

## **AN EXPLORATORY STUDY OF THE ROLE OF INTERNET TECHNOLOGIES IN THE FIELD OF INDUSTRIAL MAINTENANCE: IS KNOWLEDGE MANAGEMENT THE WAY FORWARD?**

*UM ESTUDO EXPLORATÓRIO DO PAPEL DAS TECNOLOGIAS DE INTERNET NO  
CAMPO DE MANUTENÇÃO INDUSTRIAL: GESTÃO DO CONHECIMENTO É O  
FUTURO?*

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### **RESUMO**

Estudo exploratório sobre a possibilidade da tecnologia Internet impactar uma atividade industrial específica. A Manutenção Industrial foi por muito tempo a relação pobre na indústria apesar de ser indispensável tanto no processo contínuo de fabricação como na produção. A pesquisa parte da premissa de que a manutenção tem duas funções-chave que podem ser relacionadas à disciplina de administração. Estas são: a aquisição de peças sobressalente ligadas as compras; e o desenvolvimento dos técnicos, engenheiros e pessoal subcontratado que são supervisionados juntamente por gerentes de produção, compra e de recurso humano. A aproximação adotada foi de uma revisão de práticas atuais seguida por um estudo com um informante chave. Foram entrevistados os peritos em várias áreas industriais principais junto com um líder de opinião de uma Federação de Manutenção Européia para analisar até que ponto a tecnologia é provável de afetar tanto a compra de sobressalentes como a gestão da informação.

**PALAVRAS-CHAVE:** Manutenção Industrial, ICT, Gestão do Conhecimento, Manutenção preditiva, CMMS (Computerised Maintenance Management System), manutenção remota

### **ABSTRACT**

This is an exploratory study of how Internet technologies are likely to have an impact on a specific industrial activity. Maintenance has long been the poor relation in industry despite being indispensable both in continuous process manufacturing and in discrete production. The research starts from the premise that maintenance has two key functions that can be related to management disciplines. These are the acquisition of spare parts, which is attached to purchasing and the deployment of technicians, engineers and subcontractor personnel which is jointly supervised by production, purchasing and human resource managers. The approach adopted was a review of current practices followed by a key informant study. Experts in several major industrial concerns were interviewed along with an opinion leader from a European maintenance federation were interviewed to analyse to what extent technology take-up is likely to affect both purchasing of spares and information management.

**KEY WORDS:** Industrial maintenance, ICT, knowledge management, predictive maintenance, CMMS (Computerised Maintenance Management System), remote maintenance

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## 1) INTRODUCTION

This paper deals with the opportunities the internet can bring to the maintenance industry. Here maintenance means primarily maintenance repair and operations within an industrial production environment.

Historically, maintenance departments have existed to remedy breakdowns. This was a rather expansive practice because breakdowns can cause standstills that cost and therefore new ways of doing maintenance appeared. The new vision was to prevent these breakdowns in order to reduce costs incurred due to excessive downtime. Preventive maintenance was the first technique to obtain this goal. It was based on the belief that it was less expensive to replace machinery parts on a regular basis than to wait until they finally broke. Predictive maintenance goes even further. This new method enables users to detect minor defects or irregularities in the machinery with different types of sensors. This new method requires sophisticated technical equipment. Still this is worth the investment because predictive maintenance payback is achieved since only those spare parts that need to be replaced are changed when necessary.

With the implementation of CMMS<sup>1</sup>, maintenance professionals can now register information related to their activities in a computerized format. Even the data from predictive maintenance can be brought into the system and elaborated upon.

These technological innovations have accompanied the wave of outsourcing that has been witnessed over recent years. Indeed due to the complexity of the work, it is in some cases financially more attractive to outsource certain tasks. The question that needs to be answered is: How can new ICT improve maintenance practices.

As the purpose of this paper is to provide a strategic insight into the possibilities of using the internet in maintenance, qualitative interviews were chosen as the method to see what was occurring in industry. The pulp and paper industry was selected for the field study.

The interviews made it very clear that this industry is not ready or interested in the possibility of purchasing spare parts online. This does not mean that there is no interest in using the internet for maintenance practices. Remote maintenance for example is more demanded.

Surprisingly it is other, more simple, internet tools that are seen as interesting namely remote consulting and information about accreditations and norms.

One should not give up on e-markets either, but maybe they came too soon and too fast. For the moment providing knowledge management seems the appropriate way to provide added value by using the internet in maintenance.

