2.1 The Phenomenon of Maintenance

The analysis of post-industrial society brings out the spread of attention towards social phenomena that imply increasingly greater spaces for the dimension of maintenance. We refer in this connection to:

- the transversal nature of many aspects and components of development;
- a strong characterisation of economic and social transformation, in terms of continuous technological innovation;
- the pervasive nature of innovation, in both social and technological terms;
- the expansion of tertiary productive activities, which have reached the level of the services economy itself.

In this context, the culture of maintenance is progressively becoming a transversal class of activities, due to the importance it has taken on in various areas, the consistency of the activities performed, the growth in the relative demand and renewed requirements of sedimentation and stratification of the cultural and scientific base.

The desire to preserve and maintain material property has been expressed since ancient times. Translating this desire into the related and variously structured activities, however, is a direct expression of the times and different societies involved, which thus brings out two pairs of significant relationships within the ambit of man’s attitude towards maintenance:

- the man–time relationship;
- the man–object relationship.

Maintenance requires timed, long-term actions, which are often wide-ranging and strictly programmed over time. Lack of action is in itself sufficient to provoke the deterioration of objects and plants, whose maintenance, moreover, is not guaranteed by the performance of occasional corrective action. Time is a potential that must be used in the best possible manner.
Maintenance is influenced by the man–object relationship, through the various possible attributes that man confers upon the object itself, in terms of quantity, quality, durability, value, functions and the related structures and systems.\(^1\)

In twenty-first century society, a relationship of coexistence seems to be configured between man and object, which is realised through the permanence and duration of the object itself, thanks to the growth of the maintenance services that accompany the burgeoning assortment of increasingly refined and complex objects that surround us.

In terms of the technical concept of maintenance, there are two strategies that can be adopted in the maintenance of objects and plants: prevention and correction.

The spirit of maintenance is and must always be recognised as essentially preventive.

True maintenance does not consist of actions that are performed after a breakdown has occurred.\(^2\) The inspiring principle of maintenance is distinguished from pure and simple correction, which is performed through repairs that depend upon the abilities, improvisation and manual capabilities of individuals, through a succession of absolutely unplanned activities.

The structuring and development of the concept of maintenance, understood as the idea of maintaining objects and complex systems in a good state of repair—or better yet in so-called normal operating condition—is definitely one of the most important aspects of contemporary technical thought, as it has developed during the course of industrial evolution in the twentieth century.

In the field of production, the passage from manual labour to mechanisation, automatic actions and automation—as the result achieved by widespread electronics—has determined an important and definitive fracture between the producer and user, thus conferring the dignity of an independent science to maintenance.

The availability of resources for maintenance, finally, has become an indicator of the level of economic development of a country and of the competitive position of a company.

Recourse to several indicators, such as the rate of maintenance,\(^3\) allows us to distinguish developed countries from developing countries, by studying the evolution of the function of maintenance.

In developing countries, insufficient maintenance activities are often one of the factors that slow development of the economy down, by triggering a process of uncontrolled growth in the demand for machinery and plants, which are used, abandoned, cannibalised and perhaps replaced, but hardly ever maintained.

---

1 Historically, various types of man–object relationships have been noted: spiritualist, ascetic, and positivist.
2 A failure or breakdown is an incident that can theoretically be avoided, through successive intervention to valorise and implement continuous improvement of objects and plants.
3 Indicators made up of many variables, which take into due account the expenses of standardisation, maintenance and social security.
In general terms, various different configurations of the demand for maintenance can be seen:

- extension and enhancement of maintenance activities in the ambits (geographical area and/or sector), which lack services today;
- refinement and specialisation of intervention in ambits that are already served;
- innovation to transfer new technologies and models of management;
- externalisation or, better yet, tertiary expansion to include the service.

Through progression of maintenance services towards the tertiary sector and resorting increasingly to external providers, the competence acquired in the industrial sector can be made available to satisfy the demand from generally under-served sectors (management of complex networks, infrastructures, health, public services, territory).

