Diagnostic and Predictive Maintenance

Self-maintenance is the ability to maintain the productive potential unchanged in time, beyond the intrinsic value of the assets. All this by using personnel within the company, while trying to minimize the stoppages, the fixed costs of the warehouse and the environmental risks, while managing fewer but more motivated human resources.

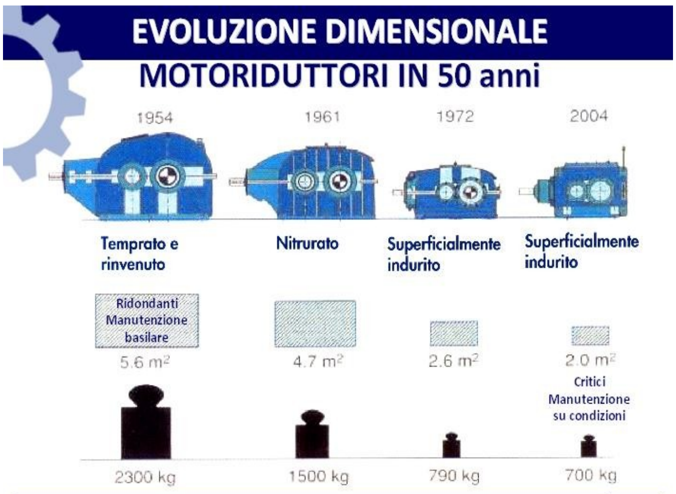
These are some of the "wishes" of the people who need to think about production and demand maximum efficiency and rapidity of intervention from current maintenance.

Just twenty years ago, when most Italian and European industrial settlements were started, this was a difficult goal to achieve.

Many installations in heavy (and processing) industry have been conceived as big hardware investments, with little attention to the LCC (Life Cycle Cost) and objective maintainability.

Economic return and short-time asset repayment were prioritized, evaluating their effectiveness only in terms of goods production per hour; purchasing at a low cost was a guaranteed success.

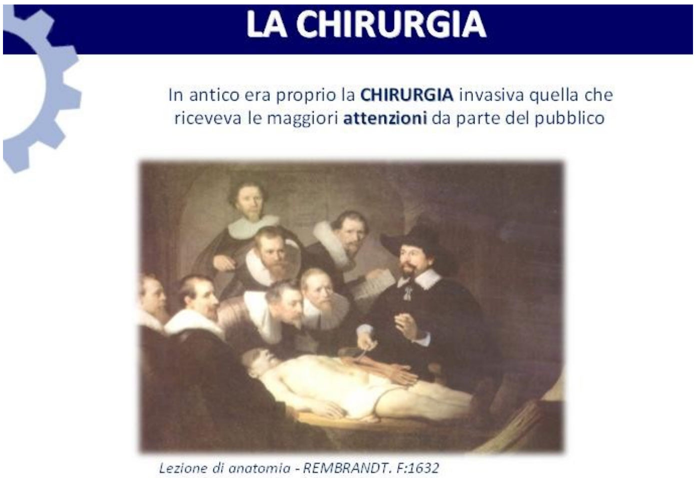
It turned out that throughout the life of the plants, the cost for planned interventions (or worse, breakdown interventions) far exceeded the initial investment.



Over time, many machines have become obsolete, but they're still essential to the process, and the only practical solution was to resort to Diagnostics and Predictive Maintenance, the only guarantees against the risk of uncontrolled decay. At the same time, technological advancements have responded to the need to increase production margins by designing machines that are faster, less bulky and cheaper, but also much more critical!

Nowadays, in order to implement early diagnostics within ordinary maintenance, it is necessary to accommodate the production demands required by large distribution and at the same time to insert ourselves into current procedures without disrupting them. Very often these are "political" choices that can only come from the pressures of a truly motivated managerial staff.

The active search for the "root causes of failure" is much more developed in the field of human physiopathology; in this case, too, in order to treat the symptoms related to aging (an indisputable process in today's society), we need to use diagnostic tests that are increasingly more sophisticated, albeit simplified and cost-effective. All this to ensure an extensive application, available to everyone. Living organisms are constantly employing instruments of self-maintenance (in biology we call it homeostasis) without knowing it. When these processes stop or slow down, they trigger degenerative phenomena (generically defined as "malaise").



Hence the use of preventive medicine and the commitment to reach the famous *Life Extension Factor*, without compromising the autonomy and industriousness (both physical and intellectual) of modern man.

The discovery of diagnostic tools for use in the industrial field that are simple, effective and timely is now facilitated, thanks to internet search engines.

The future convergence of the terminology used will be surprising.

The intermingling of human physiopathology and mechanical diagnostics is well present in these virtual containers of information, confirming how innovation in these sectors proceeds according to guidelines dictated by universal protocols.

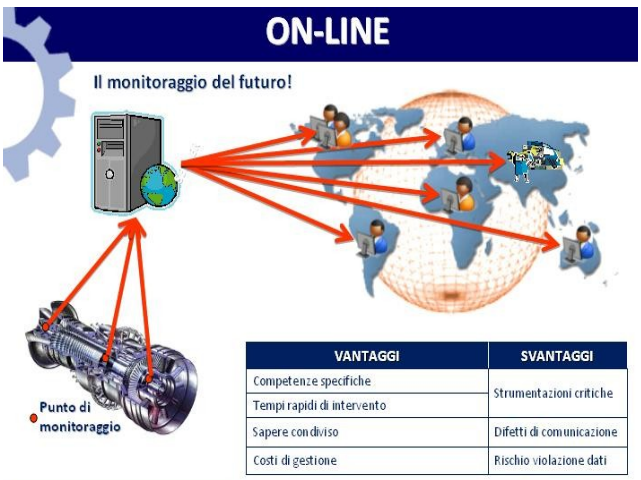
On other occasions, I examined which and how many links there are between medical prevention and machine care and how stimulating it is to borrow definitions from the medical language that today are also used in the advanced industrial sector.