### 1.1 Research question

After an overview of what maintenance today is all about, it was decided to investigate this reality. The new trends in maintenance clearly indicate that new technologies can improve maintenance practices. The research question therefore seems quite logical: how will the new ICT affect maintenance?

This paper does not want to limit itself to giving an overview of what could be possible with internet applications. The purpose is to look for realistic answers.

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<sup>1</sup> CMMS : Computerized Maintenance Management Systems

It is rather the goal to seek strategic insights into the issues than to be able to predict when the "real" e-commerce applications take over the old industry. It is also therefore that qualitative research methods are more appropriate. Once a clear view of the situation has been determined, quantitative techniques can then be used in subsequent research to acquire more profound understanding of the issues.

## **1.2 General methodology and structure**

It was decided to begin the research with a review of current literature about maintenance and knowledge management. This proved difficult since there is a shortage of specific books about the subject and maintenance frequently merits only a few lines in works on operations management. However some useful information was found in the specialised press and academic journals. Nevertheless the most valuable information was obtained from the interviews of experienced maintenance managers and this enabled some tentative conclusions to be drawn.

The paper starts with an industry overview. This overview is mainly based on articles found in specialised magazines and surveys performed by renowned institutions. It will provide the reader with a solid qualitative insight into the maintenance industry. Then the major tendencies and the most important issues in maintenance today are analysed in order to clearly lay out all the issues related to the research question. Then the theoretical and literature approaches are compared with the results of the interviews carried out in the field in order to draw provisional conclusions.

## **1.3 Literature Background**

Knowledge management specialists have rarely addressed the issue of maintenance management specifically. Some researchers have addressed it indirectly by examining the knowledge issues associated with manufacturing or construction industries (BLUMENTRITT & JOHNSON 1999, ANUMBA et al 2000). Other authors have focussed mainly on the supporting role of knowledge management techniques in relation to different functions, notably after-sales service (PENTLAND 1992) and technical support (DAS, 2003). In the case of maintenance management a different approach is needed since the domain covers several functions including purchasing, human resource management, training and quality management. It is also interesting to note that several previous articles have addressed the issues of tacit and explicit knowledge (SPENDER 1996, SCHMIDT 1999). This is particularly relevant in the maintenance industry since explicit knowledge made up of concrete measurements and quantitative data held in specific maintenance management information systems coexists with implicit knowledge that is essentially the experience of the operatives who carry out the different maintenance tasks in the field. This view is also shared by Rosenberg (1994) who puts forward the fact that formalized measures of knowledge such as patents and R & D expenditure frequently neglect the more mundane aspects of knowledge acquisition.

## **2 The maintenance industry past and present.**

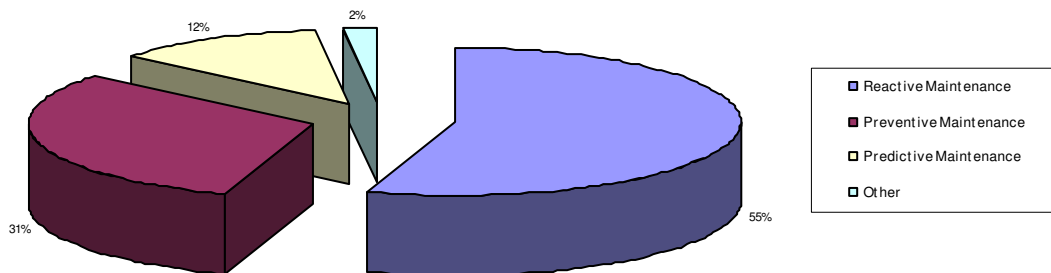
Maintenance used to be the wicked-surgeon department of a company. Most operations asked for immediate undertaking without preparation. Inventiveness and

good hammering were two of the core competences needed to be a good maintenance technician. Thirty years ago maintenance costs in U.S. companies were between 0.4% and 0.8% of sales. The proportion is now significantly higher.

In 1992 a typical manufacturer operated using approximately 55% reactive maintenance and 31% preventive maintenance practices (LANGAN, 1995).

Most industrial companies are embracing these new technologies and working methods. The question is: what is next? This paper looks at the internet as a possible next step to innovation.

Figure 1: Maintenance Activity Typologies in 1992



*source Langan*

Overtime, another key indicator, constituted on average 15% of the total working time in maintenance organizations. This figure is relatively high. Since maintenance is putting in so much overtime, it confirms the reactive approach that is usual in industry. Reducing overtime is essential if a maintenance organization is to be truly cost-effective.

