality (for complete training in an immersive digital environment) and Augmented Reality (to work closely with machines and systems).

BuDDy
Digital assistants able to create a virtual bridge between the workshop and the technical departments, guaranteeing operators direct access to digital documentation bypassing the need to go physically to the different technical departments.

Design

Enterprise Palm, is the corporate digital platform that connects all the Group's factories for collaborative digital work, and that supports designers in the development of the order archives. At the same time, thanks to virtual commissioning it's now possible to test machine softwares on digital environments, way before having the real machine available in the workshop. On the other hand, virtual mock-up is carried out in the same way: the designers work in synergy within a digital space to test ergonomics and improve interaction between operators and machines of future construction. ■

ConnectedFieldForce
The latest generation APP to guarantee full technical assistance to the customers of the IMA Group.

by Eduardo Schumann, Improving efficiency consultant.

New challenges for the food industry

Market dynamics require flexible lines, to avoid costs, rejects and waste. Process and packaging lines must therefore be designed from the outset to minimise downtime, using interchangeable parts

ABSTRACT

Una delle sfide da affrontare nella produzione alimentare è quella di trovare il giusto equilibrio tra produttività e flessibilità. Per ridurre i costi abbiamo bisogno contemporaneamente di un'elevata efficienza e di specializzazione degli impianti. Sappiamo che le cose cambieranno, quindi abbiamo bisogno di una certa flessibilità per modificare ricette di prodotto e formati di packaging primari. La flessibilità ha un costo. Quando si effettuano cambi formato, impostazioni e regolazioni, le macchine restano improduttive e ciò si traduce in un aumento dei costi: le macchine devono quindi essere progettate fin dall'inizio per ridurre al minimo l'inattività.

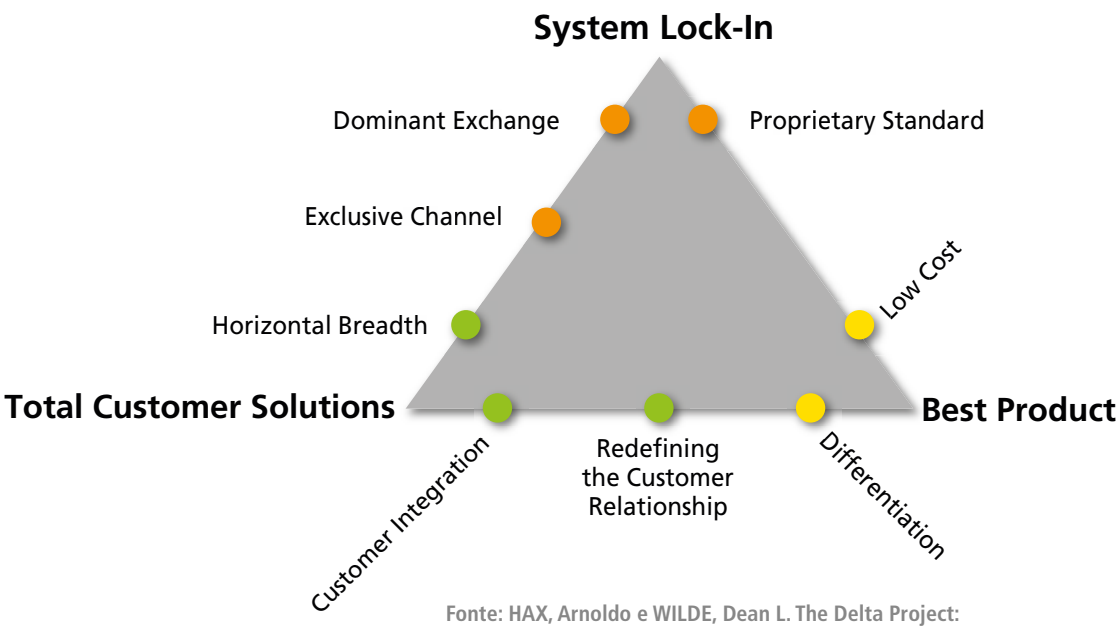
In order to keep its relevance to get a share of the pie, Food industry needs to adjust to the constant changing consumers' habits. The range of the options are bigger than ever: organic x non organic, more natural ingredients (free range eggs, no colorants, less sugar and salt, etc), packaging convenience x sustainability, fresh x shelf life, etc. Not to mention good quality. Some of those options comes with an added price tag, something that most of the consumers are not willing to pay. So, how to solve this gridlock?

Moving out of the pack

According to Michael Porter, strategy is about making choices, trade-offs; it's about deliberately choosing to be different. This approach is also confirmed by Arnoldo Hax, when looking to generic transactions (mostly of B2C) we either need to have the lowest cost or a differentiation. If you have no product differentiation, the best price will tend to win (to reduce price we often need to give up on margin damaging the company economics). In this case, the company with the best cost will probably survive at least another round.

Having competitors is already challenging, but the biggest threat of an established food product is often a "new" product (that can be a variation of an existing one). Products with a legion of adepts and good market share are constantly threatened by new launches. Even with a good brand loyalty, consumers will probably try the new products because the risk of trying something new is basically its price tag (it's not like buying a car or an appliance). Of course, the real impact of a product should be measured after the end of the promotions, normally associated to new product releases, or when it's no longer a new product. For the industry, constantly releasing new products requires some flexibility in the processing and packaging lines.

The Heinz tomato ketchup is a good example of a product that have been outliving the competition. Introduced in 1876, it still ranks high in consumer preference. To keep its relevance for so long it (.) found a good balance in the product that cannot be easily imitated by other companies. In this case, the "secret" is in the ripped tomatoes that creates most of the consistency of the ketchup. Without them, starch is needed and with it probably some sort of colorant and stabilizing agents should be also necessary. With those added chemicals, it will no longer be as natural as the original. Especially today, having a more natural product seems to be a good choice, despite an old recipe.



Fonte: HAX, Arnoldo e WILDE, Dean L. The Delta Project: Discovering New Sources of Profitability in a Networked Economy

Manufacturing Efficiency

One of the challenges we face in food production is to find a proper balance between productivity and flexibility. To minimize costs we need high equipment efficiency and specialization. In the other hand, we know things will change, so we need some flexibility to modify recipes and bottle/can sizes. Flexibility comes with a cost. All the time we are doing change overs, setups and adjustments in the machines we are not producing and that will add to our manufacturing costs.

Machines must be designed with interchangeable parts, "poka yokes" and other SMED[1)] principles from the beginning. Cleaning and sanitation must be considered as part of the production process. Improvements on those aspects will reduce planned downtime and improve equipment efficiency.

With the years of experience dealing with production lines the biggest improvement opportunity, in my opinion, still remains in the unplanned downtime. Unplanned downtime is the combination of the following elements: Operational Loss, Equipment Failure, Internal Logistics, Performance Loss and Quality Loss. It's not hard to find lines with opportunities greater than 25%. The biggest problem here is that often people are already used to it, they became the "normal", so they don't challenge those numbers any more. Micro stoppages are often not even measured. As Peter Drucker said, "If you can't measure it, you can't improve it". Measuring and dealing with those stoppages is one of the first things (to) do. Improving unplanned downtime increases asset utilization, improves efficiency and reduces costs.

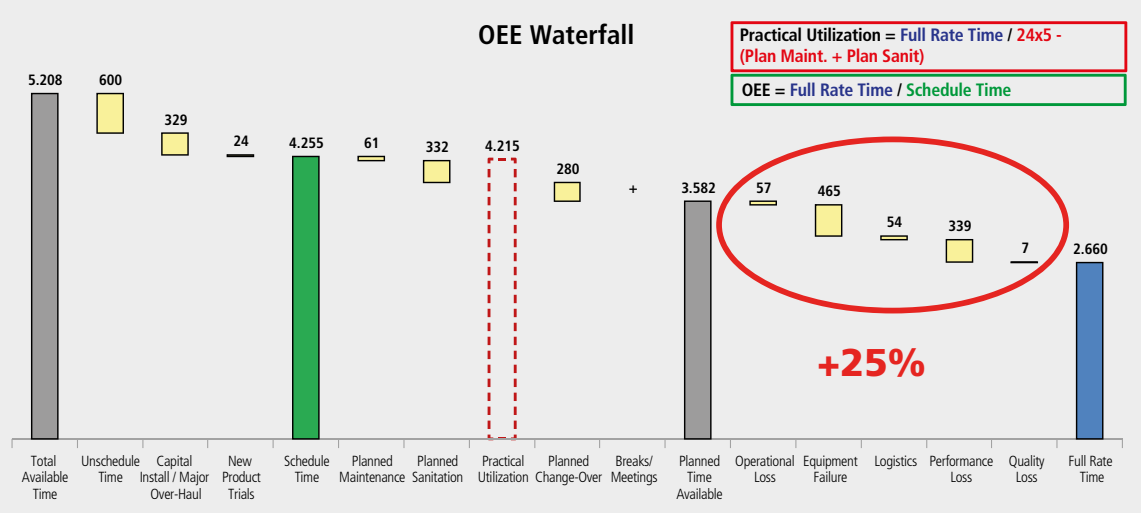
As a sub-product of improving efficiency we tend to reduce yield losses caused by breakdowns. Unfortunately, several lines were designed not taking the proper account of how much we lose in yield with scrap, change overs, cleaning/sanitation and overfill.

