Industrial Maintenance today and future trends

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Abstract

This paper describes the evolution of industrial maintenance over the past sixty years and the key areas that have influenced it. It will also explain how to achieve a situation that could be considered the "perfect world" for any maintenance professional. The paper also surveys the new technologies and ideas, and how they could influence the future industrial maintenance trends. Finally, there is a description of QUANT, the global leader in industrial maintenance outsourcing, and strategic initiatives to continue providing world-class services in the future.

It has been said that over the past 40 years, the industrial maintenance has changed, perhaps more than any other management discipline. From my experience, I believe that to be true.

The overall technical and methodical scope of maintenance has changed over time. Today maintenance is not restricted to simply repair the equipment when it breaks, it also has influence on the sustainable development of society as it influences the environment, safety of personnel and facilities, energy efficiency and financial aspects.

Companies that previously considered maintenance simply as a source of spending, increasingly have become aware that maintenance is, without any doubt, a critical factor to remain competitive.

Looking at the evolution of industrial maintenance, we cannot fail to mention the analysis done by John Moubray in his well-known book named *Reliability-centered Maintenance*, which in my opinion, best describes the changes that have occurred in industry during the last sixty years. The book describes the gradual evolution of maintenance practices throughout those sixty years.

In his analysis of the maintenance evolution, Moubray divides maintenance into three distinct generations:

The first generation covers the period up to the Second World War.

During that time, industry in general, used simple and robust mechanical equipment. Management was not particularly concerned with downtime or maintenance. Once the equipment became fairly reliable and relatively easy to repair, there was no need of any special maintenance methodology; keeping the equipment clean and well lubricated was enough. Consequently, there was no need either for systematic maintenance or special skills from maintenance professionals.

The Second World War marked beginning of the second generation in maintenance.

The war dramatically changed the scenario described above because it increased the pressure for goods of all types. This caused a shortage of manpower in the industry and increased mechanization. The 1950s were marked by the emergence of increasingly complex equipment, to reduce the need for human intervention in the production process. As manual labor decreased, the need for more reliable equipment operation became necessary, in other words, the equipment downtime became a real concern to the plant operation managers. This new concern led to the idea that the equipment failures could and should be prevented, which led, in turn, to the concept of preventive maintenance.

In the 1960s, the prevailing concept of preventive maintenance consisted of planned shutdown of equipment to perform maintenance tasks at planned intervals. This practice resulted in the drastic increase in the maintenance cost compared to other operating costs and, in this context, maintenance planning and control systems emerged as a way to have maintenance under control. Those systems were incorporated into maintenance practices and they are, still today, indispensable to any maintenance management system.

It should be noted that the capital investment for the modernized equipment increased significantly. The cost of capital necessitated the need to find ways to improve, maximize, the life of the equipment and thereby reducing the need for additional investment in capital replacement.

The third generation of maintenance, still according Moubray, started in mid-1970s.

Coincidentally, that is when I started my career as maintenance professional. At that time there were growing expectations from maintenance; unplanned downtime was less and less tolerable, since it affected the productive capacity, increased operating costs and, ultimately affected customer service.

Industry increasingly adopted the "just-in-time” system in order to reduce raw material inventories and work-in-process inventory. Any unscheduled equipment downtime could negatively impact the accomplishment of production plans.

In recent times, increasing automation in equipment and systems, brought emphasis on reliability, consequently, failures are not tolerated, especially in sectors such as hospital equipment, data processing, telecommunications, etc. Equipment failure may also negatively influence the quality of the products, climate control in buildings, the punctuality of public transport services, power generation and control among many other important services.

Today, it is fundamentally important to consider the impact of safety and environmental failures when addressing maintenance planning. I many parts of the world operations can be shut down due to safety and environmental concerns.

The integrity of physical assets has evolved from one factor that only influenced the manufacturing cost to a matter of organizational survival.