The demand for specialisation comes prevalently from the industrial sector and is solicited by several important factors:

- quality, which is a condition that cannot be foregone if the possibility to compete is to be preserved; this is also understood as economically viable management and transparency towards consumers;
- safety, which is an imperative duty;
- the environment, which is one of the new frontiers for competition, as well as the unavoidable challenge of sustainable development and the quality of life.

Although the environment is one of the factors that stimulate the industrial sector, within the ambit of territorial management, the problems of maintenance and environment increasingly tend to be superimposed and integrated, continuously providing new confirmation and legitimacy of the proposal, formulated by many interlocutors, of including the theme of environment in the category of maintenance; it would thus be possible for ecological and environmental themes to acquire the cultural, scientific and managerial background of maintenance that has led to the foundation of the new science of terotechnology in the Anglo-Saxon world.

The foundations of this science are identified with reference to a now consolidated system of:

- culture of human resources management and evaluation of property (analysis of profitability, costs and benefits, analysis of alternatives, analysis of the life cycle);
- culture of maintenance techniques;
- culture of maintenance management (monitoring, planning and scheduling of inspections and intervention, evaluation of costs and the return on investments).

### 2.1.1 Maintenance in the Industrial Scenario: A New Factor of Competitiveness

Sector figures show a phase of expansion that becomes particularly meaningful for the industrial sector, the institutional seat of ‘productive know-how’ that is
increasingly becoming a candidate as a possible referent for ‘maintenance know-how’, understood in its most modern sense, as a result of the considerations made above.4

The ability to ensure continuous improvement and realise a learning organisation is the most adequate response today to respond to the growing demand for competitiveness of companies doing business on the global market, whose development is configured according to the model that is now known as the spiral of Juran. Therefore, the changes that characterised industrial development in the Eighties are being consolidated in company organisations, through the increasingly widespread diffusion of:

- industrial automation and computer-integrated manufacturing (CIM);
- logistics;
- just in time (JIT);
- total quality control (TQC) and total quality management (TQM).

Automation and CIM involve greater complexity in plants and extremely heavy capital investments; this translates into a demand for a higher degree of availability5 of machinery and plants.

The introduction of pull type management strategies, such as JIT, requires high performance from the best plants, in terms of dependability, to compensate for both lower stock levels (of both raw materials and components and inter-operational materials) and for the greater operational regularity required of the management system with the use of kanban.

The instruments for quality control and management (TQC and TQM) require greater dependability of productive means and more accurate calibration and adjustment of plants.

In addition, the demand for greater product quality and higher levels of service, as well as the need for greater plant flexibility with modest operational costs should not be neglected.

Parallel to this, the management of maintenance for increasingly complex productive resources and systems has also undergone considerable change in order to adapt to the new context. Evolution has been developing through the meaningful contribution of three primary factors:

- the experience gained in logistical support activities for complex products and systems (especially within the ambit of military supplies);
- the experience gained in the maintenance of machinery and plants in several industrial sectors (especially in the processing and aeronautics industries);

---

4 In the industrial sector, one of the strategic lines of the maintenance function, is, strangely enough, to prevent its own self-destruction, through reductions in the cost of maintenance, with the same established objectives, obtained through intervention on the planning of products and processes, on layout, organisation and, above all on company culture.

5 Aptitude of a system and its logistical supporting organisation to provide performance as required in the time required.
• the Japanese experience in the management of production, product quality and productive processes;
• the development of logistics.

The speed of intervention and solution of a problem when a breakdown occurs is often compromised by a low degree of maintenance possibilities and by the insufficient definition of the logistical organisation supporting maintenance.

It is now a consolidated opinion that maintenance must not exhaust its duties in a more or less rapid intervention following accidental breakdowns.

The growing costs of plants and the critical elements related to their blockage, in fact, have marked the passage from the old concept of maintenance to a new formulation and new functions.

Total productive maintenance (TPM) is the most recent approach developed in industrial circles to face the problem of global efficiency of plants and machinery.

