Lean World Class®
from Predictive Maintenance to Predictive Quality

Case History

BONFIGLIOLI CONSULTING
Cordence Worldwide

Maintenance: a key success factor in industrial production processes

Maintenance is a key success factor in industrial business operations. It has a direct impact on the whole manufacturing system, product quality, and production costs. Many factories take a reactive maintenance approach, focusing on breakdown analysis and resolution only after a problem arises, but this approach, ultimately, has negative impacts on performance and results.

Good maintenance turns into **great performances** and then into **excellent results**.

How to master maintenance: Lean World Class® Maintenance Approach

At the core of Lean World Class® maintenance approach is the partnership between manufacturing / production staff, maintenance technicians, and technical services to improve what is called Overall Equipment Effectiveness (OEE). Launching a program of zero breakdowns and zero defects results in the improvement or elimination of six crippling shop-floor losses:

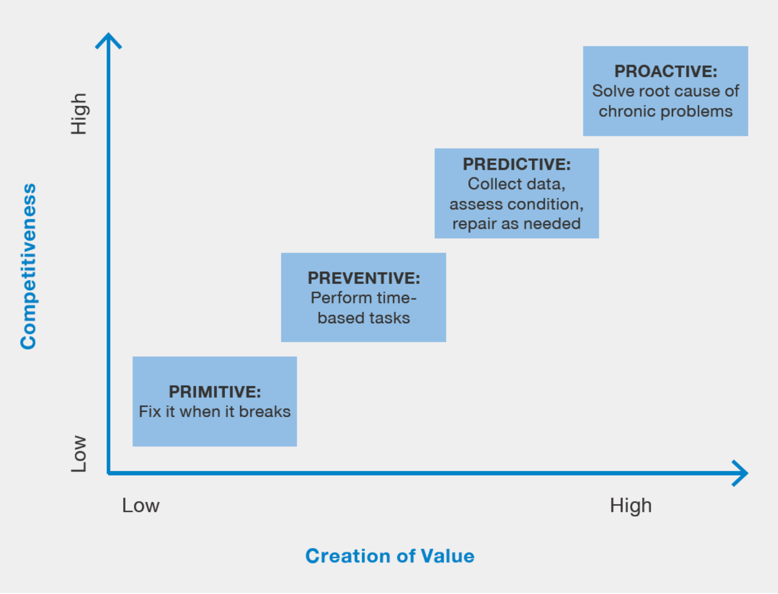
1. Equipment breakdowns
2. Setup and adjustment slowdowns
3. Idling and short-term stoppages
4. Reduced capacity
5. Quality-related losses
6. Startup/restart losses

The Lean World Class® maintenance best practices to be successful include:

- **Improving equipment effectiveness** by searching for the six big losses listed above, finding out what causes the equipment to be ineffective, and implementing action plans towards improvements
- Involving operators in **daily maintenance**, or **Autonomous Maintenance**

- Improving maintenance efficiency and effectiveness through better planning and scheduling activities using the **5S approach**. This organization method was developed by Toyota for storing spare parts and tools in a user-friendly, systematic way. The 5S approach includes:
    - Sort - remove all un-needed items; only what is needed stays (Seiri)
    - Set in Order - establish locations and quantities needed for efficient operation (Seiton)
    - Shine - cleaning through inspection (Seiso)
    - Standardize - implements visual displays and controls (Seiketsu)
    - Sustain - keep the organization effort in place through training and total employee involvement (Shitsuke)
- **Training** involving everyone in the company. Operators are trained on how to deal with their equipment properly and the maintenance team is trained on how to maintain equipment properly. Operators are responsible for performing some of the inspections, routine machine adjustments, and other preventive tasks mainly due to focused training. Moreover, supervisors are trained on how to supervise in a proactive team environment
- **Designing and managing equipment suitable for Preventive Maintenance Programs**. This means designing equipment that is easier to operate and maintain as compared to the earlier practice. In fact, design is a key success factor in proactive maintenance performance. Suggestions by operators and maintenance technicians support engineers design, develop, and install higher performing equipment, thereby minimizing long-term costs over the life of the equipment.

New technologies are also available to support these best practices and new advancements for further improvement.



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Industry 4.0 boosts improvement!

Through the Internet of Things (IoT), Industry 4.0 enables, complements, and accelerates the improvement techniques and methods that have been developed and driven by people engagement and training.