To cope with the increased equipment reliability expectations, such as reducing and eliminating failures and the consequent reduction in maintenance costs, new techniques have emerged. For example: Reliability-centered Maintenance (RCM), Root Cause Analysis (RCA), FMEA, etc.

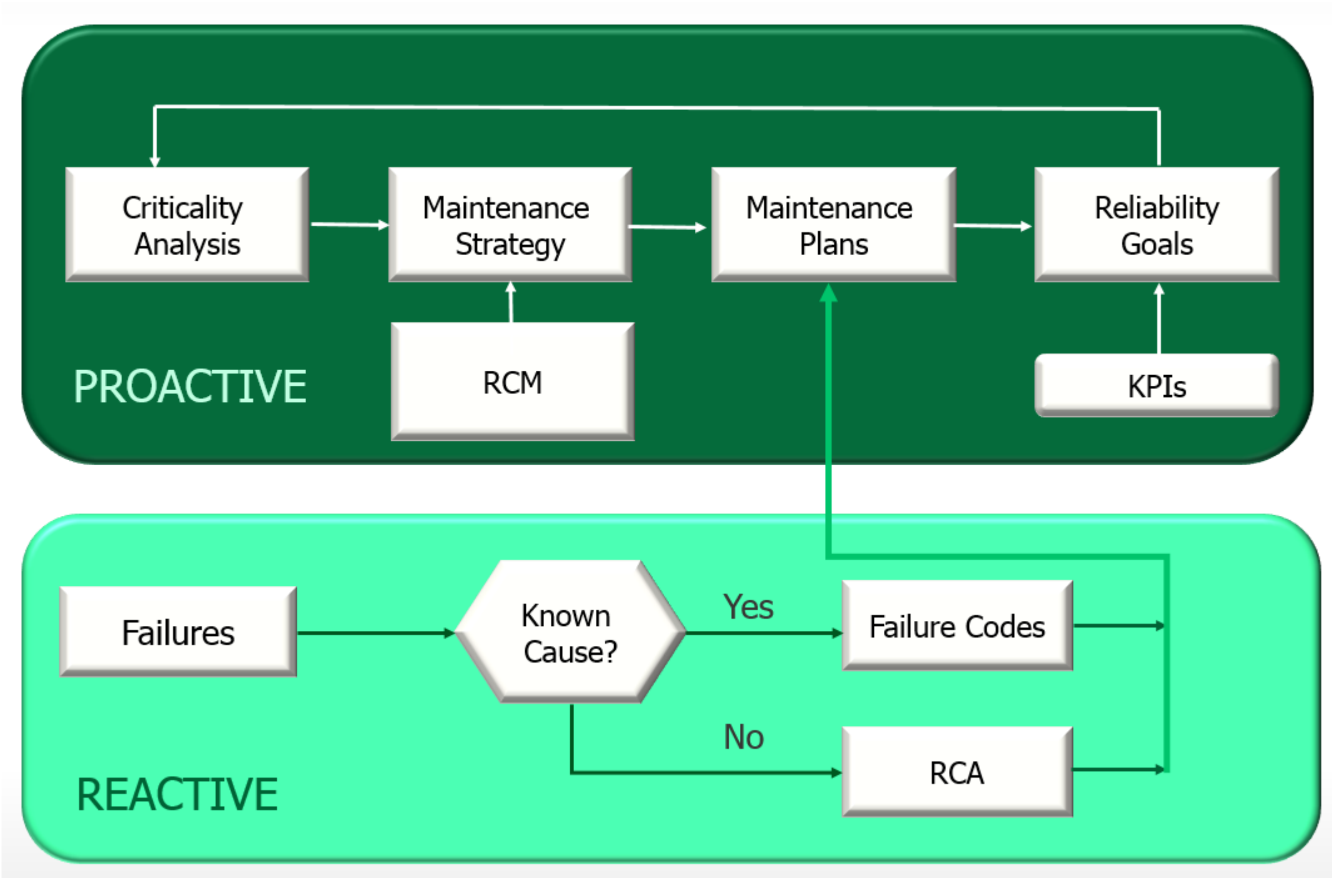
Additionally, in recent years, technological developments, especially advances in information and communications technology, enabled several innovations in maintenance. These include: predictive techniques, remote diagnostic systems and expert maintenance systems.