## 2.1 Maintenance today...

Today maintenance costs are range from 3% to 15% of sales and from 2 to 12% of product costs and are probably the largest, most out-of-control "controllable" cost in the plant (DYER, 1998).

This clearly indicates that the importance of reliability and maintenance practices has been changing. A few years ago, most organizations were often reacting to failures and the best practice was preventive maintenance programs designed to maintain equipment in good condition.

Today's environment has shifted focus to predictive and proactive maintenance approaches. Programs such as Total Productive Maintenance (TPM) and Reliability Centred Maintenance (RCM) are being implemented. Best practices involve monitoring the condition of equipment, performing failure modes effects analysis (FMEA) to determine root causes of failure, and training, developing, and involving operators to lower equipment-related costs and to increase the value added in production.

The players on the maintenance market have also changed. This change highlights the new strategic importance manufacturers are willing to give to maintenance. The most important players are: manufacturers or industrial end-users, suppliers of spare parts, machinery manufacturers, consultants, software manufacturers and maintenance associations.

Figure 2 below demonstrates how maintenance has evolved into a real asset management discipline with the deployment of successive waves of technology.

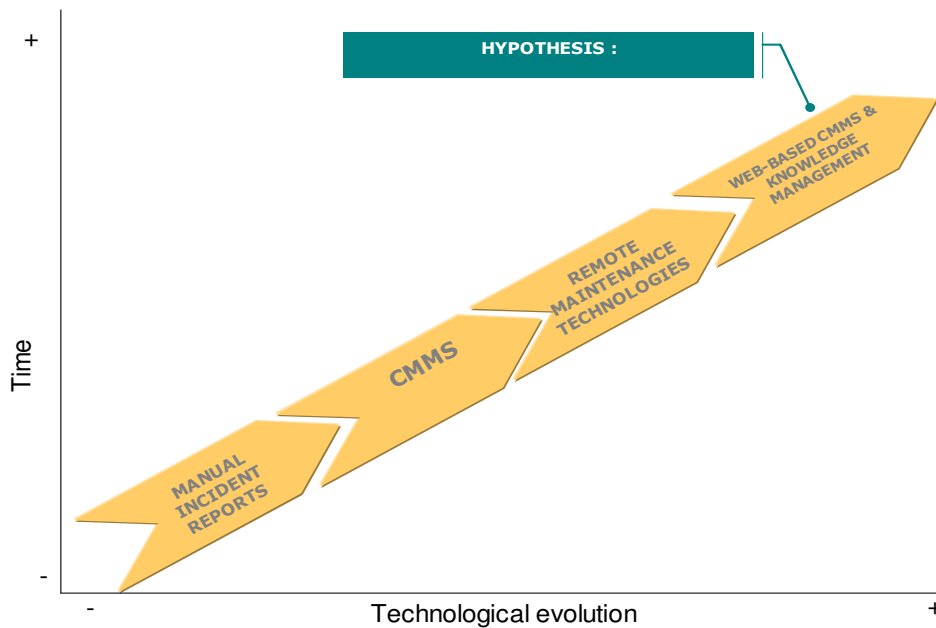


Figure 2: Predicted evolution of maintenance management

## 2.3 Maintenance issues in 2004

### 2.3.1 CMMS (Computerized Maintenance Management Systems)

CMMS systems keep track of all maintenance data and actions in a factory. The most important features of such a program are the following:

- Data analysis
- upgrade possibilities
- asset management
- work management
- resource management:
- reporting
- information exchange

### 2.3.2 How are CMMS really used?

According to a survey (SRMP, 2000) ninety percent of surveyed plants have a Computerized Maintenance Management System (CMMS) to manage equipment, material, labour and cost data in order to manage maintenance as a key part of the total operation. While this statistic seems to be positive on the surface, it is not. Even though a CMMS provides the system tools and the information framework to integrate best practices into the maintenance process, it is most successful in organizations that are committed to a long-term maintenance strategic plan to improve maintenance practices and procedures. Additionally, the CMMS system is underused; only 23% of plants are planning and scheduling all of their maintenance work activities through the system. The weighted average of work activities planned and scheduled through a CMMS is 62%.

## 2.4 Subcontracting

Contracting out of selected maintenance activities is strategically important. Another SMRP survey (2000) shows that 81% of plants are presently subcontracting some maintenance work to a third party with an average of 25% of the total maintenance budget spent on contractors. Best practices imply a clear and well-defined contracting philosophy and contractor management process. Seventy-five percent of plants using contractors (63% of all plants) agree there is a clear and well-defined contracting strategy, and 39% of these plants (33% of all plants) have an established set of indices to measure contracting performance. Safety indices, quality of work, and schedule compliance are the most common contractor performance measures.