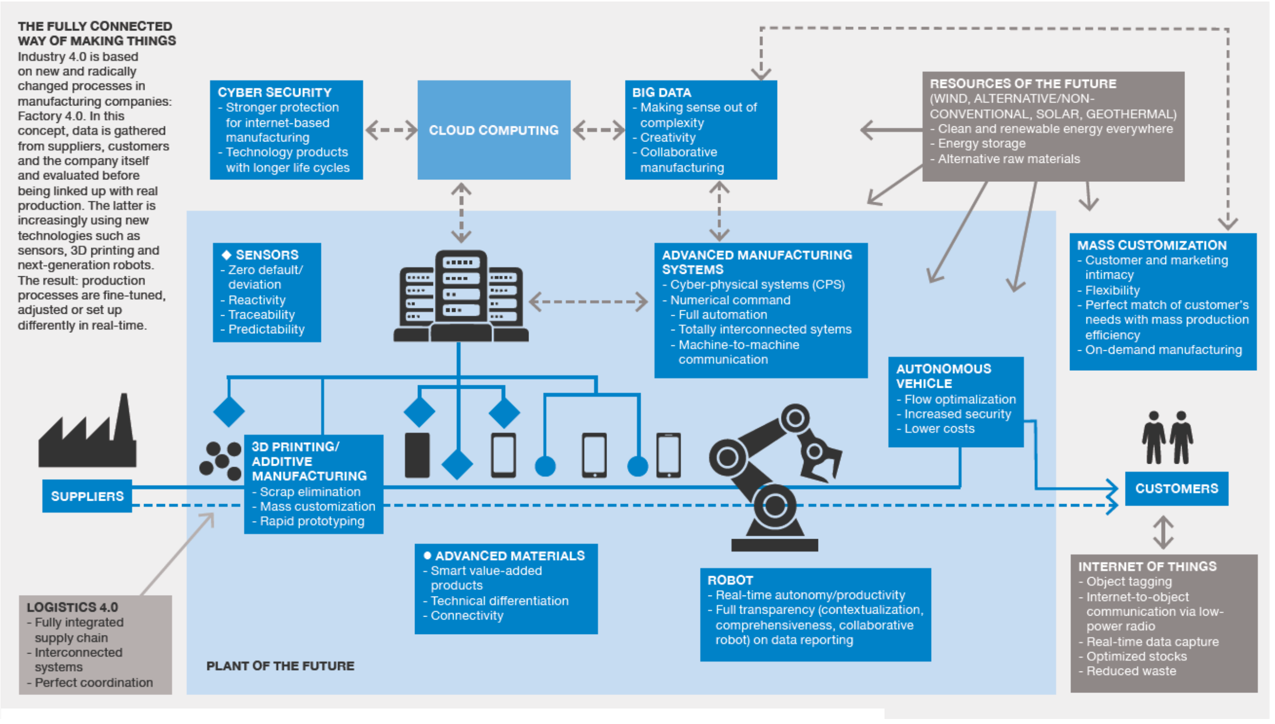
Sensors and cloud-connected machines now allow a single machine to be monitored continuously, providing insights into the status of individual activities. This yields a significant amount of data which, when collected, analyzed, and processed over time, makes it possible to predict the occurrence of accidents, failures, and declines in quality.

From Predictive Maintenance to Predictive Quality

The shift from Predictive Maintenance to Predictive Quality helps to detect and prioritize problems related to quality even more precisely than traditional statistical process control, and helps to reduce overall costs associated with poor quality.

For example:

- **Low false alarm rate** - Advanced statistical algorithms detect the increasing quality problems (with a low rate of false alarms) and can alert to quality issues at any stage of the manufacturing or production process.
- **Proactively detect quality issues** - Detect the process and product quality issues proactively and even more reliable compared to statistical process control methods.
- **Monitor product quality** - Assess quality of materials or components to prevent the introduction of substandard materials. Determine if components or products manufactured during a critical step conform o specifications.
- **Monitor process quality** - Monitor production steps to determine if equipment is properly calibrated. Determine if process input and output variables remain within target ranges. Alert in the event of unfavorable changes.



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From Predictive Maintenance to Predictive Quality | Case History

The Client

An industrial, multinational company specializing in the production of composite wood surfaces stands out for its direct control of the entire supply and production chain, from the log to the finished product.

The Industry 4.0 Project

The goal of the project was to improve quality performances by supporting the company in quickly learning how the equipment operates and understanding its controllable and uncontrollable (e.g. environmental) operating parameters.

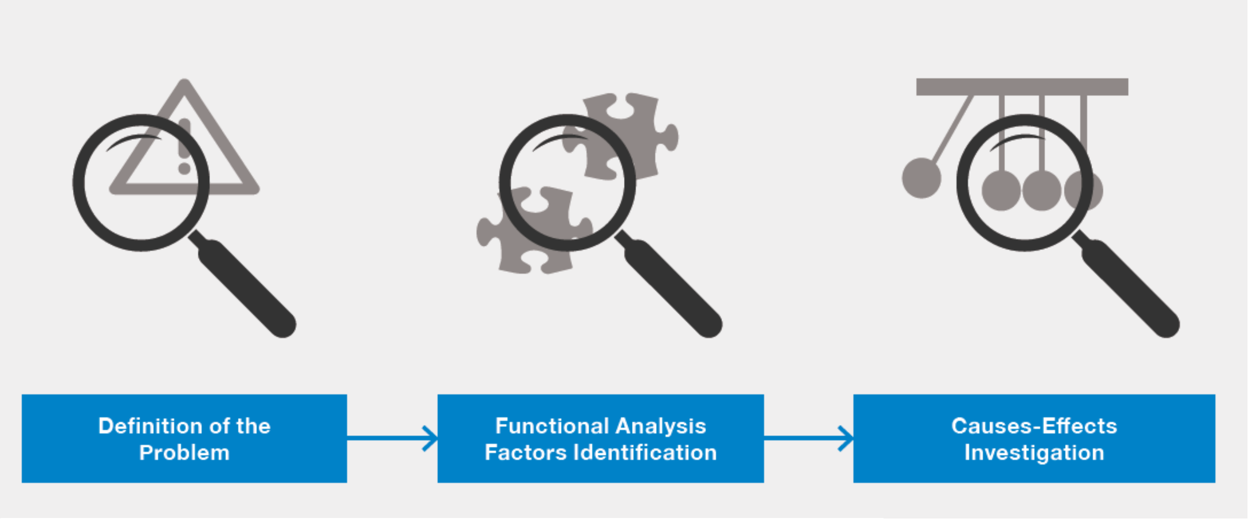
Over time this ensures **the repeatability of the process** and compliance with the required quality specifications (in terms of cosmetics, technical and mechanical features). In addition, it helps during the prototyping stage of new products thanks to a complete understanding and knowledge of the complex process.