The characterising element of TPM is the global approach to plant problems, which are managed in a unitary and non-sectorial manner, with an entrepreneurial formulation typical of global cost management.

One of its peculiar characteristics is the separation and tracing of several articulated and complex company management problems to specific and simpler elements, such as the dependability of plants and the prevention of errors and breakdowns, and the successive reconstruction in the wider context of implementation of JIT and total quality strategies.

2.2 Maintenance Engineering as a Mix of Planning and Management

It appears quite clear that the growing sophistication of plants, the increasingly high level of automation and the considerable increase in costs have given maintenance an important position in all industrial companies.

Nevertheless, it is equally clear that the changes brought out require an important organisational change, adequate operational instruments and, above all, highly automated information and management systems, connected to inspection systems designed to monitor and control signals from the plant.

Maintenance engineering is therefore the connecting element between management and performance, through research, planning, training, involvement and commitment to implement continuous improvement.

However, there is often confusion between the various aspects of the problems involved in planning and managing maintenance. There are many aspects to the problem, which transversally involve the entire business of the company; the following can be identified among the most important ones:

• product, machinery, plant and system design;
• the choice and implementation of maintenance policies and strategies;
• the construction of a logistics system;
• maintenance management;
• diagnostics;
• the performance of maintenance intervention;
• the information system.

Planning and realisation of maintenance systems and the maintenance logistical support system (MLSS), through increasingly intense use of information models and systems, are matters of concern for maintenance engineering.

The following models are worthy of mention:

• the analytical models, designed to identify the criteria of evaluation for system component breakdowns;
• the organisational models, which seek rules, methods and procedures for the economic management of maintenance.

The following analytical models may be identified:

• models of interpretation of breakdown behaviour (originating from reliability studies);
• models of analysis of breakdown patterns, the effects and critical elements (Magec, Fmeca or Amdec);
• models of technical economic analysis (life cycle cost);
• models of optimisation of projects (project management, design to cost, design to life cycle cost);
• models of analysis for the renewal of components (level of repair analysis).

Among the models of organisation and management, on the other hand, we may distinguish:

• the terotechnological model;
• reliability centred maintenance;
• TPM.

The informative system, for all intents and purposes, constitutes the obvious difference between the old and new and must become the bearing element of the maintenance system and the means of integration with the rest of the plant.

There are subsystems that correspond to these aspects, which, within the ambit of every company organisation, play an essential role in design and actualisation of product, machine and plant maintenance.

Several of these subsystems will be dealt with specifically in depth in the following chapters.

2.2.1 Product, Machinery, Plant and System Design

With reference to the first of these aspects, it is always opportune to distinguish between the various parameters expressed:
• the characteristics of reliability of machinery and plants (mean time to failure and mean time between failures);
• the characteristics of machine and plant maintenance capabilities (mean time to repair); with reference to this parameter, the possibility to distinguish the logistical component is particularly important (mean delay time);
• the availability of plants and machinery (intrinsic availability, achieved availability, operational availability).

The number and complexity of the characteristics and parameters involved lead, at times, to confusion between:

• reliability: the aptitude of a system to function without breakdowns;
• maintenance feasibility: the aptitude of a system to be repaired and maintained in normal operating condition;
• operational availability: the probability that a system, utilised under established conditions, will function satisfactorily at any given time, operating in an actual logistic environment.

The above-mentioned characteristics are strongly inter-related, but the methodologies and techniques to utilise for them are extremely different.

The first two fall within the design specifications of the plant, while the third is the result of the design of the supporting logistical system. Their definition, however, can only be necessarily unitary, if realised as a function of achieving the primary objective of an industrial plant, namely, the profitability of the company.

2.2.2 The Choice of Maintenance Policies and Strategies

The validity of the forecasts of reliability of plants and machinery is strongly conditioned by their correct operation during the period of production—namely, the choice of an adequate maintenance policy and establishment of the right maintenance/production ratio.