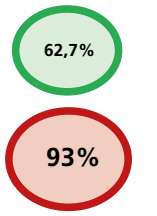
Precision engineering and the proper maintenance tools (like laser alignment) are essential not only to minimize spare parts wear and tear but also to reduce energy consumption (the level of precision required cannot be achieved by naked eye).

Under dimensioned motors are cause of breakdowns, over dimensioned are waste of energy. Air compressor leakages are often

Overall Equipment Efficiency - OEE

What is Unplanned Downtime?





- Operational Loss
- Equipment Failure
- Logistics
- Performance Loss
- Quality Loss

wasting an expensive energy. The good news is this can be improved. On top of this, new technologies can help us save energy on existing equipment better modulating the electricity flows.

Maintenance is often part of the problem, but it doesn't need to be. If we base our maintenance routines on corrective and fixed time preventive procedures, we will be doomed to fail. Good maintenance is the key to improve all the other unplanned downtimes. A robust root cause analysis is essential to create a continuous improvement mentality. Together with predictive maintenance, can boost production results and bring costs down (and this will be the topic of my next article).

Good Quality Matter

If you think quality[2] may be expensive, try out the cost of the lack of it. Right first time may cost something, but rework tend to cost more and it's often a "hidden" cost as often is not properly considered as something that could be avoided from the beginning.

Quality conformity needs a solid process and that adds steps and controls to the production (adding costs as well), but a recall costs much much more, not to mention the damages to the brand.

Do it Safely

Whatever we do in the shop floor needs to be done safely. Workers perform better in a safe environment.

Any stoppage caused by an accident add a lot of downtime. So make sure all the machines and process are as safe as possible so we have no accidents at all.

Add fail proof device in any point a mistake may cause an accident or break an equipment (if operators don't break, maintenance doesn't needs to fix it, this is always a low hanging fruit). We can never relax the attention here, any new risk must be deal with.

About everything impacts in the cost, but as mentioned before quality costs, but lack of quality is even more expensive. Same is valid for safety, maintenance, logistics and planning. So, doing the right things will tend to put costs under control.

Of course, we need to be constant looking for new ways to improve efficiencies and reducing cost.

The trick here is to find a proper balance in terms of differentiation to be attractive and relevant for the customers, while not trying to get short cuts. Keeping the discipline of doing the right thing over and over seems to me the best way for sustainable results. ■

NOTE

1) SMED = Single Minute Exchange of Dies, from the Toyota Production System

2) There are many different definitions for quality. For this analysis we are using the conformity to specification.

Predictive analytics unites with remote control

Sitma Machinery launches "We Care", a global assistance program that covers a range of needs 24/7

ABSTRACT

Sitma Machinery lancia "We Care", un programma di assistenza per coprire differenti esigenze a livello globale e in servizio 24 ore su 24. L'assistenza al cliente è basata su un sistema di CRM che è stato prima implementato in ambito 'sales' e, più recentemente, anche per la gestione dell'after-sales. Il funzionamento del CRM si basa su un software evoluto ma il vero punto di forza è nell'elevata conoscenza delle macchine da parte degli operatori: sono degli esperti di meccatronica con competenze trasversali.

Specialized in designing and building machines, systems and whole lines for the packaging, post-press, DM/transpromo and e-logistics industries, Sitma counts 9,000 machines installed in 70 countries. With such an amount of machinery distributed, the company is constantly developing its offer of services.

Customer service is centered around a CRM system, first implemented in the sales area and more recently used in After Sales to define and manage requests, requirements and interventions.

CRM employs state-of-the-art software but its true strength lies in the expertise of the machine operators. Added to their mechanical skills are proficiencies in electronics, programming and planning; they are consequently experts in mechatronics who possess cross-competencies.

Each Sitma machine is currently equipped with IoT systems for remote connection and diagnostics. Thanks to the integration of virtual channels with a comprehensive network of sensors, the systems facilitate remote assistance. Specific algorithms, through data collection, are able to make predictions regarding maintenance and performance optimization. Every single critical component of the machine is monitored in order to avoid stops during production.

"We Care is the program that integrates these tools," explains Fabio Moro, After Sales Manager at Sitma, "and enables predictive maintenance and servitization. That said, our people's skills are the mainstay of our approach to the customer."

The three macro areas of the We Care program include: After Sales, Consulting and Academy. Consulting plays a highly important role within the concept of service, as the study of requirements leads to solutions for improving production performance through customized programs that minimize the fixed costs of maintenance.

The Academy capitalizes on over 50 years of know-how to develop specially designed courses to train personnel who will be using the machines. Today, the website provides high level information and hosts an e-commerce portal for easily ordering and purchasing consumable components, soon with the possibility of ordering spare parts or components subject to wear. ■

Fabio Moro, After Sales Manager at Sitma.

AI directs the pharmaceutical industry sector

Artificial Intelligence assists companies in the IV industrial revolution; maintenance processes also optimised

ABSTRACT

Il progetto AI-Intelligenza Artificiale di Marchesini Group definisce una precisa visione del paradigma Industria 4.0 nel settore farmaceutico. Il progetto si articola in modo piramidale su tre livelli di operatività: la linea di produzione, i sistemi SCADA con le tecnologie di line management, infine i software e le tecnologie che permettono l'estrazione dei dati elaborati per trasformarli in informazioni di aiuto alle strategie di Business Intelligence.

Marchesini Group's AI project defines a specific vision of Industry 4.0 in the field of pharmaceuticals. The AI project is represented by a pyramidal system on three operating levels: the production line, the SCADA systems with the line management technologies and the software programs and technologies that extract the data processed to convert them into useful information for Business Intelligence strategies. Artificial Intelligence and deep learning algorithms enable businesses to better comprehend their processes and production indicators (KPI and OEE) and to improve the quality of their production flow, making it possible to easily pinpoint feasible causes for production drops or sugges unexploited potentials.

LEVEL 1

Intelligent machine & production line

The line chosen to launch the AI project consists of three machines for the primary and secondary packaging of pharmaceutical blister packs.

The "Integra 320" robotic blister packaging system has 5 multi vision cameras that monitor the shape, thickness and colour of the pills, as well as a NIR system that recognises the active ingredient.

The "BL-A420 CW" labeller tracks, serializes and labels the cartons so that every single pharmaceutical product packaged has its own unique identity.

The "MC 820 TT" Track & Trace case packer bundles the product at the end of the line. Thanks to experience gained on this "4.0 Ready", line the next ones will form a generation of machines and lines designed according to concepts of IoT. On this first level we also have the use of additive manufacturing (for which Marchesini has a specific prototyping centre), robotics, integrated cameras, serialization systems and cyber security technologies.

LEVEL 2

SCADA system & line management

The SCADA system provides operators with exhaustive parameters on the mechanical and functional state of the machine, at any time and in any position, be it physical or remote. Machine parameters are constantly tracked by the SCADA systems, offering numerous functions and consequently helping to cut machine monitoring costs thanks to access in real time to all the information related to the industrial processes. The vertical integration of the production lines with the SCADA and Line Management systems improves the overall production, quality and flexibility indicators.

LEVEL 3

Business intelligence & data analytics

Since the first 4.0 line was presented last year, all the machines and lines of Marchesini have been equipped with a native, state-of-the-art and modular 'software suite' called Yudoo, which exploits data transmission in real time on the UPC-UA protocol. Created by the group's partner SEA Vision, yudoo incorporates a variety of functions distributed within packets that customers can select and will provide a complete set of information based on what is requested. Yudoo collects huge amounts of data, which up to now remained hidden within the production environment, to then process and use them for various aspects: for example, to correct errors in advance, to pinpoint causes for production drops, to eliminate unscheduled down times by anticipating routine maintenance operations.

Future challenges of Industry 4.0

The contextual management of these three levels means that the semi-closed machines and lines of Marchesini become totally open ecosystems, delivering and capturing internal and external data. Thanks to the OPC-UA protocol and to interlinked technologies, complete communication is guaranteed not only inside the factory – between the machines themselves and the management systems, such as ERP e MES – but also between machines and entities outside the company (such as those that dispatch the serialized codes to be used).

Thanks to software combined with augmented reality viewers, it is also possible to offer more effective and cost effective assistance. The combined use of this information and these technologies turns the customer's factory into an AI Factory: a totally interlinked environment where intelligent machines, their related devices, the people and the factory management systems interact to create products and services in innovative and efficient workplaces. ■

by Eduardo Schumann, Improving efficiency consultant.

World Class Maintenance: guaranteeing top efficiency

Today, it is no longer acceptable to have poorly designed machines, which then become costs, those costs that companies now absolutely need to avoid

ABSTRACT

Lo scopo della manutenzione è quello di assicurarsi che tutte le macchine e apparecchiature critiche funzionino correttamente (nelle loro condizioni operative).

Se si vuole raggiungere il top nell'efficienza, a livello di classe mondiale, ciò deve avvenire al più basso costo sostenibile. Rispetto a questi obiettivi, l'intervento reattivo ("aggiustare in fretta") è un completo fallimento. Non tutte le apparecchiature/macchine sono uguali, né le loro criticità. Quindi, una delle prime cose che è necessario fare è classificare tutte le attrezzature in termini di criticità, per il singolo reparto o per l'intera azienda.