On the occasion of this Convention, I would like to give my contribution on what makes the "Predictive Maintenance" hypothesis increasingly more feasible through diagnostics, overcoming some of the physical constraints encountered by operators so far.

Potential of computerization

The current pace of technological development in the field of computer science and electronics has produced profound changes in all areas of engineering. The increasingly extensive use of the network has made it possible to relocate information without losing its accessibility. We have entered an era of "widespread" information and the repercussions in the world of maintenance have been considerable and profound.

We went from off-site procedures (with occasional interventions by specialized staff or external consultants) to on-site procedures (developing internal company skills) to real time procedures (introducing specific sensors and "weak signals" amplifiers in the most critical lines and machines) until we reached online procedures (as in, the possibility to share operating parameters borrowed from the plant in real time, with experts or consultants who are not necessarily internal). This gives us the possibility to create online shared skills, with different levels of access and permissions. For example, we can create a level of information only accessible by company personnel or consultants, while another level (without strategic or private information) would be open to everyone. This approach would allow the worldwide sharing of data relating to a particular asset, increasing its widespread knowledge and allowing the search for effective, tested and quickly available solutions. This underlines the paradox (in a system of security and strict privacy protection) that jealously guarding your knowledge is not always the winning strategic choice.



The prospects linked to the development of these technologies (thanks to PDAs, RFID sensors, autonomous web server structures...) are very exciting and allow the possibility of large diagnostic developments at lower costs.

In particular, the continuous access to already structured information, their replicability and relocation, allow us to imagine a team of experienced maintenance staff, who from the company's headquarters is able to control the entire fleet of machines stationed in other locations. The development of such technologies allows us to hypothesize enormous possibilities (practically all the "wishes" about information management can be satisfied) making this a golden age to reinvest in human resources.

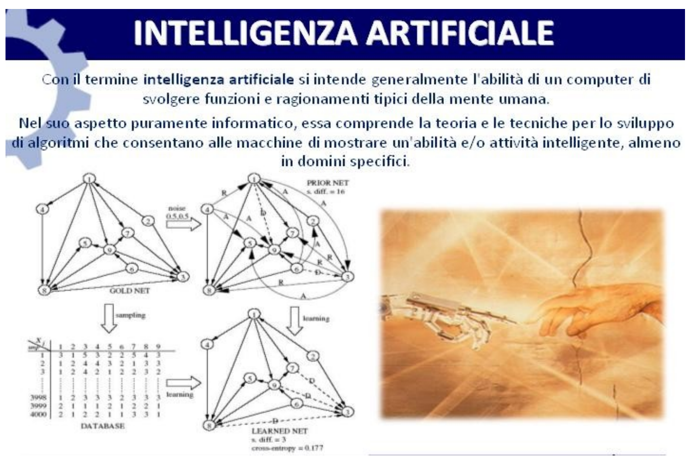
We no longer have duplicate teams of experts equally divided through each location (with the technical figure physically close to the machine, and the need to group the assets in tight spatial constraints), but teams with much greater potential than the sum of individual skills. The physical proximity of such managerial roles, associated to the "virtual" contiguity of the machinery, would allow a cultural growth and an increase of competences that the company can best utilize. Especially with a view to intellectual growth, aiming at continuing education centers that can grow young talents along with the team of experts. Without continuous commutes, more resources can be allocated to focus on real problems and corrective actions.

Collecting and transferring data is now easy. We no longer need the useful but now outdated practice of *data entry*, which has made it possible (through a historically fundamental step) to turn analog information (on paper, or detected by gauges, lights, etc.) into digital, but is always subject to human error. Every modern machine is able to return its operating parameters in a digital format, while for less advanced systems there are tools developed specifically for this activity (*data logger*).

With RFID, we have developed the possibility to label and track any physical object at a negligible cost, "magically" turning it into a digital/virtual entity able to communicate with the computer system. This overcomes the thorny problem of identification and localization of the goods.

Development Perspectives

Another potential scenario arises from the possibility of applying modern artificial intelligence techniques to current diagnostics. Thanks to the development of Bayesian or neural networks, excellent results can be obtained starting from a sum of knowledge that we can build thanks to the simplified acquisition of the monitored machines' digital data.



There is still a great deal of skepticism in the industry about delegating this delicate activity to a computer, but modern day progress is encouraging.

Especially when we reflect on the fact that it is not a matter of pitting artificial intelligence applied to diagnostics against the expert maintenance personnel (always with the goal of improving efficiency and reliability). We are not trying to establish a role supremacy, but a dynamic path, tied to an effective collaboration between different skills in specific diagnostic sectors to "educate" artificial intelligence, constantly improving its performance. The first steps to follow are related to the development of such an entity, able to distinguish the cases "worthy of particular attention" from those that are well-defined or unambiguous (derived from historical data). The supervisor will thus have the opportunity to focus their resources, limiting their creative effort to a few well-defined cases. The circle will then be closed with the transfer of the decision taken by the human mind as feedback to the artificial intelligence itself. Cases that are of dubious interpretation by the system (still in the learning phase) will progressively decrease, allowing an increasingly punctual and automated control. A long and complex path, currently the subject of intense academic experimentation. The goal, however, is well defined and clear: making it possible, through an increase of automation and computerization, to relieve the fatigue (and the low "intellectual payout") of a repetitive and uninspiring work. Hopefully, all of this will allow the expert maintenance staff, free from routine, to devote themselves to the search for more daring and conceptually stimulating solutions.

Intervention by P.G.Adriani and M. Paoli for:

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