The manner of performance of maintenance in industrial plants, which can commonly be differentiated, may be traced in the first instance to five types, which correspond to just as many widely diffused policies in the industrial world:

• Incidental maintenance (to repair breakdowns), which takes place when breakdowns occur and is the oldest and most spontaneous form of maintenance. Intervention of this kind should be envisioned only in the event the stoppage does not create technical, production or quality-related problems.
• Preventive maintenance (cyclic, programmed, systematic), characterised by intervention performed on the basis of the theoretical determination of the duration of several components that are considered fundamental for the operation of the machine, which are subject to wear and tear. It is performed periodically according to a previously established schedule (on the basis of definite elements and data on the operation of the machine and/or plants) in all cases
where the machine/line constitutes a bottleneck and in all cases where it is not possible to obtain data that permit the forecast of the time that will elapse before the machine/line breaks down. Preventive intervention is performed to avoid traumatic breakdowns, rapid reductions of productive capacity with respect to established standards and drops in quality. This type of maintenance, although it is still quite widespread, entails a considerable increase in plant management costs.

- Second condition maintenance, which considers breakdowns as the terminal point of progressive deterioration, which can be detected through monitoring of signals from the key elements; it is performed at variable intervals, in all cases in which it is not necessary to perform preventive maintenance and it is possible to programme the maintenance intervention, in harmony with the management of production, avoiding traumatic interruptions in production, partial losses of production and/or quality. The programming of intervention is based on elements such as:
  - the characteristics of machine operation and maintenance;
  - periodical inspections;
  - product/processing quality control;
  - information and/or reports of personnel assigned to the machine/line.

- Maintenance for improvement, which implies ‘engineering’ of maintenance service and leads to constantly questioning even consolidated habits and patterns.

- Total productive maintenance, which pursues the objective of maximum dependability at the minimum cost of maintenance, utilising the cultural matrix of total quality, which—initially made up of the set of new Japanese productive techniques created in the manufacturing industry—was developed in the processing industry and has received original contributions in Europe. TPM is based on three fundamental assumptions:
  - prevention, above all through monitoring;
  - continuous improvement, as a dynamic attitude oriented towards continuous research of the causes of breakdowns and maintenance intervention in general, and the removal of such causes;
  - self-maintenance, understood as the tendency for the production operator to develop all of the elementary inspection and maintenance activities directly in the field; the operator thus plays a fundamental and active role in the maintenance of the vehicle, machinery or system entrusted to him.

Historically, it can be asserted that over 30 years have passed since the methods and techniques of preventive maintenance became widespread. They were later developed in a more or less orderly manner:

- predictive maintenance;
- productive (or proactive) maintenance;
- maintenance for improvement;
- TPM.
While it is possible to define productive maintenance as a mixture of preventive and predictive maintenance, TPM can be considered a system of TPM, which goes beyond the schematisation of the types of maintenance (for breakdowns, preventive, on condition, improvement), integrating, with a view to continuous improvement, all of the operational and logistical support aspects; TPM unites the improvement of maintenance feasibility with productive maintenance.\(^6\)

The adjective ‘total’ brings out the important characteristics of TPM:

- management of total costs;
- total efficiency;
- total quality;
- total prevention;
- total involvement and participation;
- total productivity;
- total maintenance.

In terms of types of maintenance, the cultural changes brought out have led to a different allocation of resources in recent years, in particular:

- incidental maintenance settles in at 50%, on the average;
- statistical preventive maintenance carries a weight of about 20–30% of resources;
- maintenance according to condition is around 20%;
- the activity of maintenance improvement, conducted by small groups, accounts for less than 10% of the total resources.

### 2.2.3 The Construction of a Logistics System

Within the ambit of TPM, the entire process of maintenance must be managed on the basis of a maintenance plan, which will have the function of connecting the various maintenance programmes, through which it will provide for management of maintenance intervention on systems that are already operational, and the plant characteristics that will determine the project specifications and specifications of the supporting logistics system, which is the crucial element for passage from planned to realised maintenance.