The focus of this project was the implementation of an **Internet of Things Preventive Quality approach** in order to consistently improve the quality level of the output.

The quality of the finished product depends on:

- The features of input materials
- The process and its operating parameters
- The impact of non-controllable factors (environmental) on the process

The traditional approach to investigating cause and effect, involves implementing a Design Of Experiment (DOE) methodology, which we have done, to test and validate causal relationships via executing a set of experiments.



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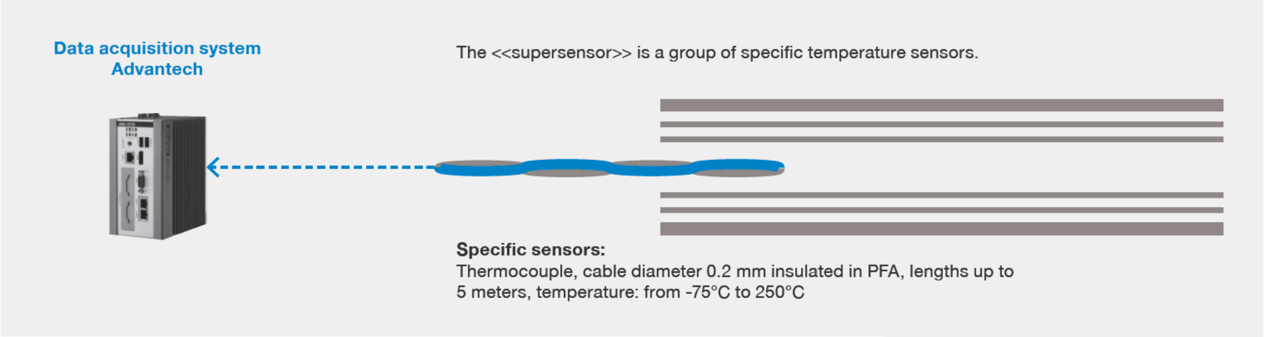
A well - performed experiment may provide answers to questions such as:

- What are the key factors in a process?
- At what settings would the process deliver acceptable performance?
- What are the key, main and interaction effects in the process?
- What settings would bring about less variation in the output?

The implementation of DOE with enabling technologies aims to accelerate the learning curve by decreasing the number of tests (i.e. on raw materials, machine operators) and thus optimizing the machine instructions in a shorter time.



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The support

One of the factors considered to have the highest impact on the quality of the final product is the temperature between the wood sheets (5-6 sheets in total) while they are processed in to the equipment (press machine). Data have been collected about the actual temperature and its variation (curve) over time.

To test the correlation between temperature and quality, it was decided to put in place a **"super sensor"** capable of measuring the actual temperature over time.

The data collected (understanding the correlation between internal sheet temperature and polymerization glue) was helpful in developing a mathematical model to create a high-performance machine set-up that increases machine/ equipment productivity.

This case study shows how Enabling Technologies helps to overcome traditional models and approaches which have arisen from the previous industrial revolutions.

In this specific case, the combination of IoT (internet Of Things), sensors and Advanced Analytics enables the generation of predictive models to have great impacts on process quality and, consequently, on final product.

Design of Experiment (DOE) method was mainly recommended to launch a structured and functional approach in testing, leading to the identification of few key factors and their impact on processes and systems response.

Industry 4.0 and Advanced Analytics allow instead to develop complex and multivariable predictive models.

The foundation for generating self-learning systems aiming at deployment of continuous improvement methodology have thus been laid, and the core concept of predictive quality is being redefined.

Since 1973, Bonfiglioli Consulting, an Italian management consulting company, has been working side by side with organizations to support their growth and success in global markets.

We support our clients in understanding the value they can deliver to their customers and in developing the operational models necessary to achieve their growth and revenue goals.

An extensive service offering to support our clients in making the changes and improvements necessary for their growth:

- Value Innovation
- Value Change Excellence
- Digitalization
- Change Management

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Thanks to our Lean Factory School®, Bonfiglioli Consulting is the point of reference for continuous training to promote business culture. It is also an innovation center where Industry 4.0 technologies are tested.

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