What's Maintenance? I ask this question often in my presentations. The most usual answer I receive is to "fix things". Well, if we need to rush to fix a critical equipment, we, as maintenance team, failed on our job. For me, maintenance purpose is to make sure all critical equipment is running properly (within their operating conditions). On top of this, if we want to achieve a world class level, it also needs to be at the lowest sustainable cost. Reactive work completely fails in those criteria. There are some important elements in that sentence. Let me try to explain them one by one.

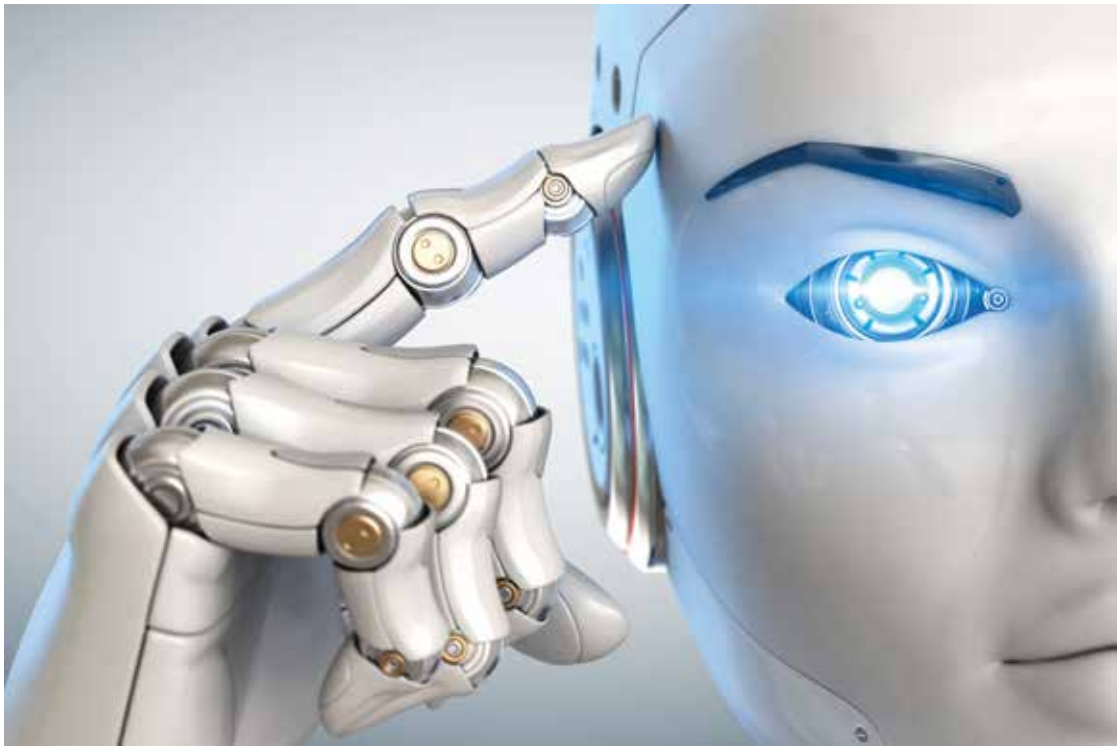
Critical Equipment

Not all equipment are the same, nor its criticality. So, one of the first things we need to do is rank all equipment in terms of criticality for the unit or company. We need to consider the risk (or its impacts) for at least: production, work safety/environment, quality/FDA safety and maintenance in this ranking. Using some metrics (a scale from "A" higher to "E" lower, for example), try to reach a normal gauss distribution[1]. Doing that, "A"s should represent something around 5% of the total equipment, while "B"s should be around 15%. In a standard Pareto[2] distribution, "A" plus "B" should account for about 20% of the equipment but that should correspond to near 80% of the problems (or risks). Of course, the initial focus, if not done already, should be on all "A" equipment. Once we have them under control, we move to the next group. Equipment with very low criticality should be analyzed by the best economical way to be maintained (and that may even be, in some cases, running to failure). Bear in mind that criticality is dynamic, so this exercise must be done periodically.

Running Properly

Trying to simplify a more complex explanation, every equipment was designed to operate in a certain speed in a given operational condition. The point here is, we get creative. We change recipes, bottle sizes, parts, speed, cleaning and sanitation methods, packaging materials, etc. Most of those things will affect how well the equipment runs and, if it doesn't run well, we have the usual suspect: It will be maintenance fault…

One way to measure how well the equipment is running is to control the line OEE[3] and the line utilization. If the line runs just one SKU[4] then it's easy, that's the final OEE. Otherwise we need to remember that different SKUs will



probably have also different performances (it's faster to fill a small jar with a low viscosity sauce than the opposite, for example). A target must be set based on the planned production for all the SKUs, considering change over time, cleaning and sanitation, normal line speed, normal time to change rolls of films, load boxes, etc. So, don't call yet Maintenance if the line performance is low, but it's within the expected performance for that specific SKU. If we don't have a target for each SKU, the line performance results may not make any sense (it will be low if we are running predominantly low performing SKUs or high if otherwise). If the line is meeting the expected target, than let's assume its running properly. It, however, doesn't mean we cannot improve it (every planned and unplanned downtime may be an improvement opportunity), but that is another story. At this point you may be asking: why OEE and not availability? Despite availability being more directly related to maintenance performance, the other 2 elements of the OEE are also affected (either for good or bad) by maintenance. So having OEE as main KPI[5] reinforces, among other things, the need for team cooperation and integration between production and maintenance.

Lowest Sustainable Cost

Machines need some time for maintenance and the Maintenance team will have its time either for good or for bad. For good happens whenever we apply the proper techniques and use all the windows of opportunities to do the required interventions with no additional downtime or, for bad, in case of a machine breakdown. Here time is money. A fast and specific intervention as result of a predictive inspection or a sensor reading will more likely be effective. In case of a breakdown, it will take some time to figure out what happened and what is the extension of the damage. Not to mention that some failures compromise other parts of the equipment that otherwise would still be ok. And, of course, we may have the

Machines need some time for maintenance and the Maintenance team will have its time either for good or for bad

Time based preventive routines are actually not much better than running to failure in terms of costs

production and yield losses as consequence of the breakdown. All those will also turn to cost.

Getting better at corrective for critical equipment is not a good solution. Direct your efforts elsewhere. There's no sense in getting better in something that should not be done at all.

Time based preventive routines are actually not much better than running to failure in terms of costs. Several studies got similar results, ranging from 80 to 88% of the spare parts normally replaced in such routines did not show signs of tear and wear that justified the replacement. It means, money thrown away. To make if even worse, in most of the cases, it doesn't avoid breakdowns either. So, we spent money to replace parts that were not bad yet, to avoid breakdowns that still happened…

As I mentioned before, rushing to fix a critical equipment is bad. Critical equipment should not fail. We need to monitor (preferable with sensors) the potential failure points (Paretos, analysis and FMEA studies[6]) are required to determine those points). It's imperative that we monitor the right things. Overloading a machine with sensors may not give us reliable information (don't confuse data with information). If we get really good with the on-line predictive maintenance, time based preventive routines may not be needed and corrective may be completely avoided.

Monitoring is part of the task. Another part involves improving reliability of the spare parts we use. There was recently development of new materials (new alloys, ceramics, coatings, etc.) and new production techniques (including precision tools and 3D printing for hard metal). Most of the equipment we are using now, were developed before those materials and techniques became available at a reasonable cost. We can modify the equipment to take advantage of them (using the right opportunities, like an overhaul). Sometimes, the cost of those new materials may seem higher than what we are

normally buying. The cost that really matters is called "Total Cost of Ownership"[7]. So, if a spare part cost a little bit more but last much longer it will have a better Total Cost of Ownership than one that the initial cost is lower but requires constant replacement. Not to mention that the cost of the spare parts is not the final cost, we need to add the time for the maintenance team and the time the asset is not producing to the equation. In summary, when we consider all costs, cheap spare parts may not be cheap at all.

There's more. Every time we open a machine there's a possibility we end up creating a new problem. Machines are not just a bunch of parts assembly together, they require tuning and adjustments. More complex the machines more important the usage of precision tools like laser alignment, digital calipers, torque wrench and so on. On top of that, to minimize more errors, machines could be built using more "poka yokes"[8] and standardized and interchangeable parts and pieces.

On top of monitoring and improving the machines we have cleaning and lubrication. Poor lubrication is, for example, the main cause of bearing failures (too much, not sufficient, wrong grease, contamination, etc.), but yet in many cases we leave this task for operators because its "simple". Perhaps it's time to rethink. Avoiding problems is one of the best ways to minimize costs. If it doesn't break, we don't need to fix it.

There's no magic here. The lowest sustainable cost will be the total cost of keeping the discipline of doing the right routines to maintain the machines running properly. Considering the current technology we are mostly using, this tends to something close to 2.5% MC/ERV[9] (where MC=Total Maintenance Cost and ERV=Estimated Replacing Value).

Keeping the discipline costs money. There's a limit some parts can run. Not keeping the discipline costs even more, it falls back to the reactive mode (correctives), accelerates equipment deterioration and brings higher costs for either overhauls or asset replacements.

Keeping the discipline costs money. There's a limit some parts can run

Can we do it better?

