THE MAINTENANCE FUNCTION A TOOL TO INCREASE AND TO KEEP-UP OUR INDUSTRIAL COMPETITEVENESS

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Abstract

1. Maintenance is not a question of costs, but costs come as a result of optimized maintenance. Today the maintenance cost of European industry doubles every 10th year. This comes as a result of the industrial development. Our maintenance personnel have huge challenges, trying to update their industrial competence as fast as the changes in our Industrial equipments.
Minimization of our operational costs starts with the investment in high quality production and utility equipments. Today we know that up to 70% of future problems and costs are already decided when we start to use our new equipments.

2. Maintenance is not a cost that are to be reduced as much as possible, but an investment to keep-up the value of Investments already made in; Personnel, Equipments, Administrative routines and Organizational structures.
As a result of this, we have to do a lot of training to keep-up the necessary level of competence at all our employees. We have to establish Efficiency Engineering Teams to improve our Overall Equipment Efficiency.
We have to invest in equipments with minimized Life Cycle Costs. We have to invest in Computer Assisted Maintenance Management Systems that adapts itself to the technical condition of our equipments, and that has a reliability Data Bank, and we have to establish flexible organizational Structures.

Introduction

Why Maintenance?

In a forum like this it shouldn't be necessary to raise such a question, but looking around us, it seems that for most managers, our maintaining function are only looked at as a cost, that has to be reduced as much as possible, not taking into consideration the fact that a low level of maintenance, increases unplanned breakdowns, with as a result that the equipment efficiency are reduced, and as a result of this again, our income are reduced. Normally much more that the increase of our maintenance costs! Or, and more important, disaster happens, with loss of human lives as a result.

My first statement: Our maintaining function should never be considered a cost, but as an Investment, to keep up the value of Investments already made!
Maintaining of our production and utility equipment is management of the wear process of a component! Remember, it is never equipment that are worn, but the different components! And this is the same within our; Petroleum, Aero nautical, Public Roads or Manufacturing Industries, and we have to identify clear targets and strategies to reach our targets.

Quote from a very wise man, Mr. Nelson Mandela. He has said that; "Vision without action is merely a dream… Action without vision is merely passing time.. But, action with vision can change the world….!
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MAINTENANCE COSTS IN EUROPE?

In Europe today we do not have any exact figures about the maintenance costs. This is mainly because of the fact that different countries has different understandings of what maintenance costs really is, secondly also because in some areas, the understanding of what Maintenance really is, are weak. A rough estimate can be made by the looking at statistics from EU, and it shows that in the year 2002, the maintenance costs was app 1650 billion Euro. This does not include maintenance of Health care and military equipments.

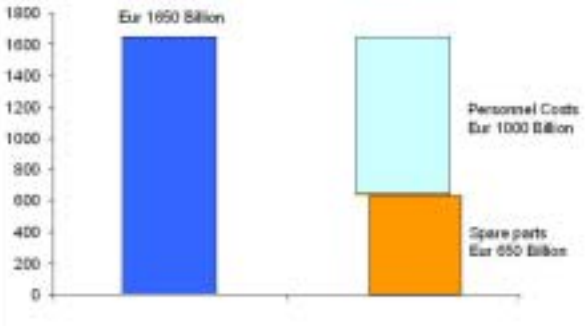


Figure 1 Estimated maintenance costs EU in billions

Extremely worrying is the fact that it seems that the maintenance costs doubles every 10th year. The speed of the increase is accelerating even more. Today it looks that the maintaining costs will be in the area of 3500 Billion Euro in 2011-2012.

Maintenance costs in the period 1970-2000 in Europe:

1970	-	180	Bill Euro
1980	-	350	Bill Euro
1990	-	690	Bill Euro
2000	-	1420	Bill Euro
2010	-	3500	Bill Euro ??

A serious question then could be; What is the cause of this, and not at least, Who is going to pay these costs?

How to break these Maintenance costs? Do we invest in equipments that has the necessary, built in, reliability, or do we focus too much in the purchasing of "cheap" equipments? Do we have right knowledge or strategies to manage the wear process of our equipments? Do we involve our personnel in the right way with as a target to build up, ownership, to strategies and goals? And not at least; Do we train our personnel in such a way that they are capable, and motivated, to identify future problems or breakdowns at an as early stage as possible, and to execute actions to reduce/eliminate the real causes, before it becomes a real problem and cause!