Perhaps one of the biggest challenges that maintenance professionals face today is, in addition to learning all the new techniques and methodologies, is to decide which one best meets their organization's needs. They need to clearly understand the cost / benefit of each one of the many offered alternatives.

Talking about my personal experience in this area, wherever I go, I am frequently asked the question:

“How does one move from reactive maintenance, fixing what is broken, to proactive maintenance, preventing the failure in the first place or at least minimizing the consequences?"

I would like to digress slightly because the answer to this question, in my opinion, summarizes the maintenance evolution from the “Fix it when it broke” to what can be considered the “perfect world” of any maintenance professional.



To better understand, let's look at the flow diagram above. Starting from the bottom, the part named "reactive", the first step is to understand why the equipment is failing. If we know the causes of failures, then we need to group them to identify what are the most important.

At this point, it is worth noting that we need to assign codes to the failures. This is necessary in order to provide simply direction the staff in identifying the failure and then to group them for further analysis by the reliability engineering group.

If we are unable to identify the cause or causes of failure, then we should use the Root Cause Analysis (RCA) to assist in their identification.

The output of "reactive mode" will have data for maintenance and reliability engineering, data representing the causes of equipment failure.

However, this alone is not enough; we must now examine the actions that are at the top of the flow diagram, the "proactive mode". At this point the maintenance and reliability engineering starts by defining the plant equipment tree or equipment hierarchy, which is the backbone of the reliability maintenance process. It lists and organizes all production equipment in a logical hierarchical structure, where each piece of equipment is identified by its position in the production process, and given a name and code.

The next step is to analyze the criticality of the equipment using Quant standard procedure, which results in the breakdown of equipment at three levels (A, B, or C). The basic criteria for the definition of this criticality involve aspects of safety, environment, production, quality and cost. Once the criticality is defined, then the strategy of maintenance will be defined from the RCM (Reliability-centered Maintenance) analysis.

The maintenance plans are then implemented in CMMS (Computerized Maintenance Management System) and executed accordingly.

The plant performance is monitored using different indicators (OEE, technical availability, MTBF of critical equipment, maintenance costs, etc.) to verify how the maintenance activities are influencing them.

Over the time, for every failure which impacts the plant performance, we must ask why the existing plans were not able to avoid it or minimize its consequences. The answer to this question will serve as feedback to the system, promoting the review of the existing maintenance plans.

When established, the process of continuous improvement will have a stabilization effect and then a significant reduction in failures.

The situation considered to be the “perfect world” for any maintenance organization occurs when the maintenance team is working most of the time in the proactive mode, without fire-fighting, without emergency calls in the middle of the night, without operations managers complaining about equipment downtime, without maintenance budget overrun and without stressed maintenance people.

Even today, we see that not all industrial segments have their maintenance programs at the same stage of development. For example, reliability, availability and asset life cycle planning had initial focus in the nuclear industry and this was quickly followed by the aerospace industry, but not so many other industries have this same focus.

The concern for the safety and risk analysis have been developed in the chemical and petrochemical industry and, in certain way, spread to most industries.

In some other industrial segments, where the equipment failure is “acceptable”, as long as the repair and return to operation time is short, often the up time is more important than reliability. In other words, the focus is more on reducing the equipment downtime than its probability of failure.

Looking at future trends of maintenance, based on the resources listed in the bibliographic reference and in our experience; we see the emergence of new models such as the customization of maintenance services, which are directed specifically to customer needs. Good examples are the integrated services for rotating equipment; the supply of bearings, vibration analysis and lubrication service through performance-based contracts. This type of service releases the plant staff to focus on their core business without worrying about the management of services, acquisition of lubricants and bearings.