Activity	Frequency of response (%)
Technical services for maintenance buildings and facilities (HVAC, plumbing, painting, etc.)	86
Equipment and component overhauls	75
Supplementary labour hire for on-site inspections and repairs	64
Supplementary labour for shutdowns	64

**Table 1: primary activities for contractors**

Table 1 shows the primary activities for contractors. Statistically, it appears that more continuous/batch process plants (80%) use contractors for supplementary labour in shutdowns than in discrete production plants (31%).

## 3 Maintenance typologies

Traditional curative methods are now increasingly superseded by preventive and predictive techniques.

### **3.1 Preventive Maintenance**

Preventive maintenance has been in use for some decades now. In most companies the benefits of this procedure were commonly known and accepted. Though the basic principal was to replace mechanical parts before they could provoke a failure and standstill it has become clear that in many cases replacements were unnecessary and therefore expensive.

### **3.2 Predictive Maintenance**

The use of sound, smell, vision and touch to detect symptoms of a bad bearing or misalignment made the development of sophisticated gadgets possible that now can sense problems long before they become obvious to us. Modern predictive maintenance equipment uses the following approaches to monitor plant machinery performance.

- Vibration sensors
- Oil analysis
- Infrared thermograph
- Ultrasound sensing equipment

### **3.3 Capabilities of predictive technology**

Recent developments in the science of monitoring machinery to predict maintenance, schedule repairs and minimize downtime have created effective systems for breakdown prediction.

Sensing and predicting potential problems in motors, pumps and gearboxes is nothing new. Most maintenance and operations departments are familiar with using vibration analysis, oil sample analysis, and infrared sensing and ultrasound monitoring to track equipment performance. Experts in the predictive maintenance field estimate that up to 75 percent of manufacturing companies in the U.S. use some form of predictive maintenance techniques<sup>2</sup>.

Companies carry out predictive maintenance in a variety of ways. Large companies can often justify owning the sensory equipment and training employees to operate it although the outsourcing wave in many bigger companies is putting this activity in the hands of outside contractors. Many smaller companies have found outside contractors a cost-effective way to monitor their equipment's performance.

To make predictive maintenance technologies cost-effective, the first step is to decide which pieces of production or support equipment are critical. Many people in the predictive maintenance industry cite the 20-80 rule, which states that only 20 percent of the equipment in a facility is absolutely critical to keep things running. The other 80 percent "only" slow things down or make life difficult if they fail or develop problems. The goal should be to identify critical equipment and initially spend resources monitoring it instead of trying to monitor everything in the plant.

### **3.4 Spot-checking and continuous checking**

As the price of portable predictive sensing equipment drops, the temptation to

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<sup>2</sup> <http://www.ecomworld.com/search/author/article>

monitor everything that moves in the plant increases. Workers are often given vibration or infrared detectors and sent on a mission to check every motor, pump and valve in a plant. The result: a massive data bulge that overwhelms any attempt to monitor and develop a predictive maintenance program.

In leading-edge asset management systems, vibration and temperature sensing equipment constantly monitor critical motors, pumps and related equipment. Instead of spot-checking equipment once a week or once a month for excess vibration, data is collected continuously. Spot-checking catches equipment as it is failing and online asset management gives you data that helps analyse why it is failing.