There's so much we can do with some equipment, but it doesn't need to be like that. We can change the equipment for better. At some point, equipment needs to be maintained. Unfortunately, some engineers seems to forget that, especially when we see machines with no easy access for parts that requires constant inspection, lack of "poka yokes", no SMED exercise[10] for designing the equipment, poor use of interchangeable parts, etc. To improve productivity and further reduce operating costs we need machines that are designed for maintenance as well.

Same applies for production lines projects. Maintenance should start somewhere between FEL 1 and FEL 2[11], not at the end of a project. Optimization can only happen if done in the early stages to maximize synergies, improve designs, make use of standard spare parts to optimize stock parts inventory (whenever possible, of course).

If we improve machine design (better considering maintenance) and improve line projects, the MC/ERV can go down to something near 2.0%. Nowadays having machines poorly designed is no longer acceptable. Companies need this kind of savings, so a better integration with suppliers is needed to move to the next level: a World Class maintenance starts with a World Class equipment. ■

NOTE

1) La distribuzione normale, o di Gauss (o gaussiana), è una distribuzione di probabilità continua che è spesso usata per descrivere variabili casuali a valori reali che tendono a concentrarsi attorno a un singolo valore medio. Il grafico della funzione di densità di probabilità associata è simmetrico e ha una forma a campana, nota come campana di Gauss.

2) L'analisi di Pareto aiuta a definire i maggiori fattori che hanno influenza su un dato fenomeno ed è molto utile nei processi decisionali. Sfruttando queste osservazioni, è possibile analizzare un insieme di dati in modo da determinare le poche variabili (fra le tante in esame) che influenzano significativamente i risultati finali di un determinato fenomeno.

3) L'Overall Equipment Effectiveness (OEE) è la misura di efficacia totale di un impianto. È un indice espresso in punti percentuali che riassume in sé tre concetti molto importanti dal punto di vista della produzione manifatturiera: la disponibilità, l'efficienza ed il tasso di qualità di un impianto. L'OEE fornisce un'importante chiave di lettura dell'efficacia delle misure adottate fornendo al tempo stesso un supporto per la misurazione dell'efficienza.

4) SKU: acronimo di Stock Keeping Unit; in supply management, serve per identificare il singolo articolo gestito a magazzino.

5) KPI: acronimo di Key Performance Indicator, i KPI sono indicatori quali-quantitativi utilizzati per valutare l'andamento delle performance aziendali, ovvero per verificare il grado di raggiungimento degli obiettivi prefissati.

6) La FMEA (o Analisi dei modi e degli effetti dei guasti, dall'inglese Failure Mode and Effect Analysis) è una metodologia utilizzata per analizzare le modalità di guasto o di difetto di un processo, prodotto o sistema. Per tutte le combinazioni modo di guasto – causa, si valutano, soppesandoli, tre fattori: probabilità di accadimento (P), gravità dell'effetto (G), rilevabilità da parte dei controlli (R) e la loro analisi porta ad individuare i modi di guasto più critici mediante l'Indice di Priorità del Rischio RPN (RPN=PxGxR).

7) Total Cost of Ownership (TCO), in italiano Costo Totale di Possesso, è un approccio sviluppato da Gartner nel 1987, utilizzato per calcolare tutti i costi del ciclo di vita di un'apparecchiatura. L'approccio TCO è basato sulla considerazione che il costo totale di utilizzo di un'apparecchiatura non dipende solo dai costi di acquisto, ma anche da tutti i costi che intervengono durante l'intera vita di esercizio della macchina.

8) Poka-yoke, termine giapponese, significa "a prova di errore". È utilizzato nel settore del disegno industriale per indicare una scelta progettuale o un'apparecchiatura che, ponendo dei limiti al modo in cui una operazione può essere compiuta, forza l'utilizzatore ad una corretta esecuzione della stessa.

9) MC/ERV è un diffuso indicatore che rappresenta il costo totale di manutenzione (MC) come percentuale del valore di sostituzione stimato (ERV). È uno strumento prezioso per stabilire obiettivi a lungo termine, soprattutto se usato correttamente in combinazione con obiettivi di affidabilità degli impianti. Realtà World-Class tendono ad avere il loro costo di manutenzione nel range 2,0-2,5%.

10) Lo SMED, dall'inglese Single Minute Exchange of Die (cambio stampo in un solo digit), è una metodologia – integrata nella teoria della *lean production* – volta alla riduzione dei tempi di setup (o tempi di cambio produzione o formato).

11) FEL è l'acronimo di Front-End Loading; il riferimento è al processo *stage&gate* per lo sviluppo progetti, in base al quale un progetto deve passare attraverso *gate* formali a tappe ben definite (da cui FEL 1, FEL 2, etc.), ciascuno preceduto da uno specifico stage in cui effettuare la ricerca di informazioni strategiche necessarie per affrontare il rischio e le conseguenti decisioni, per passare poi alla fase successiva. Il tutto al fine di massimizzare le probabilità di successo. Il FEL include una pianificazione e una progettazione robuste all'inizio del progetto, quando la capacità di influenzare i cambiamenti nel design è ancora elevata e il costo per tali modifiche è relativamente basso. Sebbene ciò aggiunge tempi e costi alle primissime fasi del progetto, questi sono minori rispetto all'alternativa dei costi e degli sforzi richiesti per apportare modifiche in una successiva fase o, peggio, una volta installate le macchine.

Savings may end up being very expensive!

by Eduardo Schumann, Improving efficiency consultant.

Cutting Operational Team in Maintenance may actually add more costs in Production than the potential savings

ABSTRACT

L'articolo si sofferma sui costi nascosti e palesi della manutenzione di impianti. Stabilisce quella che dovrebbe essere la regola generale per calcolare il budget della manutenzione, visto come percentuale del Valore del Patrimonio ed è la misura di riferimento universale del successo delle prestazioni manutentive. Si considerano infine gli aspetti dell'overtime (ore straordinarie) e si suggerisce di bilanciare fra ore straordinarie e ore ordinarie.

I often receive questionings about maintenance costs. Particularly about cost-cutting. Let me try to explain this point a little bit better. If you are in a process-oriented organization or have not installed a reliability-centric model, chances are you still have improvements left to be implemented, it means both your costs and your service level may not be yet at an optimal point. In this case, there's still plenty of work to be done. Once we reach this optimal point reducing further costs may be tricky, especially because cutting costs in maintenance will more likely increase costs elsewhere (and sometimes they may not be that clear).

One way to establish a maintenance budget target is to use TMC/ERV, in other words, the Total Maintenance Costs (people + services + spare parts + others) divided by the Estimated Replacing Value of the assets (not considering depreciation). It is not a perfect method but gives a very good starting point.

A rough figure will place the optimal cost somewhere between 2% to 2.5% MC/ERV as a maintenance budget target (considering asset replacement will be done out of CAPEX). This ratio may vary little considering machine designs, technologies in use and regulations. In general terms (there are some valid exceptions), companies with numbers above 2.5% still can improve towards a more reliability centric model and cash out some money while improving reliability and availability at the same time (doing the "right" things).

Companies with numbers below 2% MC/ERV may appear to be low but is highly likely to be experiencing additional costs elsewhere, caused by maintenance issues. Those costs may be hidden in sub-optimal OEE, normally resulting from either lower performance and/or excess of machine breakdowns which will also affect service levels, yield losses (products and packaging materials), quality, energy consumption and rework.

They may also be hidden in additional CAPEX resulting from a faster deterioration of the assets. Not to mention safety and regulatory risks that could eventually result in avoidable accidents. It seems when an accident happens, people remember the things that were left undone, but then it is already too late.

One of the most common targets of cost-cutting is over time. It kind make sense, most of the work should be done during regular shift hours. However, there's a detail here. If Maintenance and Production are using the same shift hours, the math may not work. Maintenance goal is to ensure machines are working during production shift hours. Unless we have over capacity (which is rare nowadays), having preventive routines during production shift hours we may avoid over time in maintenance but adding much more cost on Production due to the lack of equipment ready to use. How much cost equipment stopped during regular shift hours? How many production workers hours are lost? Can we meet the demand using normal shift hours? In this scenario, cutting Operational Team in Maintenance may actually add more costs in Production than the potential savings. Savings are important. The goal should be reaching the lowest sustainable maintenance cost while ensuring all critical equipment is running properly. Below that point, "savings" may end up being very expensive. ■

"Small" but with full-scale customer service

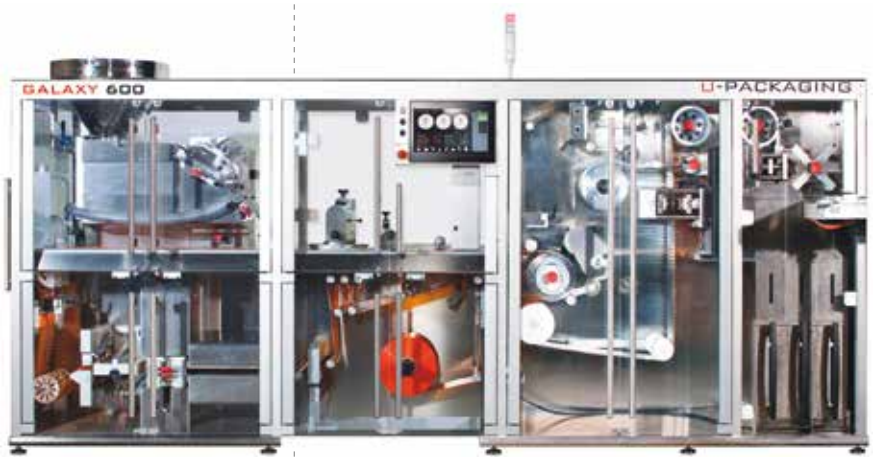
The packaging machines intended for SMEs in the pharmaceutical, nutraceutical-herbal medicine and cosmetic sectors have to be 'smart' when it come to repair and maintenance

ABSTRACT

Specializzazione ed interdisciplinarietà dei tecnici addetti alla manutenzione, predittività, teleassistenza, formazione per dare autonomia a chi opera a bordo macchina e manutenzione routinaria: sono i cinque punti chiave della strategia di U-packaging per assistere i clienti nella manutenzione di macchine dedicate ai settori pharma, nutraceutica-erboristeria e cosmetica e destinati ai mercati di Asia, Europa ed Africa.