"WORLD CLASS" MANUFACTURING

In figures, World Class Manufacturing can be identified as:

- Overall Plant Efficiency 85%
- Overall Equipment Efficiency 85%
- Unplanned Breakdowns 0
- Unplanned Production stops 0
- Changeovers < 10min
- Relation between Manufacturing time, and Through Put Time <1:100
- Documentation availability < 30sek
- Reclamations on Maint.work 0
- Reclamations on delivered Products 1 of 20000
- Accidents 0
- Unacceptable release to environment 0

Requirements to companies that are targeting World Class level are that they:

- Measure/Benchmark themselves, against their competitors.
- Have a good knowledge of their core competence.
- Promote a continuous Improvement culture.
- Have a team culture, where competence and responsibility are delegated to groups of employees.

Looking at these figures, for many companies, they look impossible to achieve, but it is a fact today, that many companies, using the TPM concept, developed by Toyota and JIPM, (Japan Institute of Plant Maintenance), and hard, disciplined and target oriented work, thru 4-6 years has achieved such a level, where they has, as an example, achieved an OPE of 90%, and an OEE of up to 95%. In all plants, having achieved such a level, the close cooperation between production and maintenance departments, and not at least the ownership of the production personnel, taken, for the execution of the daily maintenance work, has been very important, or crucial.

Having just entered the third year thousand, we all have to realize, based on available information, that some of our existing resources, here on mother earth are on their way to disappear. This means simply said, that our consumption of raw materials, are higher than their availability to us. This can't continue, and we have to make some radical changes. As an example, we have the "Throw away" habit, that are growing within our industry, where some years ago, as an example, we repaired an electrical motor and reinstalled it, as of today we throw it away and instead we install a new one! A waste of materials and, from my point of view, a waste of knowledge, plus the fact that we usually don`t know anything about the future operational problems, caused by the new electrical motor.

One of the things that we, from my point of view, has to do, is to teach our youngsters, to have respect for our nature, and to participate actively in the extremely important work of reducing the spending of our raw materials, by maintaining already invested values, in equipments, cars, buildings, systems and environment. This means an exchange of our habits from the: "Use and Throw away" habit of today, to the maintaining of our assets, with the target of lengthening their lifecycle!

Looking around us to identify some interesting examples, we will see that:

- In Switzerland, in many places, they are still using rolling stock of an age of about 60 years of age, being operated within any problems, with a high reliability.
- In Japan, at Toyota, in some of their plants, they are still using manufacturing equipments, being up to 30 years of age, manufacturing high quality and "environment friendly "cars.

As we all know, the Toyota Corporation has developed the TPM concept, as well as the TPS concept. But not only this, they have also developed some Ethical rules that are quite fascinating. This I will come back to.

The Meaning of Maintenance

Maintenance is management of the wear Process of a component, with as a goal to lengthen the Life Time, increase or keep-up the Reliability, and to minimize the Operational Costs.

In short the word Maintenance means:

- All actions necessary to identify the actual technical condition of a component.
- Recondition it to the Target technical condition.
- And keep-up the Target technical condition.

To identify the actual Technical condition we make Inspections.
To identify the actual Technical condition we make Repairs.
To keep-up the target condition we make Service work.

We could say that Inspection is the Heart of our Maintenance work. This means the engine of necessary actions to be made.

By Inspecting, we collect necessary information, to identify where we are on the wear curve of our components.

As a result of Inspections made at app 65.000 components, we know that:

1-9 months before a breakdown we can measure Vibrations.

1-6 weeks before a breakdown we can measure Particles that comes from wear.

1-4 weeks before a breakdown we can measure a change in the sound, and,

1-5 days before a breakdown we can measure a change in the temperature of the component.

As a result of this again we know that increase of the operating temperature with more than 10 degrease C often reduces the life of the equipment with more than 50%.

To improve our maintaining function today, and make it possible for us, to direct our available resources towards equipments that are important to functionality and safety, we often execute a Criticality evaluation, dividing our production and/or utility equipments, into three criticality classes:

- Most Critical
- Critical
- Not Critical

For equipments, identified as Most Critical, we simply say that zero, unplanned are accepted. For Critical equipments we say that 10-15% of all breakdowns are accepted to be unplanned, and for equipments defined as Not Critical we accept to run to breakdown.

For Most Critical Equipments then, we know that:
50-60% of total maintenance workloads inspection.
30% of total maintenance workloads are Service.
10-20% of total maintenance is Planned Repairs.

For Critical equipments, the Inspection workloads are reduced to 40-50% and Service work to 20-25%.

The increased understanding of the importance of quality Inspection work has also had an impact on the development of software systems, for management of our maintenance activities (IPS). This has among others, resulted in the development of 5th generation IPS`s.