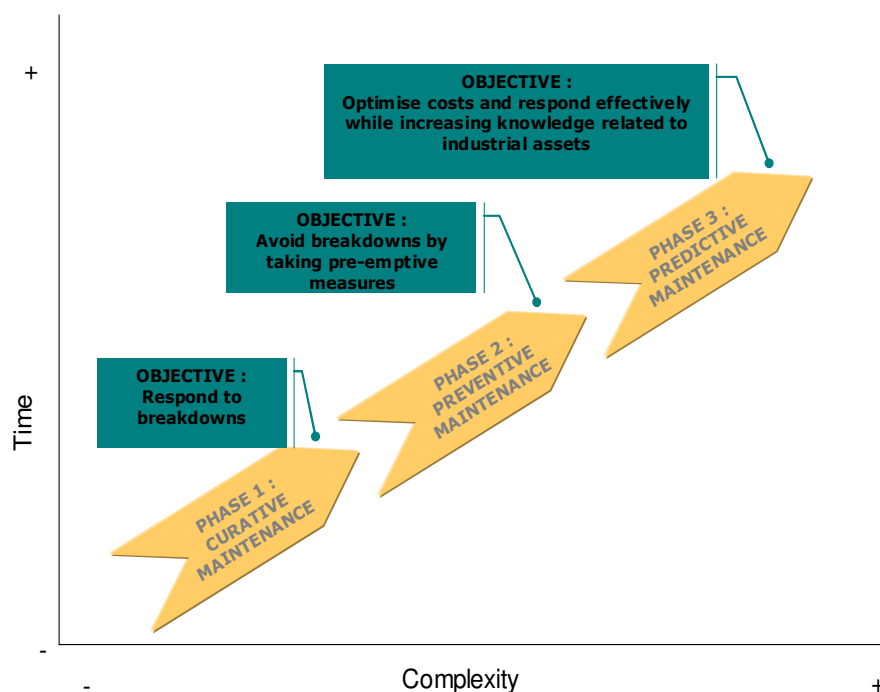


Figure 2: evolution of maintenance typologies

#### 4 Internet opportunities for maintenance

In this section the main possibilities of ITC for addressing maintenance issues will be dealt with. Most of them are still in a start-up phase in the real world but the technological platforms are already there.

##### 4.1 Remote maintenance

As predictive maintenance uses data, which is transmittable by a network, it offers the opportunity to keep an eye on machinery from a distance. Costs will normally drop as wireless technology comes online. There are none on the market now, but several companies are working on them. The initial cost of system components will be higher, but the installation cost will be minimal compared with the costs of hard-wired



systems of purchasing.

## **4.2 Knowledge Management**

Here knowledge management is referred to as the accumulation of experience and tacit knowledge that goes beyond the simple quantitative indicators that are generated by information systems such as CMMS. It is noted that in the installations of the chemical plant AZF in Toulouse, France, such systems were extensively deployed prior to the deadly explosion in 2001. Sadly the mere deployment of such information technologies is no guarantee of industrial security. One of the theories advanced to explain the catastrophe has been the inexperience of newly-integrated subcontractors.

## **5 Field study in the pulp & paper industry**

### **5.1 Methodology**

In this paper qualitative research is being used to attain the goals. After the literature and industry review, it was necessary to make a comparison between theory and reality. This basically requires selecting an industry and investigating the changes that had occurred or are likely to occur through internet usage.

Qualitative interviews may be used as an exploratory step before designing more quantitative, structured questionnaires to help determine the appropriate questions and categories. Conversely, interviews may be used after results of more standardized measures are analysed to gain insight into interesting or unexpected findings.

The qualitative research performed in this paper is intended to be a template from which to conduct further quantitative research.

### **5.2 The pulp and paper industry**

It was decided to conduct interviews in a specific industry. The choice of this industry was very important because it had to be satisfactory to a number of stipulations. The most important was that it had to be an industry where maintenance was considered critical. Hence a continuous process industry was selected. Clearly this is maintenance in a professional industrial environment where significant amounts of capital are invested in plant and machinery.

Secondly the importance of maintenance has to be substantial. By adding this criterion it is sure that cost saving through excellent maintenance becomes a company priority. In this type of firm innovative forms of maintenance are most visible. Two different types of companies satisfy this criterion.

First of all there are industries where maintenance is a big part of the budget. Changing the way of doing things and bringing more efficiency means a big change in the budget and the competitive position of the company. An excellent example is the aviation industry. Companies like Boeing and Airbus do not only build planes. They also have a big responsibility in maintaining those aircraft in perfect condition. This asks for continuous check ups and replacement by spare parts.

Secondly maintenance makes a big difference in companies where a breakdown as a result of bad maintenance practices. Continuous production processes are of that kind. Some examples are the petrochemical and the pulp and paper industry. It was

decided to obtain information from this latter industry.

The importance of maintenance in this industry is undeniable. For example, in France the average budget for maintenance is between 1 and 2.5% of total revenues. In the pulp and paper industry this average was about 7% in 2002.<sup>3</sup>

Interviewees were contacted in 15 pulp and paper plants in France and Belgium. Their job profiles included technical directors, technical purchasing managers, maintenance managers and production managers.

The range of products manufactured included magazine papers, newsprint, fine papers and packaging boards, and all companies served both domestic and international markets.

In order to get an institutional perspective on the situation, a further interview was then carried out with the president of a European federation of maintenance engineers.