U-packaging was founded in 2014 outside Bologna with the goal of supplying automated machines that are differentiated from those of the large groups of Packaging Valley in terms of size, applied technologies and customization options.

The range of machinery includes four models of thermoforming machines for blisters and trays, two horizontal cartoning machines and integrated systems for printing and control of variable data. The philosophy that drives the construction of the machines is based on the following criteria:



- Small but high-performing: they are the smallest on the market but are equal in performance thanks to patented technologies and innovative design solutions: blister and thermoforming machines with an output of 80 blisters/min. in less than 2 m in width, 250 blisters/min. in less than 3 m, and 600 blisters/min in slightly over 4 m.
- High technology: they only use Siemens drive components and logic with a user interface on large operator panels inspired by mobile devices.
- High level of customization: what is difficult and costly for the big players on the market to offer is the norm for U-packaging, thanks to R&D systems accompanied by innovative production systems.
- Aesthetics: design is characterized by understated, yet typical Italian styling.

Using these criteria, U-packaging builds machines for the pharmaceutical, nutraceutical-herbal medicine and cosmetic sectors in Asia, Europe and Africa. Maintenance plays a critical role for the small-sized company, which has embraced broad horizons and internation-

al ambitions from the start. Their strategy is based on five factors:

Specialized and interdisciplinary: the technicians dedicated to assistance personally take part in the assembly and observe every single component-phase; and with the goal of maximizing specialization, they oversee no more than two machine models each. The multi-disciplinary approach, i.e., the ability to work on both the mechanical and electric/electronic aspects, allows a higher number of operations to be performed with a reduced number of staff.

Predictivity: various sensors installed in focal areas alert the operator of potential malfunctions well before they actually occur; the possibility to anticipate them greatly reduces machine downtime.

Teleassistance: a cloud service to which the machines are connected (or connected on demand) allows the technicians to identify current malfunctions in real time by means of a direct communications system installed on the machines. The system uses augmented reality, with step-by-step instruction to the operators on the required actions in order to reduce the cause of breakdown and quickly reactivate production.

Training: the company's U-academy unit benefits from the collaboration with partners and provides educational services so that those working on board the machine are able to understand and solve the main causes for malfunctions and machine breakdown. This service integrates and completes the brief training sessions offered during the F.A.T. and S.A.T. phases.

Routine maintenance: the periodic maintenance carried out on a quarterly, biannual or yearly basis involves a protocol similar to that implemented in the aeronautics industry: controls are made not only on the parts most subject to wear, but on entire units of components of the machine and/or line. A form is filled out so that the technician has record of the control of specified components.

This combination of technologies and services is not very sustainable for medium and large builders of automated machines; whereas for a company that has adopted the 'small' philosophy, the fixed costs are lower, production processes rationalized, and the sales team closer knit.

U-packaging maintains a relationship with employees by offering a company welfare system based on the Anglo-Saxon model; it incentivizes environmentally friendly practices and encourages the joint collaboration with the customer more than the sale, aiming to characterize the machine according to an Italian approach. ■

by Eduardo Schumann, Improving efficiency consultant.

How to optimize results and minimize breakdowns

Equipment got more complex, companies an ever-increasing need for productivity and, on top of everything, costs reductions

ABSTRACT

Massimizzare i risultati, ridurre i guasti. I costruttori di impianti seguono la logica di tenere gli impianti nelle condizioni di operatività originali, mentre gli utilizzatori inseguono il miglioramento della prestazione.

Le operazioni di manutenzione preventiva fanno guadagnare i fornitori, non l'industria che si confronta ogni giorno con il taglio delle previsioni di spesa e con l'efficienza e che quindi si orienta verso altre soluzioni. La soluzione è che costruttori e utilizzatori condividano due obiettivi: efficienza e controllo dei costi, con la prospettiva di fare business entrambi ma in un modo del tutto innovativo.

In questo articolo, uno schema delle attività che portano all'efficienza di prestazioni e costi, dalla progettazione fino alla manutenzione, a prescindere dal fatto che progettazione e manutenzione siano svolte internamente o eseguite al fornitore.

Long time ago (before the WWII), maintenance routines were very simple. Basically, fixing when it breaks. A relationship with a supplier, in this case, wasn't that hard, based basically on spot transactions. Over the time, things changed. Equipment got more complex, companies an ever-increasing need for productivity and, on top of everything, costs reductions. The relationship with most of the suppliers regarding maintenance got, somehow, stuck in time.

Despite all the new technologies available nowadays, most of the maintenance guides and routines proposed by the suppliers, when we buy new machines, are still set on time base preventive routines. As I explained on a previous article, especially in terms of costs, time based preventive routines are not much worse than fixing when it breaks. Despite making sense replacing some parts before its nominal lifetime is reached, several studies show that the majority of the spare parts replaced in time based PMs do not show signs of wear that justified the replacement. More than that, they do not avoid breakdowns either. Guess who pays the bill? The cost of this inefficiency goes to the clients. The biggest problem here is that current maintenance budgets cannot afford that anymore.

There's a process that needs to be followed to achieve optimal results, independent of being internal or outsourced. Trying to summarize, it should include:

New projects

- Analysis of new equipment (while still in project)
- Reliability of the components
- Standardization of spare parts
- Sensors required for on-line CBM and predictive routines
- Preventive routines
- Follow-up of installation and commissioning of the new equipment (which must use precision engineering)

Maintenance Engineering and Routines definitions

- Alignment with the corporate maintenance strategies
- Critically ranking
- Predictive, Preventive, Corrective and Lubrication routines definition
- Critical spare parts definition
- Equipment history
- Reliability and FMEA studies

- Risk analysis
- New vendor development
- Application of SMED methodology on maintenance routines
- Testing
- Training
- Analysis of the machine monitoring

Planning & Scheduling

- Maintenance Cost Structure
- Year and monthly planning (master schedule)
- Overhauls
- Resources analysis
- Detailed scheduling with activities to be executed, knowledge/certification to do the job, time required, tools needed, spare parts to replace, safety equipment to be used and so on
- Work orders
- Follow-ups and improvements for the next service

CBM

- Predictive routes and equipment monitoring and trends
- Sensors analysis
- Oil analysis
- Production losses
- Fault prevention

Execution of the maintenance routines

- Work assignment and execution
- Short Interval Control of the execution
- War room (in case of major activities)
- On the job training and coaching
- Follow-up
- Analysis of eventual deviations
- Process & Controls Audits

Root cause analysis

Results and budget control

- KPIs and leading indicators
- Weekly follow-up routines
- Daily follow-ups
- Improvement opportunities
- Reporting

Several of those activities can be outsourced, but that's only a small part of the issue. As we can see, the goal, for me, is not to maintain the equipment in their original condition, instead to optimize its results (especially avoiding/minimizing breakdowns). If we have a part that is constantly failing, it does not matter if this is an OEM part, it needs to be replaced by something else more reliable (with different design or material) improving the asset lifespan. In this point, clients and suppliers start to have different goals. Suppliers tend to want to keep their equipment the way they originally designed it and, in the other side, more and more, clients want results.

Also, keeping the time-based preventive routines means business for the suppliers. They sell spare parts and services. The more needed, more business. Huge budget cuts and the need for improving efficiency pushes clients in other direction.

I believe a new way of partnership is needed to align clients and suppliers to a common set of goals. Two of the key elements in this alignment should be equipment performance and costs. Where performance should either be OEE or total packages produced. ■

by Eduardo Schumann, Improving efficiency consultant.

Going digital

Industry 4.0 will help us do more with less, but it will require well-documented process and capable humans

ABSTRACT

La digitalizzazione completa richiederà la sostituzione di circa il 40-50% delle apparecchiature e le restanti avranno la possibilità di integrarsi nella rete digitale, con l'installazione di sensori o attuatori adeguati. Il primo vantaggio della digitalizzazione sarà il miglioramento dell'utilizzo delle risorse; il parco macchine di un'azienda genererà maggior valore rispetto ad oggi.

We are entering the age of Industry 4.0 with several interesting technologies becoming more available and affordable, but somehow, we are often facing +50 years old issues. Considerable yield and packaging losses remain a reality in several industries, being a good part associated with poor changeovers and unplanned downtimes.