Additionally, maintenance contributes to sustainability. The concept of extending the life of physical assets and maximizing reliability at minimum cost, which are the day-to-day maintenance goals, provides an authentic competitive advantage to the business. This is done by avoiding unnecessary replacement of equipment and parts, as well as supporting efficient operation of industrial plants with minimal energy consumption.

Another maintenance trend for the future is the development of support for decision-making systems. Today many industrial maintenance decisions involving risks for equipment, costs and people are still made based on inaccurate or even missing data.

Some years ago, I experience a difficult situation at a petrochemical site, where we provided maintenance services that illustrate the deficiency in decision making on the shop floor. At this site, the vibration data collected from a boiler fan electrical motor indicated that one of the bearings should be replaced immediately, a fact that was promptly reported to the customer's engineer responsible for the utilities area. We also requested the customer to plan for the boiler's immediate stoppage to replace the motor bearing.

The boiler stoppage required shutting down all functions at that petrochemical site and the engineer who received the information questioned the accuracy of the diagnosis. He wanted to be absolutely convinced of the need of the required intervention before escalating this message to plant managers and to the site general manager.

We informed that the diagnosis was accurate and explained the possible consequences of the catastrophic electrical motor bearing failure should the electrical motor continue running.

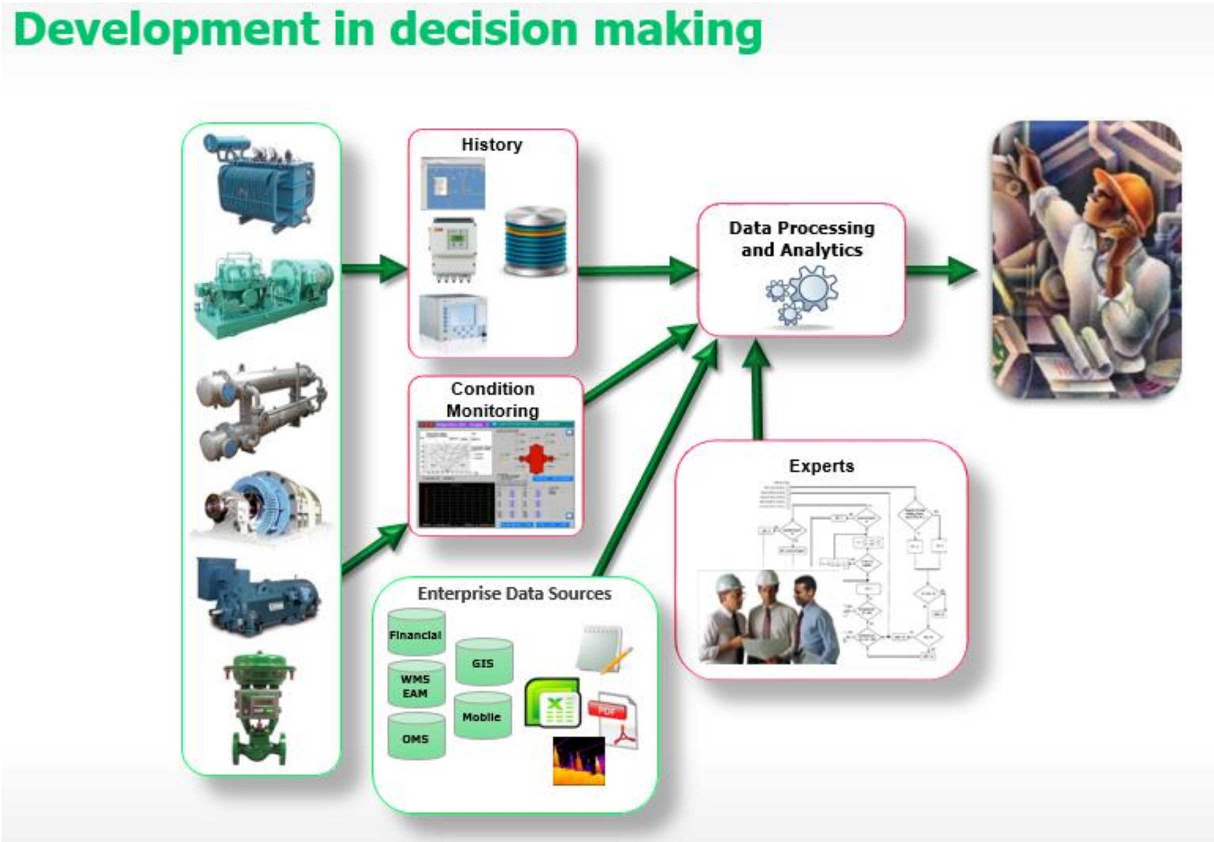
We issued a formal report with our recommendations that the motor bearings should be replaced immediately. The customer rejected the recommendation and asked that we simply monitor the motor while operations continued. Some 15 hours later, the bearing failed causing the destruction of the motor and a total plant shut down.