### **5.3 Some specific characteristics of plant maintenance in the installations investigated:**

Most of the maintenance departments have good reputations and appear to perform effectively. A few years ago most of the maintenance was still done by the company itself but new tendency/policy is perceptible. More and more complete maintenance contracts are outsourced. More and more special "leasing" contracts are made when machines are purchased and such contracts include after-sales service with stringent conditions for the supplier (maximum of 4 hours downtime or financial penalties are levied).

Subcontractors can be local or international. The choice between both is mainly based on the flexibility needed (local subcontractors are seen as faster and competent on a broader level) and the specificity of the problem (sometimes maintenance is so particular, that local companies do not have the expertise).

As the making of paper is a continuous process, one defect in the machinery can bring the whole plant to a standstill. The cost of these breakdowns can run up to more than 10 000 € per incident.

The majority of all problems are solved internally but if the problem is too complex external experts are contacted. These problems mostly require contacts with the contractor who built the paper mill. In the paper mill business two big constructors rule the market.

In the plants structured procedure are drawn up so that everybody knows 24/7 who to call too in the event of an emergency.

### **5.4 Examples of critical situations**

The following incidents constitute critical breakdowns that can bring a plant to a standstill. It is therefore a high priority to resolve such incidents rapidly and if possible in a cost-effective manner:

- a broken bearing on the paper press
- an object fell into the paper machine. E.g.: an iron bar goes through the press

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<sup>3</sup> M.D., La maintenance outil de production, Revue du papier carton, mensuel n°53, April 2001

rolls.

- a frequency regulator break-down
- electric engine problems,
- coupling problems
- malfunctions in PLCs (program logic circuits).

When asked to judge what was likely to make a problem become critical most respondents identified quality and safety as key factors in assessing a difficult maintenance situation. Another issue invoked was “knock-on effect” meaning that if a part is not replaced, the damage could spread to other parts of the machine. Unavailability of maintenance personnel or their lack of knowledge is not an issue in most companies; four of the interviewees admitted that it occurs but claimed that it is rather rare.

The shortage of information or documentation sometimes occurs. And in some cases respondents claimed that manufacturers do this on purpose to increase their importance and to sell after-sales service contracts. However the most frequent problem encountered is the unavailability (in the plant’s own stock) of spare parts.

### **5.5 Spare parts:**

To decide which spare parts have to be kept in stock a thorough analysis is done. Firstly, the list provided by the manufacturer will be examined. Normally the plant assumes that this list is too large. From experience, the list will be reviewed after certain periods. So the main criterion to keep spare parts in stock is the manufacturers list!! This list will then be adapted after an analysis of the technical and maintenance department. Other significant criteria to decide whether or not to keep a part in stock are lead time and frequency of use. The suppliers-list of spare parts is not followed completely. More and more suppliers are forced to keep the parts in stock or to supply products on leasing contracts. Concentration on core business is the main reason for this policy.

On the other hand some local or particular situations will influence the decision. For companies based in Northern France, for example, the proximity of the European distribution centre of SKF, a major ball-bearing manufacturer means that stocks are minimised. With SKF some agreements are made that SKF keeps in stock some of the expensive bearings or bearings with a normal delivery time of more than 3 months. Of course the supplier has for that same bearing an identical agreement with other clients. These are criteria not to keep some spare parts in their own stock.

Mostly spare parts are acquired from manufacturers, but sometimes distributors are preferred. This is the case mainly in situations where time is not that important and a comparison in price can be made or when the original manufacturer’s delivery time is longer. In general you can say that the breadth of the distributor’s network sometimes makes them more interesting for the paper manufacturers.

A situation becomes critical mostly because the spare parts are not there! Normally the analysis of the problem is not too difficult. If the spare parts are not there, you can easily assume that the time needed to repair goes over forty-eight hours.

The parts kept in stock are those that breakdown the most (through experience). In value most important are mechanical components such as rollers or print plates. The reason not to keep specific parts in stock is because of costs or delivery time. It can

therefore be supposed that there is a certain amount of arbitration between maintenance professionals and cost control specialists concerning which components have to be kept in stock

What is very specific in this industry is that there are a number of suppliers of spares that are very difficult to copy. The service provided by such suppliers is seen as bad everybody in the industry knows that service is not seen as a priority and hence the customers appear to have little choice in the matter.

Predictive maintenance is only in start-up phase in certain plants and machine manufacturers deliver both equipment and training. The predictive maintenance initiatives that have been taken are essentially in-house operations.