For any reparable system, but for complex products and systems and industrial plants in particular, due to their articulation and complexity, the construction of an adequate MLSS,\(^7\) or the set of structures, materials, activities and actions that

---

\(^6\) TPM is often defined as profitable PdM (efficient productive maintenance) for the substantial economies that it produces with a wide and extensive diffusion in productive sectors.

\(^7\) The concept of MLSS was introduced at the beginning of the 1980s by the United States Department of Defence, with the definition of integrated logistics support (ILS); only later was ILS extended beyond military ambits.
guarantee the definitive operational capability of the industrial plant, has acquired decisive importance.

An MLSS is therefore made up of:

- maintenance organisation;
- maintenance plans, programmes and procedures;
- technical documentation;
- personnel;
- equipment;
- spare parts;
- an information system;
- diagnostic instruments and equipment;
- techniques and instruments to identify breakdowns and isolate causes.

The MLSS ensures the availability of the instruments to plan and manage reliable and correctly maintainable plants with controllable maintenance costs, while TPM provides the cultural basis and methodology to obtain the involvement of all operators, to eliminate every functional anomaly and any waste, with a view to continuous improvement.

### 2.2.4 The Management and Performance of Maintenance

The objectives of the subsystems of management and performance of maintenance are to achieve the technical and economic optimisation of maintenance, seen in the enlarged concept of TPM; the most important activities can be traced to:

- definition of the proper level of maintenance, through optimisation of the maintenance/production ratio;
- definition of the procedures of programming and performance of intervention;
- the economic optimisation of global costs (direct maintenance and lack of maintenance);
- planning and optimisation of consumption of resources earmarked for maintenance, even through recourse to appropriate information technology supports;
- optimisation of performance (high levels of efficiency);
- involvement of personnel;
- improvement of user/customer relations;
- control and guarantee of the quality of performance.

With reference to programming intervention, it is possible to distinguish between the following types of maintenance:

- ordinary maintenance, which is characteristic of periods of normal plant activity. This obviously constitutes the largest component; ordinary maintenance, which is subject to planning, must guarantee aging of the system that is coherent with the designers expectations;
• extraordinary maintenance, which includes all intervention on the plant that goes beyond planned ordinary intervention, in terms of both complexity and costs; it generally determines an increase in the value of the plant, after a certain time in its useful life.

• revamping, which consists of a veritable refurbishment of the plant under changed conditions of operation or different requirements imposed externally.

The macro-processes that the management subsystem must in any case ensure are:

• management of resources and works;
• management of external performance;
• management of technical materials;
• management of means of work, plants and services;
• system inspection.

Each of these macro-processes can be divided into processes involving additional activities.

2.2.5 Diagnostics and Analysis of Breakdowns and the Related Effects

Periodical verification of the operational status of the plants and machinery permits determination of their degree of reliability and maintenance needs. The objective is to define:

• analysis of breakdowns/failures;
• analysis of effects;
• how and when to intervene on the plant;
• what materials are necessary for intervention;
• how to reduce preventive intervention.

The contribution of machine/line operators is particularly important for diagnostics, providing they are available and willing and receive sufficient training and motivation.

The operator, in fact, may perceive:

• anomalies of position (unscrewed bolts, machinery out of axis, etc.);
• abnormal noise;
• odours that indicate overheating or malfunction;
• vibrations.

---

8 It may be performed when the machine/plant is idle (even only through visual inspection) or in movement (visual inspection, non-destructive tests, etc.).

It is opportune for periodical visits to be performed with the definition of structured inspection itineraries with different methods, according to whether they are performed on idle or operating plants and machinery.
Total productive maintenance provides for an extension of the meaning of diagnostics, placing the accent not so much on the need to diagnose failures or abnormal operation, as much as to identify, diagnose and eliminate the causes of anomalies in operation.\footnote{TPM functions with reference to the classification of breakdowns, implementing intervention for continuous improvement, whose immediate result is to control all phenomena of control and breakdown.}

In this sense, we refer to two principle types of failure:

- accidental failure, provoked by the intervention of external agents;
- breakdowns due to deterioration, due to all of the various ‘natural’ phenomena of aging (wear and tear, abrasion, fatigue, etc.).