There are several very promising new technologies on the horizon that will improve the way we produce things. Some like On-Line Monitoring/Condition Based Maintenance, Artificial Intelligence, Augmented Reality, 3D Printing, are already available. Of course, there's the right moment to bet in new technologies. Very early adopters may pay an extra burden for learning and adjusting new things. Sometimes it worth being a pioneer. In the other hand, fast followers can see what is working and jump on the most promising solution at an already better cost with fewer risks. Change, however, is inevitable.

Smart factories

With the integration of those new technologies we get to the vision of Industry 4.0, most enterprise processes – manufacturing, product development, customer relations, and the workplace itself – must become fully digitized. Industry 4.0 introduces what has been called the "smart factory," in which (as generalized synthesis) cyber-physical systems monitor the physical processes of the factory and make faster-decentralized decisions. The physical systems become the so-called "Internet of Things" (IoT), communicating and cooperating with humans in real time.

A new vision of maintenance

As part of IoT, Condition Based Maintenance is very good and proved technology that I implemented on several sites. This could be possible by specific sensors on the equipment that collect and report data on the condition of the machinery. Based on the sensor data, early signs of problems are detected for timely cor-

rection at minimal costs, maintenance resources can be prioritized and optimized, and machine availability can be increased. Now CBM it is getting even better. Artificial intelligence is now able to help identify issues related to combinations of factors that standard trending analysis of isolated sensors could not. This makes CBM even more powerful, increasing, even more, its already good benefits. Which raises a question: why isn't it more widely used? Brand new equipment is often lacking those more modern capabilities.

What is the most important cost?

Of course, cost matters, and a lot. I will insist on one fundamental question: which cost do you believe is the most important? The one-time cost of the project or the combined cost of the equipment and its operational expenses (including maintenance and packaging) over the years? Although the answer seems to be obvious, several companies do not focus on the total cost of ownership looking just for the lowest cost of the equipment of the current project, ignoring that the OPEX of such equipment will cost several times more along its lifecycle than it would loading with better design and technology. It may cost a little bit more upfront, but the return of the investment tends to become way better.

How to use three-dimensional printing

With 3D printing, we can use improve machine design (it makes easier to create poka yokes, for example) to increase reliability, minimize failures and unplanned downtime (and all its associated costs). Basically, any machine with moving parts and is not for one-time use will need maintenance at a certain point in its lifecycle (which is the case of production equipment). It means we need to dismantle it and put it back the same way it was before. Nowadays, even trained technicians from top suppliers sometimes fail in having a right first time due to suboptimal machine designs. Imagine what happens with not so trained technicians… The technology is ready to use and if we combine 3D printing elements with new materials to improve machine design, the possibilities are even better.

Legend of the acronyms

AR Augmented Reality

SMED Single Minute Exchange of Dies

FMEA Failure Modes & Effects Analysis

CBM Condition Based Maintenance

Help from augmented reality

Keeping the operational discipline of the maintenance and production teams is often a challenge. Making sure the operators are following all the standard operating procedures is not always easy, especially in areas with high turnover. The discipline of preventive routines and change overs can now be improved with augmented reality, reducing errors and improving right first time of the lines. Looks like science fiction, but it really works.

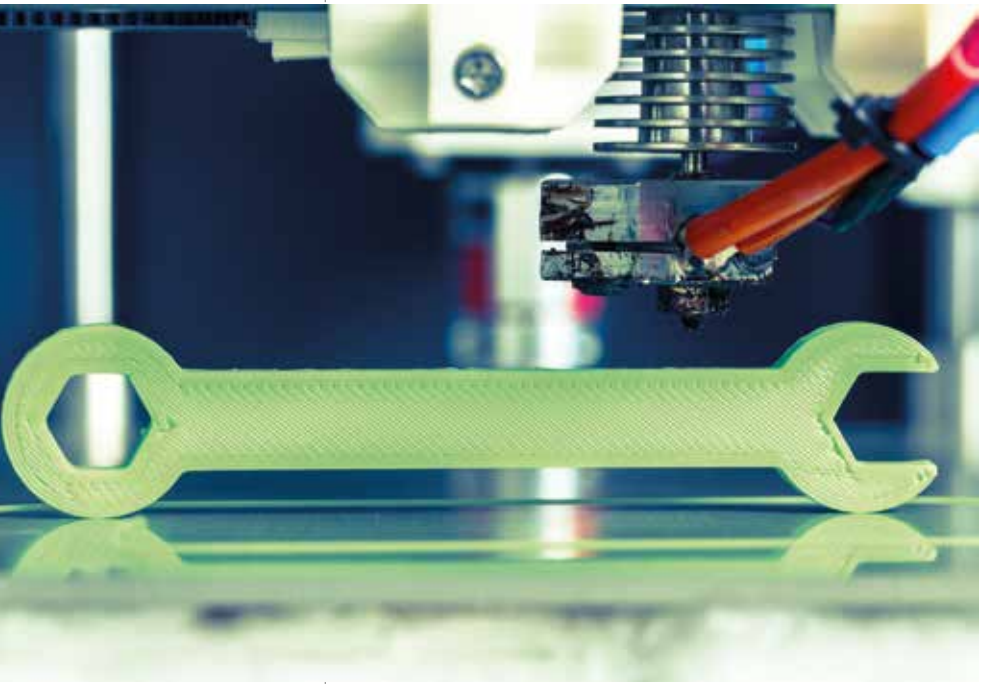
The future market for automatic machines

Recent studies on Industry 4.0 confirm that the full digitization will require the replacement of about 40-50% of the equipment and the remaining have the possibility to become integrated into the digital network, with the installation of appropriate sensor or actuators. The first benefit of digitization will be improving asset utilization drives value by making the best use of a company's machinery park. Every minute a machine is idle or down causes a loss (either capital expenditures or lost revenue). Industry 4.0 levers, like predictive maintenance, can thus drive value by decreasing machine downtime.

The disruptive technologies of Industry 4.0, such as IT-enabled manufacturing and increased computing capacity, hold the promise of smart factories that are highly efficient and increasingly data integrated. Data is the core driver: leaders across industries are leveraging data and analytics to achieve a step change in value creation. A big data/advanced analytics approach can improve production volume and reduce downtime.

The hierarchy of activities

As Industry 4.0 is a clear way forward there are, however, several steps to get there. We need to ensure basic conditions are in place before moving to implement some digital technologies. Most of the new technologies do not replace the needs of standard routines. In Maintenance, there's a hierarchic of the activities, like a pyramid (I will cover this in another article). To reach a higher level we need to master the lower level (and keep doing it). Most of the new activities instead of replacing the existing ones will complement each other. For example: to implement AR we need to have done a proper SMED. To implement SMED we need good standard routines. To install sensors for CBM we need to understand the machine, its critical points, its FMEA, the most common issues (through paretos), etc. We need data and feedback from good operators.



Industry 4.0 will help us do more with less, but it will require well-documented process and capable humans. The way of working will be different, but is there any place in the world that is working today the same way it was working 10 years ago? ■

Creating a maintenance culture of success

An ever-changing environment. To achieve sustainability, every business needs to reinvent itself from time to time

by Eduardo Schumann, Improving efficiency consultant.

ABSTRACT

In questo articolo Eduardo Schumann pone le basi culturali e metodologiche per affrontare il problema dell'efficienza economica degli impianti industriali. Le nuove tecnologie, utilizzate correttamente, possono aiutarci a ottenere una migliore efficienza senza manutenzione ma, senza una cultura e un ambiente di cambiamento adeguati, potrebbero non riuscire. Se non rafforziamo e non riconosciamo i comportamenti giusti, le persone smetteranno semplicemente di farlo. Diffondere prima delle tecnologie la cultura della manutenzione significa passare da una modalità reattiva, pompieristica, che interviene quando scoppia un incendio, ad una proattiva, che previene i problemi e che si basa sull'integrazione fra metodo, comportamento dei team, tecnologie ausiliarie, produzione di dati e loro interpretazione. Schumann suggerisce di adottare mentalmente ed operativamente uno schema a piramide, che indichi le priorità e le sequenze per arrivare al risultato ottimale: la sostenibilità economica delle attività di manutenzione.

The whole industry is changing. Artificial intelligence and Industry 4.0 are no longer utopic ideas for a distant future, they are already installed in several companies. With them, things we used to do also need to be reevaluated. There are new challenges and opportunities at hand. Maintenance teams cannot keep doing just the same old things. Maintenance leadership must be able to create an environment of continuous improvement and change, without compromising fundamental tasks and good practices. To achieve sustainability, every business needs to reinvent itself from time to time. Change is necessary. However, change is also difficult and challenging. People tend to resist new things (finding all sort of justifications) and, for whatever reason, this is very accentuated in Maintenance.

So, why do we need to keep changing? What do we want to achieve with Maintenance anyway? For me, maintenance purpose is to ensure all critical equipment are running properly at the lowest sustainable cost possible. The maintenance culture must be aligned with this motto. Process and behaviors should be oriented to avoid breakdowns and unplanned downtime on any critical machine. Whatever we use today, the most advanced technologies, the current best equipment will all become outdated and even obsolete in the near future. So, the same way we need to maintain our assets, we need to maintain our people, processes, and culture to take advantage of new opportunities to improve.