What could have been a planned maintenance repair of some hours, a misinformed decision caused complete chaos for many hours with the additional cost caused by the unplanned all plants shutdown.

To avoid this type of situation, research is being developed in order to provide automated assistance in decision-making processes by using data fusion methodology, commonly defined as a combination of multiple sources to obtain improved information; in this context, improved information means less expensive, higher quality, or more relevant information.

The data fusion methodology is used to combine multiple data and other real world information into a consistent and accurate representation of the issue at hand.

A support system for decision making should merge various types of information such as data obtained in the condition monitoring, the monitored variables history, financial data, data from maintenance work reports and expert’s recommendation. The combination of these data produces an appropriate support for decision.



Developments in technological tools, even those developed for other purposes, end up benefiting industrial maintenance. In industrial maintenance, it is important to mention the use of wireless sensors, miniaturization, micro-electro-mechanical systems (MEMS), and disruptive technologies such as nanotechnology, algorithms, self-healing components and the Pervasive Sensing concept.

Wireless sensors are used mainly for monitoring and diagnosis with the advantage of enabling continuous monitoring and at low cost when compared to portable instruments.

Miniaturization also plays a key role among the technological advances, to give just one example, the first large scale digital computer, the ENIAC developed in the mid-1940s, weighed 30 tons and occupied a built area of 270 m^2. Currently, a tablet, small and light, has infinitely more resources, and not just computational, than its ancestor.

Among the mentioned disruptive technologies, we should highlight the self-healing components; those components "identify" that they are damaged and start the self-healing process. Finally, it is worth mentioning the ubiquitous sensing (pervasive sensing). For example, a vehicle built in 1990 had approximately 10 sensors on board; a similar model produced in 2005 had approximately 50 sensors with built-in diagnostic software. The systems and sensors are already present everywhere, for example, the mobile phones have high quality cameras, GPS, and can record live audio and video as well as music using internet connection.

In the context future trends in industrial maintenance, how is QUANT, global leader in industrial maintenance, with more than 25 years of experience managing and executing industrial maintenance preparing to continue providing world-class services in the future?

Among many strategic initiatives recently launched in a global event in Madrid, QUANT leaders from all over the world met to discuss the Strategic Plan deployment and implementation. At least, three major topics could be identified about what the company is doing to continue providing world-class services:

QUANT has a group of professionals exclusively dedicated to Research & Development activities, continuously developing and improving Quant world-class maintenance concept, always aligned with market demands (modularization and flexibility) and technological innovations.

Technological advances would not be effective without good management and empowered people. QUANT has a comprehensive Talent & Competence Management Program in order to provide the best maintenance professionals in all regions where it operates.

QUANT also has R & D initiatives to partner with customers to develop specific solutions according to their needs.

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