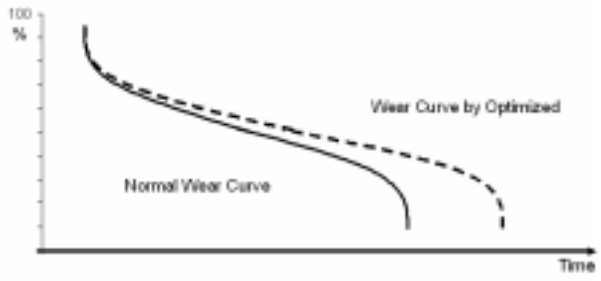
Some of them have a built-in Reliability Database that makes it much easier to start the use of an IPS, as it gives suggestions for standard intervals for Inspections and different types of Service work. As it is used a factory dedicated Reliability database, are to be developed, based on operational conditions as load, humidity, dust and temperature. An interesting function is also the fact that such systems, automatically, changes the inspection intervals, when, as an example, no problems has been identified as a result of 3-4 inspections.

Service activities influence directly on the length of the life of our equipments and consist of the following activities:

- Oiling – Greasing
- Cleaning
- Adjusting
- Exchange of components
- Conservation

Our Service activity reduces the speed that the Utility reserved are, consumed with, and as such the quality of our Service work are incredibly important.

Utility Reserve curve



An optimized service work gives as a result, up to 20% increase of the “normal” MTBF. This means in short that we reduce the Maintenance costs and we reduce the production losses, caused by unplanned production stops.

In short we could say that; Maintenance is an activity with the goal of making it possible for an equipment to function, according to specifications. This means to keep the Technical condition.

DIFFICULTIES OF OUR MAINTENANCE JOBS

Investigations made the last years shows as an average that from the total maintenance workload:

5-10% are defined as Difficult and therefore has to be executed by Specialists.
30-35% are defined as Medium, and therefore has to executed by Specialists, supported by the Operators.
60-70% are that “simple” that it can be executed by our trained Operators.

Today, and I hope you will agree with me, we don’t educate Maintainers. What we do is to educate

Mechanics and Electricians that are very good in making repairs, but their knowledge when it comes to:

- Inspection of equipment by using only their senses, to identify the actual technical condition.
- Reading of a failure development picture.
- Identification of remaining lifetime of an equipment, by evaluating consumed utility reserves.
- Cost/benefit evaluation of suggested actions to be made and the evaluation of LCC/LCI/LCP.
- Because analysis and the use of the Deming P-D-C-A circle, to identify the real causes of problems and to eliminate or reduce them, are minor!

Today, top managers within most of our Industries are more and more aware of the enormous potential which has been wasted all the time, by using our personnel as interchangeable parts, and by considering them only as a variable cost, instead of motivating and educating them to use their skills, experience and potential, to the benefit of not only themselves, but for the company, by which they are employed.

In the future we have to, in a totally different way than today, develop a long term strategy to take care of the invested values, and to keep up their availability to us. Not only to increase our industrial competitiveness, but to keep it.

To make this possible, we have to start to look at our Maintenance Function as an Investment, to keep up the value of investments already made.

ACTIONS TO IMPROVE OUR INDUSTRIAL COMPETITIVENESS

To cope with the challenges given to us, to achieve a level of World Class maintaining, the following Pillars, or Focused Areas, has to be improved:

- Investments in New Equipments
- Continuous Improvements
- Autonomous Maintenance
- Planned Maintenance
- Competence Improvement
- Quality Maintenance

1. Investments in New Equipments

When investing in new Production and/or Utility equipments we have to remember that up to 70% of all future problems and costs, are already decided for, caused by the: Design, Materials selected, Manufacturing and Commissioning methods used, by the Manufacturer. The problem is that usually, our Purchasing Department, are not “interested” in such costs. What they are interested in is to find the cheapest equipment that fits our requirements. Here we have to change the way of doing this. We have to ask for guarantees for the Total Life Cycle Cost (LCC) thru the years of the use of the equipment and we also have to know the possible Life Cycle Profit (LCP). In parts of the North Sea, as an example, using such a concept, the Investments increased with up to 18%, as the Operational costs was reduced with up to 25%.

2. Continuous Improvements

OEE (Overall Equipment Efficiency) are one of the most important parameters for the measuring of the efficiency of our plants, and the involvement of our maintenance activities. To identify our OEE values we have to measure three parameters:

- Availability
- Capacity
- Quality Loss

• Calculating our Availability we take the theoretical availability (8 hours?) and deduct the time for planned stops during the day, i.e. time for Changeovers are not deducted.

• Calculating our Capacity we use the designed capacity of the line or equipment. Define what has been produced during the Available time of the Line or Equipment, and we calculate our Availability loss in %.

• Calculating our Quality Loss we take rejects in % of quality products produced.

Example:
Availability 92% x Capacity 84% x Quality Loss 96% = OEE 74,2%.