New technologies, used properly, can help us to achieve better efficiency out of maintenance but, without a proper culture and environment of change, they may fail.

Are we acknowledging and rewarding the right behaviors in Maintenance?

What is the current culture we are fostering? Are we encouraging the best behaviors?

Let's do a quick check. In the past month, who did you praise most: the people that fire fought a breakdown or the people who avoided breakdowns from happening?

How many times did you compliment a maintenance guy for fixing a breakdown? How many times did you compliment somebody for not letting a machine break?

It doesn't matter much what we write in pro-

cedures and routines. If we do not reinforce and recognize the right behaviors, people will just stop doing it.

Likewise, how many times our maintenance guys taught operators on how to use machines properly to avoid breakdowns? If operators do not damage machines, maintenance doesn't need to fix them. It's one of the easiest low hanging fruits.

The more we (maintenance) interact with operators, by helping them to operate machines better, the more response on early issues we get (different noises, strange vibrations, high temperature, etc). Are we also reinforcing this kind of behavior?

For critical equipment, we need something better. We need efficiency. If we list all the things we need to do to achieve a high-efficiency level, we can see the need to install some process to be able to create the base for another more advanced or sophisticated process

What got us here, may not get us there

We cannot capture the full benefit of new technologies if we are still firefighting issues on the shop floor. Our first target should be minimizing unplanned downtime and after that reducing the planned downtime (yes, normally we can also do much better at it). Improving unplanned downtime has nothing to do with fixing things faster. There's no sense in getting better at something that should not be done at all. We should avoid breakdowns, especially on critical equipment. But don't stop there, small stoppages and speed losses also tend to account for significantly improving opportunities.

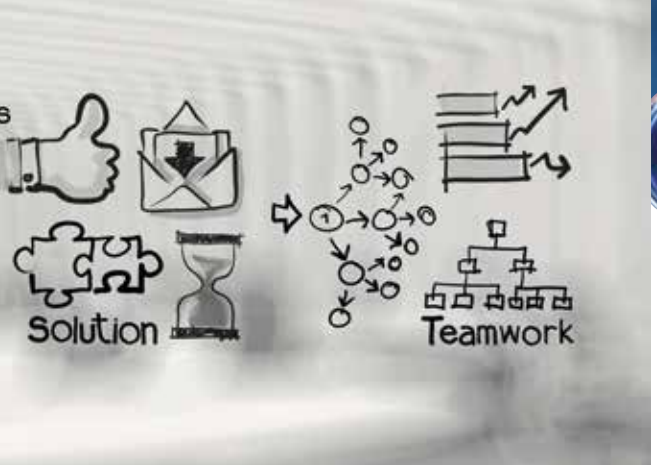
Next, we need to go after the planned downtime. Time-based preventive routines are actually not much better than running to failure in terms of costs. Several studies produced similar results; 80-88% of the spare parts normally replaced in such routines did not show signs of tear and wear that justified the replacement. It means, money thrown away. To make it worse, in most cases, PMs doesn't avoid breakdowns either. So, we spend money to replace parts that were not yet bad, to try to avoid problems that will keep happening because we not acting in the right places… It gets even worse, some people instead of reviewing the PM process itself opt for reducing the time between preventives, adding even more costs to the business. Don't forget cleaning and change-overs, if not done properly may lead to equipment issues and breakdowns.

For critical equipment, we need something better. We need efficiency. If we list all the things we need to do to achieve a high-efficiency level, we can see the need to install some process to be able to create the base for another more advanced or sophisticated process. There's a kind of optimal order for doing things in maintenance. If we put all in order, we will get something that resembles a pyramid.

The behavior improvement is part of what I call "pro-active" level, but this is the third level. The first level, "fundamentals", most of the time, unfortunately, leave us in a firefighting mode. However, we need to build those fundamentals; we just can't stop there. The following level is "planned maintenance". Things start to get better at the "pro-active" level where we should be doing continuous improvement, root cause analysis (RCA), fault elimination, reliability studies and so on. But guess what, we can do better still. I will get back to this later.

We, as leaders, need to push implementations and take people by their hands until they reach a point they can do improvements by themselves. Firefighting and time-based preventive routines are way below of what we can achieve in maintenance. Current budgets and quality requirements entail us to do much better. And better, in this case, is possible.

Nowadays having good technicians is just a small part of what we need. We need to create teams with both diversity and participation to achieve a collective intelligence which will be



bigger than the sum of the parts. The behavior of the leaders is instrumental to foster this kind of team. Capable teams will take ownership for the right tools and processes to improve and sustain high-level results.

New technologies, used properly, can open new options. Artificial Intelligence, for example, is very promising. Like other processes, we need good and reliable data to apply Machine Learning. Data can come from sensors (on-line monitoring/CBM). The usage of AI and neural networks can help us to predict failures and improve maintenance that would be very hard to do with just standard sensors (especially when the failure is a result of a combination of factors). Augmented Reality is another example, we can improve the efficiency of changeovers (leading to fewer errors which impact both in quality and availability). Using those new technologies, we can free time from technicians to do more added value activities and, of course, minimize costs.

As Einstein said, insanity is doing the same thing over and over again and expecting different results. So, it's time to review old concepts and aim for high efficiency at maintenance.

How to convince the team that they need to think and work differently than we have in the past?

As I said before, it is common to have resistance to change, especially in the maintenance area.

It doesn't matter our current state, we can be using the top technologies and state-of-the-art equipment or outdated machines. Sooner or later even newer technologies, materials or production methods will become available leaving our practices and equipment obsolete. We need to have in place a continuous improvement mentality, so implementing new changes will be part of the routine and we will keep up with whatever happens. Continuous Improvement is an enabler of change, but it needs to be done by the entire team (not a person or group). Every technician in the shop floor must do root cause analysis (with support if needed) and think about how to prevent failures or how to improve machines to avoid risks.

The new processes and technologies must help people to work better. We want the teams working smarter, not harder. Here again, new technologies can help a lot doing the repetitive work better than a human could, freeing time for creativity, innovation and other more added value activities (RCAs, FMEAs, reliability studies and so on). New processes and technologies should be implemented in such a way that people understand the value-added of the new things and they cannot see themselves working again in old ways, otherwise, there will be a risk to fall back to the previous stage (if it's comfortable to go back, people will do it).

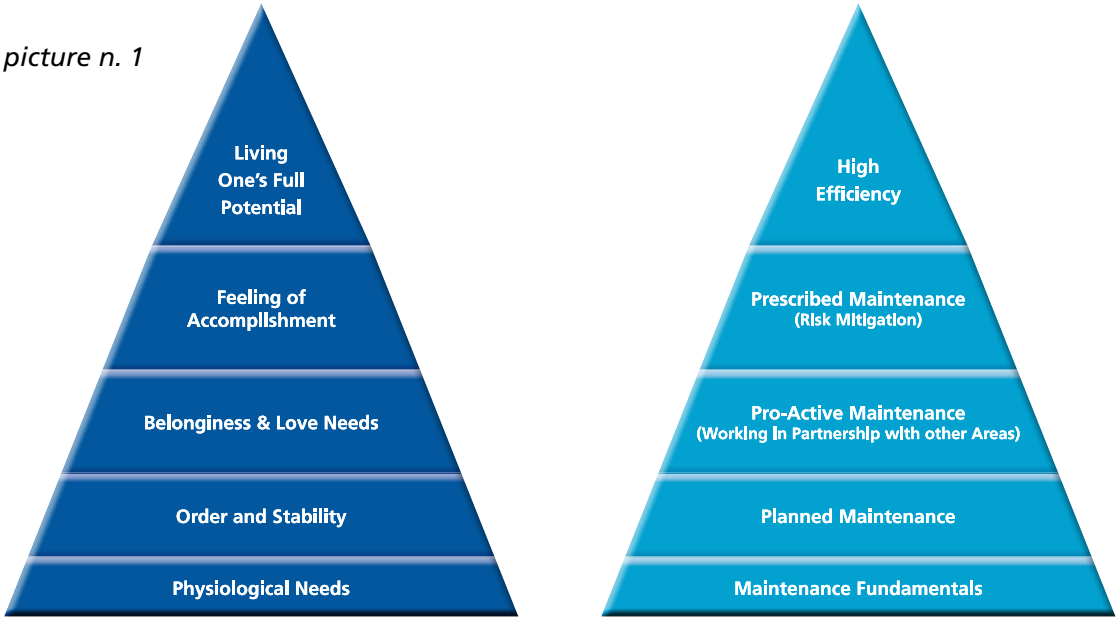
What is our goal anyway?

As I said in the beginning, maintenance purpose should be to ensure all critical equipment are running properly at the lowest sustainable cost possible. It means we know and have internal alignment about the most critical equipment. We need the best process and techniques in place, not to fix or firefight, but to make sure equipment are running properly at high efficiency: no breakdowns, no unplanned downtime. As a consequence, we can achieve an optimal cost.