In the case of accidental failure, the cause is presented with the reason for the specific event or ‘special’ event, but which, in any case, is not natural or ‘normal’; in this case, the diagnosis of the cause and the implementation of radical intervention for its removal are possible.

In the case of failure due to wear and tear, a distinction can be made between:

- natural deterioration, which is therefore inevitable; and
- accelerated deterioration, provoked by shortfalls that have taken place in the phase of design, maintenance or operation, all of which belong to the category of errors that can be avoided.

When analysis of breakdowns/failures has been performed, it is necessary to:

- define the principle manner of failure and the components involved;
- select the critical components;
- develop a cause and effect analysis for each failure;
- identify the symptoms or signs of failure;
- analyse the operational aspects.

A complex system or machine, in any case, has a limited number of reasons for failure, which concern an equally limited number of contents and critical components (generally a score or so).

The greatest difficulty lies in extrapolating the critical components from the myriad of components that make up the machine. The use of modules for the disassembly of the machine on various levels may be of assistance in this task.

The critical indicators (to be attributed to the manner of failure) allow us to define the priority criteria of intervention; the weak signs provide indications to activate inspection plans, the reasons for failure suggest intervention for improvements.

In general, the critical indicators are made up of the product of two weights: the first is related to the failure, but is measured in terms of the lack of availability of the machine, and the second is related to the aspects of the plant. The two weights are combined in the critical matrix, which permits the attribution of a system of
points to every manner of failure and the organisation of maintenance or improvement intervention in harmony with a classification of priority related to the indicators.

The matrix constructed in this manner permits preventive analysis of improvements that may be achieved in relation to specific operations that may be performed in various directions:

- horizontal: by intervening on the availability of the machine (reducing the frequency of failure and down time);
- vertical: intervening on critical points of the plant (through improvement of plant flexibility).

Awareness of the operational conditions provides the elements to propose modifications relative to the feasibility of maintenance, support logistics and procurement of materials.

Awareness of the manner of failure and the relative critical points provides the basis for evaluation of the effects that the failures may produce in an industrial plant, with reference to production, quality and safety.

Analysis of the effects on production must lead to an evaluation of the seriousness of the down-time consequent to the failure of the components, subsystems, set, plant or factory.

Indicator values may be assigned to each of them, which may be obtained from pre-defined matrixes, built for the type of productive activity and/or machinery.

For this purpose, it is necessary to refer to the organisational structure of the works typified, with reference to the level of interconnection of the plants; thus, it is possible to identify:

- plants with a low level of interconnection: these are generally plants on line with a low level or no interconnection (the only interconnection is derived directly from the productive flow);
- strongly interconnected plants: in which the functional failure of a subsystem can be due to breakdowns in other subsets or machines; in this case, it is of fundamental importance to identify the input interfaces of each subset.

Industrial plants are characterised by increasing levels of complexity and self-sufficiency in terms of operation.

One of the most important management objectives is to guarantee operation: the operator replaces the worker; the maintenance personnel replace the operator.

2.2.6 The Information System

The technological and organisational innovations that have characterised industrial production in recent years have made significant contributions to changing the importance and role of information technology, which improves the manner and efficiency of management.
Integrated information technology systems have spread in the field of maintenance, as well, for the technical management of machinery and operational management of maintenance.

Information technology systems fundamentally fulfil the task of providing complete ‘visibility’ of the maintenance system.

The objective to pursue is the realisation of an information system that assists maintenance in the phase of seeking failures, in intervention and re-planning of maintenance as a function of the indications coming from the management of the plant itself.

The approach of TPM and of all of the most recently introduced maintenance policies calls for extensive recourse to preventive maintenance, not so much of the statistic type, but according to the condition of the machinery.

The problem of an approach of this type is to succeed in identifying the symptoms of failure at the right time or, in any case, to intervene in an abnormal situation in operation of the machine.

This problem is considerably simplified by the latest generation of machinery, equipped with diagnostic devices capable of controlling many important parameters and detecting operational anomalies.