### **5.6 The internet as a tool**

Internet use is still in its infancy in many companies. The reasons for this late integration are security and costs. More and more suppliers are contacted through e-mail. Digital scanners are used to send drawings in digital format to suppliers. This allows significant time-saving. There is more and more internet usage to find information through search engines, namely contact details for suppliers. Normally, catalogues are consulted to compare price, afterwards an offer is requested through e-mail. Internet use is still variable between different plants in the industrial groups concerned. Some maintenance professionals are regular users of internet technology while there are some factories that are not even connected yet.

When it comes to consulting an inventory with purchasing facilities for spare parts, SKF started a program like that, but on both sides, neither customers nor suppliers are fully prepared to implement this. However, if an up-to-date database existed, the majority of the interviewees claimed they would certainly consult it. Many think it still is too early to implement e-procurement in their companies but if solutions are operational and reliable they say they would use them.

If the delivery time for spares is shorter by ordering through the internet, they would certainly use it. Price is frequently less important than time particularly if the situation is urgent. But the service and the quality have to be guaranteed. All interviewees are very suspicious about new or different suppliers, because they know the quality of the products they use now, and they are not willing to take the risk of having products of a lesser quality.

The way to pay for an online spare part service does not appear to be that important. Many interviewees believe that a fee for service type payment model would be preferable initially, and that after a positive evaluation, subscription to such services would not be a problem.

### **5.7 Questions concerning certifications & norms**

Two major quality certifications are demanded in this industry: the Iso-9002 norms and CE-label. The ISO norms are now being integrated into a complete TQM strategy. Since 2001, maintenance management is now taken into consideration for the acquisition of the ISO certification. The majority of the respondents indicated that a solution enabling rapid information exchange on the subject between, inspectors, consultants and subcontractors would undoubtedly facilitate the process of preparing for

audits and inspections.

Information on such subjects is normally directly transferred to the head of department concerned. The other sources of information used are subscriptions to specialised magazines.

A new norm required by customers is the HACCP norm, which certifies quality of wrappings for edible products. It is generally accepted by maintenance professionals that innovative solutions are required to educate the workforce when new norms are implemented. In some of the companies contacted a lot of this information available on the intranet. This service is provided for the whole department but the information available is not sufficient and is frequently not well-organised.

In several companies not following a procedure or a norm has had financial implications. If the product does not meet certain norms, the client will for instance reject it. On an environmental level problems with soil pollution already occurred as well. Many maintenance professionals would like to be informed in real time, about new norms and certification rules. However, online learning seems very difficult to implement, because a lot of the rules also have a practical aspect, which has to be taught on the job.

Almost all the managers questioned saw this type of service as very useful and are sure that the investment in subscription to it would be approved if it delivers the service it promises.

## **6 Analysis**

### **6.1 Interview analysis**

By doing these interviews a much better view on the market was obtained. Secondly it showed that the need for information specific to maintenance professionals (rules, regulations, standardisation, contacts, stock levels of suppliers) is huge.

- On the spare parts market it is very difficult to come to a positive conclusion because there are both technological and behavioural obstacles to overcome. It is not yet clearly established that stakeholders are ready to purchase online. However, the possibility to consult online catalogues has short-term possibilities and is attractive to the men in the field.
- The biggest problems/opportunities is the supply side for spare parts, which is not standardised. This mainly because of the monopoly of a few manufacturers, who gain a lot by selling 'particular' spare parts. These manufacturers are not always customer-oriented but change is on the way. Portal technology providers may have an opportunity not only to give more access to the market for other competitors, but maybe even to provide the extra service to the customers the large suppliers will have to retain.
- The outsourcing process is very active in this sector. This is comprehensible, because it is a very low margin market. Focussing on core business seems useful. Maintenance used to be more of a department inside the firm to solve critical situations in a "creative" way.
- Predictive maintenance is reinforcing this outsourcing movement, because maintenance is becoming more and more complex. It also changes the characteristics of on-site maintenance; the workforce needs more IT and statistical input. Even though now both companies have the intention to keep this predictive

maintenance in-house, there may be an opportunity for online service in maintenance notably in the fields of data mining and data-management.

- The need for a specialised maintenance workforce is considerable. EFMNS is therefore making considerable efforts in accreditation programs. Internet can be of an importance here as well. Through internet theoretical exams can be done, and online learning is also a possibility.