The optimal cost will be a combination of factors. Spare parts are one of the biggest costs, but often not taken in the right account. If a spare part is not lasting as much as we need, another alternative is required. Today there are plenty of possibilities using new production

The optimal cost will be a combination of factors. Spare parts are one of the biggest costs, but often not taken in the right account. If a spare part is not lasting as much as we need, another alternative is required. Today there are plenty of possibilities using new production methods and materials

picture n. 1



methods and materials. But we need to look at alternatives focusing on the Total Cost of Ownership (TCO). Good spare parts, with the right design and materials that last longer (and so minimize replacement and all its related costs), will help to achieve the optimal cost.

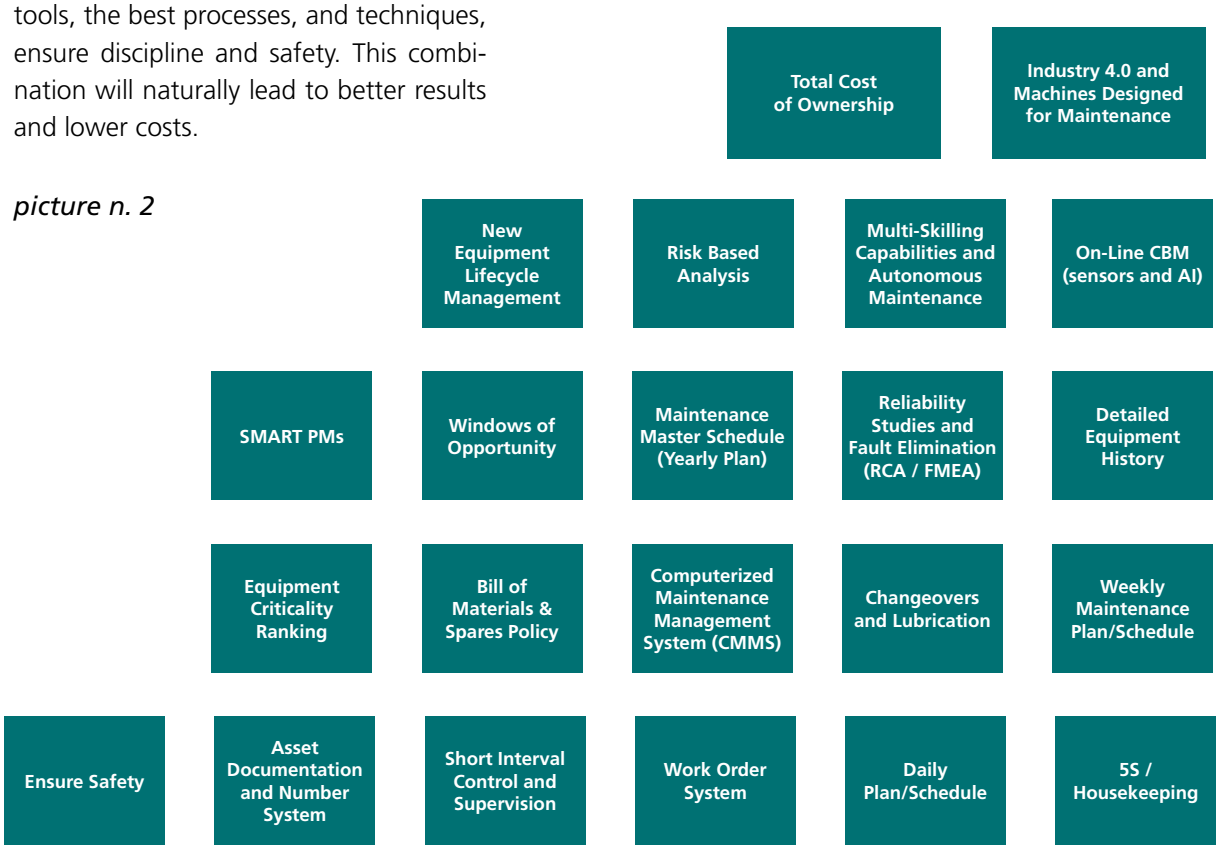
It doesn't work the other way around. We cannot cut the maintenance budget and expect better results. But we can install the right tools, the best processes, and techniques, ensure discipline and safety. This combination will naturally lead to better results and lower costs.

Where should we start?

As we roll out new initiatives and implement new technologies, we need to keep doing some fundamental things. Things will not work at an optimal level when those fundamentals are not properly in place.

Something similar to the Maslow's pyramid of needs: We cannot live in the higher levels if the lower ones are not fulfilled. Making an analogy

picture n. 2



and transporting the psychology concepts to maintenance, we would have something like the *picture n. 1*.

We need to have the fundamentals (safety, work orders, daily plans, 5S/housekeeping, etc) to start doing planned maintenance. We need that to move to a pro-active level and so on until we reach a high-efficiency level.

So, we need to start at the base of the pyramid: fundamentals.

Maintenance results will improve each level we climb until we reach the high-efficiency level (high reliability and lowest sustainable cost).

The maintenance pyramid

Adding more details, the picture would look like this one *(picture n. 2)*.

We all want to be at the top, on the high-efficiency level, but we need to master the other levels first. We cannot stop doing the lower levels to aim higher. If something goes wrong on the lower levels things go south like Maslow states.

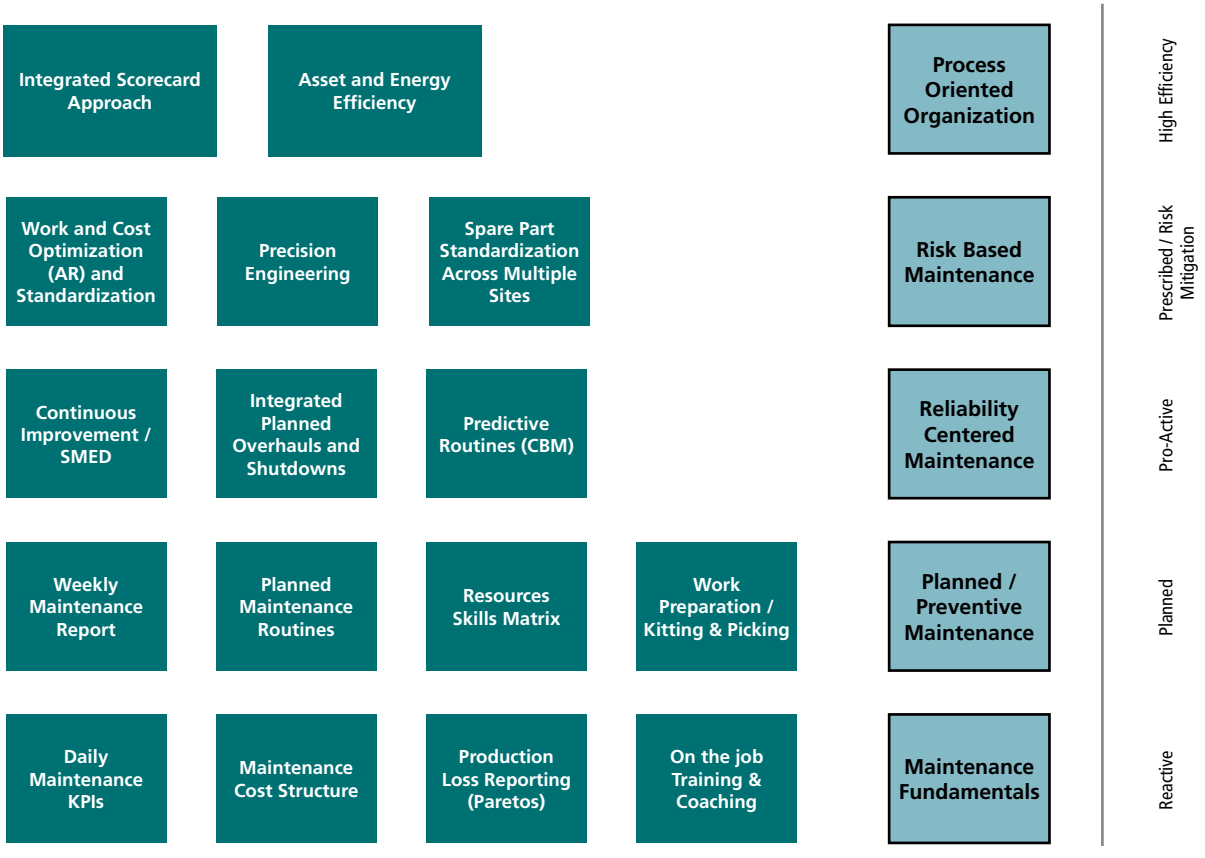
In my point of view, maintenance should start in early stages of a new project, so we can optimize a project looking through the maintenance point of view (Industry 4.0, machines designed for maintenance, asset efficiency, maximize synergies, parts standardizations, right materials, proper design, machine loads, easy access, poka yokes, energy efficiency and so on).

But we also need to ensure safety, an efficient work order system, a daily schedule, a monthly plan, on the job training, etc. We cannot focus on optimizations when equipment are constantly breaking.

There's no magic here. The lowest sustainable cost will be the total cost of keeping the discipline of carrying out the right routines to maintain the machines running properly.

Do we need to install all those processes and controls? It depends on the results you want to achieve from the Maintenance area.

Keeping the discipline costs money. There's a limit some parts can run. Not keeping the discipline costs, even more, it falls back to the reactive mode (correctives), accelerates equipment deterioration and brings higher costs for either overhauls or asset replacements. So, the choice is yours. Choose wisely. ■



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