If the machines that call for continuous monitoring of controlled parameters are analysed, an additional problem for maintenance personnel crops up; to succeed in filtering, with the mass of information arriving from the machines, the few meaningful bits of information for maintenance purposes, for the machine history and manner of failure.10

The information system may be developed precisely in this direction, in order to respond in a clear and rapid manner to this type of problem and ensure an effective benefit to the maintenance personnel.

A system of this type will envision the employment of an expert system, capable of ‘intelligently’ managing the incoming information, of providing a reading and interpretation of that information and suggesting the most appropriate intervention in relation to the various situations.

It is possible to build an entire information system around the expert system, with all of the procedures for intervention and the manner of connection with company realities, in order to achieve:

- management of works and resources, whose fundamental purpose is to request the work order;
- technical plant management, whose fundamental purpose is the management of the machine and plant;
- management of continuous improvement;
- management of maintenance engineering.

---

10 In many cases, the interpretation of the data collected may require the intervention of additional professional figures that possess specific competence different from the competence of the machine operator.
The new information system must then be able to interface the expert system with the machines and other components, such as:

- the sensors, whose task is to collect signals from various plant machines;
- the communication networks, when ensures the exchange and flow of information throughout the factory;
- the front-end, a computer that provides for continuous monitoring of signals and their selection, to send only the important ones to the expert system it is connected to;
- the model of interpretation of failures, which permits us to forecast the duration and behaviour of the machines.

These elements are then integrated with the standards present in all traditional information technology systems:

- the plant database;
- the system of management of works and resources;
- the system of plant management.

### 2.2.7 Conclusions

It has been seen how, historically, the maintenance culture of the processing industry has been deeply enriched by the contributions of the manufacturing industry, which is evolving towards forms of integration and automation of productive plants and services (internal and external), with important impact on the organisational structure of the factory, the professional figures present and on maintenance, which assumes a central function on the management level.

In speaking of the manufacturing industry, of automation and organisation, the decisive contribution of the Japanese model of production cannot be neglected, which has conditioned plant culture through its most significant element, in an extremely meaningful manner: the global nature of the approach.

Problems are not dealt with in the ambit of sectorial strategies, where the achievement of an objective sometimes entails the sacrifice of others; a global vision must be acquired, instead, which makes TPM an obligatory road to take, in terms of maintenance, in this process of change.

Another important change of orientation in the development of the industrial system is included in this context.

In fact, the culture of conservation has appeared and is beginning to replace the culture of substitution, which testifies to the passage from an industrial to a post-industrial phase.

The symbol of this new industrial revolution is definitely automation.

Through automation, the responsibility of the process goes back to the productive system, eliminating many staff and operational support figures, as well as dividing 'those who do and those who think'.
The spread of the culture of maintenance, in any case, constitutes the fundamental element for the assertion of the concept of ‘maintaining’ as opposed to the concept of ‘building again’.

Today, the problem of correctly maintaining and managing industries, infrastructures and services has become the central fact of civil development, in a framework of sustainable development.

The increase in prosperity has brought a great increase in property and an important increase in the population in recent years; this leads to increasing use of resources and a serious problem of environmental impact.

Precisely for this reason, it can be asserted that raising the quality of life essentially means maintaining instead of building, preserving instead of consuming.

In technical industrial terms, this means keeping existing plants in efficient operating condition, both to preserve productivity and guarantee the protection of the environment; it means applying the principles of continuous improvement of plants and, in an even more massive manner, of services.

In order to work in this direction, it is necessary to perform maintenance, utilising the technologies and methods of improvement maintenance and TPM.

Systems operators must perform initial maintenance intervention and have the motivation to conserve. Outside of industrial companies, this is also true for museum attendants, building porters, bus drivers or train engineers, and the managers of water purification systems.

Such, therefore, is the objective it is necessary to strive and work for in coming years.

Bibliography


Methodologies and Techniques for Advanced Maintenance
Fedele, L.
2011, X, 222 p., Hardcover