Our Operators should be heavily involved in the measuring of the losses, identification of causes for Losses, and coming up with suggestions for elimination/reduction of the losses. To support the Operators, we should have a dedicated team of Improvement experts (Efficiency Engineering Team) that continuously are supporting the Operators and working with specific actions to improve the Maintenance Function. Such an Efficiency Engineering Team are usually defined as a part of the organizational structure of the Maintenance Function.

3. Autonomous Maintenance

One of the characteristics of to-days maintaining work is that our Operators participate in the maintaining work. The importance of the maintaining activities has been recognized for corporate survival in a competitive society, and the review of operators roles and maintenance activities, has become necessary.

In the future therefore our Operators will have to act as Key Elements in the Continuous Improvement Process to be made, and as such they have to be responsible for the

daily; Inspection, Service and Repair work, to be executed. To train and foster them to do so, the following stepwise plan has to be executed:

0	Basic Training
1	Cleaning as an Inspection, Removing of unnecessary Equipments
2	Elimination of causes for problems, Improvement of capability
3	Development of Service Check Lists
4	Basic Inspection Training
5	Autonomous Inspection
6	Standardization
7	Autonomous Maintaining

In step 1-3 we focus on the equipment, with as a result the reduction of errors and non quality products. In the steps 4 and 5 we focus on our operators, with as a goal to change their attitudes, and believing that 0-failures is possible. In the steps 6 and 7 we focus on the factory to go from corrective to preventive actions.

4. Planned Maintenance

In this phase, we have to coordinate our improvement activities with our Autonomous Maintenance Activities, and we divide our activities, usually into 4 steps:

1. Identification and elimination of causes for difference in Lifetime between equipments of the same type.
2. Actions to lengthen the lifetime.
3. Preventive Maintenance.
4. Condition Based Maintenance.

As a part of these activities we should also develop a requirement definition for our CMMS (Computer Assisted Maintenance Management System) and evaluate the existing CMMS, in relation to the needs that we have in the market today, we have IPS or CCMMS`s with reliability databanks, that makes it possible, as the time goes, to establish specific factory dedicated intervals for Inspections, Service and Repair work, involving operating conditions for; Temperature, Dust, Humidity and Load. When implementing a CMMS of the 3 and 4 generation, please remember that of the total project costs:

5-10% is Software-Hardware
90-95% is Engineeringware

Please also take into consideration, the importance to establish Line workshops, for the operators to use, during their maintenance work.

5. Competence Improvement

Today, more knowledge, understanding and competence about production and maintenance, and not at least the correlation between them:

- More initiative, and
- Increased productivity

Are expected from each employee, at all levels!

To cope with these challenges, our Operators should have competence to:

1. Identify equipment abnormalities and to perform necessary improvements.

2. Understand equipment mechanics and functions, and to identify possible causes when trouble occurs.

3. Understand the links between equipment, process and quality, and to predict abnormal conditions, and its causes.

4. Perform quality 1.Line Maintenance.

5. Perform continuous improvement of activities directly or indirectly influencing his/her job, independently or in cooperation with other related departments.

6. Understand importance of cleaning, and accept that cleaning isn't just removing of dirt. It is an inspection.

Maintenance operators should have competence:

1. About equipment functions and needs of maintenance, in such a way that he/she can instruct operators in correct use and maintaining.
2. To judge if an equipment operators in a normal or abnormal way.

3. To identify reasons for abnormal functioning, perform cause analysis, suggest corrective actions and execute the work.

4. To suggest actions to improve equipment reliability and to plan and perform corrective actions.

5. To criticality evaluate production and utility equipment and define cost optimized maintenance methods to achieve set goals.

6. Continuously to optimize equipment opera- and maintainability to minimize time for inspection, service and repair.

7. To perform cost/benefit analysis of suggested actions with the goal of optimizing results.

8. To act as a positive support to production, engineering, purchasing and spare parts stocks.

6. Quality Maintenance

This step is in many ways one of the most important steps in the optimization of our maintaining activities. Until now, our maintaining activities, in most plants, have been focusing on the keeping up of the availability and reliability of our equipments. In this step we should focus on the identification of at which point of the Wear Curve, our equipments starts to produce, products that are rejected caused by to low quality. Using this as a basic, we have to identify and specify specific Inspection methods to identity this points. Standard repair methods and/or intervals for exchange of the equipments, also has to be defined.

CLOSING REMARKS

This presentation does not have the intention to teach you how to deal with your maintenance challenges. But if it has managed to give you some thoughts, to use within your own plants, for improving and keeping-up your competitiveness, I will be happy!

Thank you and Good Luck!

References

Prof Nicolaus Mexis, IAS
Dr. Tokutaro Suzuki, JIPM