- The widespread use of leasing contracts is another interesting evolution. As this is not the core competence of suppliers, Internet can play a role here as well. It can provide added-value by serving as a knowledge centre.

However there are several reasons that will slow the development of e-markets in the short term:

- Companies are not ready to adopt the internet channel, implicitly for reasons of purchasing control and the desire to maintain a tight grip on component supply and pricing issues

- The marketplaces are difficult and expensive to start up with the cost of cataloguing parts identified as a major obstacle.

- The risk of not being able to deliver the promised (fast or cheaper) service is significant for the marketplace operators.

Entering through the knowledge and consulting side seems easier for several reasons:

- The interest is there.

- New norms and regulations are emerging, and with the current difficulties in the food safety field, this tendency will certainly continue. There is a clear need to have fast access to this information.

- Investment is not that high particularly when compared to the sums required for e-marketplaces.

- If, for norms and regulations, as well as for consulting, national or international associations could support a company, it gives them considerable extra quality label, which makes them more credible.

- If you obtain credibility in this aspect of maintenance, the clients will be easier to convince to use the internet service also as a spare part intermediate.

- If subscription would be obtained (which seems easier to be obtained for information than for purchasing), it gives you the benefit of having working capital in advance.

- Several companies are already providing norm and certification information on the intranet. This is of course not a core competence, but it may indicate that subscription services for groups of users with similar informational needs may be a possible route for development of internet-based services.

Of course the question remains of whether these interviews are enough to make a scalable judgement. It is clearly not the case. First of all, the study was restricted to one particular industry, and other industries have different features and these particularities can change the way of doing maintenance. Although extra research is necessary, notably into the conditions for successful deployment of online solutions in this sector the interviews provided a useful indicator of the current situation in terms of technology usage in maintenance.

## **7 Final conclusion:**

It is clear that the technological possibilities for the industry are huge. The benefits from predictive maintenance, CMMS and professional outsourcing are more and more accepted and implemented.

Internet can be seen as the next step. Even though software vendors are eager to sell their products, the qualitative research shows that the interest for online services is mainly in knowledge-related fields.

Information systems are surfacing as the lead management tool of the decade. Yet, maintenance players are not taking advantage of this technology to help them gather, store and disseminate information. The internet's primary function is to enable fast and easy information transmission. Today this is sometimes forgotten. Information is something that is needed in maintenance departments on an everyday basis. It is clear that the opportunities afforded by this can be implemented far more easily and more cheaply than in the case of e-markets.

Software vendors and management consultants sometimes forget that in the end it is the employees who have to accept to work with new systems. It is easy to think that everybody can rely on a broad computer access and internet knowledge if one lives and works in an environment where this is seen as normal. The reality is different. Maintenance people are not always educated to work with complex software applications and it takes time to develop appropriate solutions and train personnel.

Still the industry will adapt to the new e-markets, and sales through these channels will go up because of the innate possibilities of a wired purchasing possibility; faster and cheaper. "E-marketplaces will give buyers significant opportunities to cut prices and streamline buying processes", says Matthew R. Sanders, a Forrester analyst. "Buyers can maximize the return on their expenditures by documenting workflows, leveraging integration and increasing online purchasing", he notes. "Online buying efforts are expected to cut costs by 4% this year and 8% in the years to come", Sanders says<sup>4</sup>

In addition to the e-markets, the future of maintenance involves a "virtual" workforce. The virtual maintenance workforce will remain in one local area servicing more than one company. A maintenance service supplier can send out maintenance technicians to various client facilities depending on the specific maintenance task needed. Maintenance is no longer supplied in a "stand-by" mode, but is supplied on an as-needed basis. Computerized maintenance management systems and predictive maintenance technology make this possible.

The internet will affect the maintenance industry. The possibilities the internet provides are in many ways a solution to maintenance problems. The internet can save money for the company by enabling cheaper outsourcing, providing the necessary information to resolve urgent problems and by purchasing spare parts faster and cheaper. Once these benefits become clear and the necessary investment money is provided, companies will switch to a more networked maintenance system.

Given the conclusions reached in this paper it would seem necessary to pursue research into the use of the internet to disseminate knowledge among maintenance

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<sup>4</sup> [www.ecomworld.com/search/author/article.cfm?ContentId-758](http://www.ecomworld.com/search/author/article.cfm?ContentId-758)

communities. Several avenues can be explored:

- use of groupware and collaborative IS tools
- emergence of online knowledge portals
- online CMMS delivered in Application Service Provider mode
- use of solutions integrating web help desk functionalities.

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