



Summary.

As everybody knows maintenance is necessary in the steel plant, and the aim is to find the right balance between maintenance efforts and delay cost.

Due to the complexity of measuring maintenance efficiency we developed an empirical Maintenance Index. This index is based on the BSE-Best-Practice-Database.

Having analyzed our cost situation we identified that we were too much on the safe side. This was also expressed by the Maintenance Index of BSE. We spent too much money for only an incremental improvement in availability. Consequently we saw a huge cost saving potential without losing availability. This was the starting point of our Maintenance Cost Management project.

We considered four main directions:

- Maintenance strategy and organization
- Maintenance personnel
- Risk & spare part management
- Maintenance procedures

We have already achieved 2 million Euros of the expected annual savings of 8 million Euros.



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Excellence in Steelmaking



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Maintenance at Mini Mills – effective, but also efficient?



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Maintenance at Mini Mills – effective, but also efficient?

Introduction.

Badische Stahlwerke GmbH (BSW), one of the most productive Mini Mills in the world, reached more than 2 million tons (metric) per year with two 90 tons (metric) conventional EAFs. It is well known that Badische Stahl-Engineering (BSE) is using the developed know-how for boosting productivity of its customers.

More than a year ago we have started a mutual project – called Maintenance Cost Management (MCM) – to investigate if the maintenance efficiency really pays for it or if there are potentials for improvements without loss of productivity. This project is supported by our Best Practice investigation, which is carried out continuously by BSE and gives information about cost and operation figures of more than 40 Mini Mills.

The paper will show the key results of our MCM-project and will give answers to the questions which typically arise in the implementation of such a cultural change.

- How to measure efficiency in maintenance?
- How to organize maintenance – centralised or decentralised?
- How many people are needed on shift?
- Which procedures and methods are applicable in maintenance?

The example of the Maintenance Cost Management program shows that maintenance can be improved without losing neither efficiency nor falling into the productivity trap.

Key performance figures (KPI) of mini mills.

BSW – located at Kehl/Germany – is a so-called Mini Mill dating from the 1970s, which was the era of Willi Korff. It operates two 90 tons (metric) electric arc furnaces (EAF) and two 5-strand billet casters. The produced steel quality is for wire-rods and rebars for concrete reinforcement. In 2006 the plant achieved an annual production of 2,068,000 tons (metric) of billets with a net annual operating time of 321 days, which results in a daily output of 6,442 tons (metric) of billets.

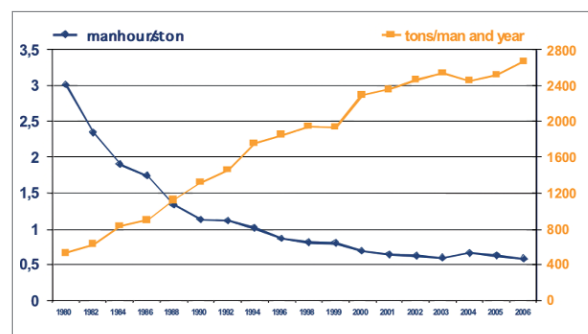


Figure 1: Rolled Products all employees (without apprentices)

Maintenance is one core process in the steel industry with a high leverage on availability, productivity and cost.

Figure 2 shows the link of these three major KPIs. It would be nice to have a formula to determine the optimum between availability, productivity and cost.

To get a right picture of the maintenance cost a split into *direct* and *indirect* cost is necessary. The more you invest in direct cost, the more your indirect costs should decrease. The cost optimum is given by a super position of both. Our experience – gained through more than 200 consultancy contracts worldwide – shows that most of the plants are running either far above or far below the optimum.



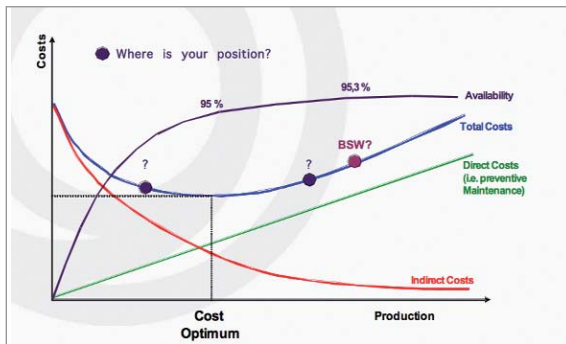


Figure 2: Maintenance Cost Curve

Experience also shows that maintenance is like a black box. Compared to the production where every minute, every ton is tracked by some kind of ERP-system and is therefore transparent for the management, maintenance gives a lot of space to hide investments (capex), time and costs. This is mainly caused by the complexity of the key figures of maintenance and due to the fact that in the past maintenance was not given a high priority. This has changed in the course of the last few years.

The following table shows the main KPIs in operations. The most frequently applied KPIs for maintenance are availability, delays and specific cost per ton. Lost production is in general not considered but in a strong market situation like today it is the decisive factor.

| Production view | Maintenance view | Financial view |
|--|---|--|
| <ul style="list-style-type: none"> ○ Heats per day ○ Tons per hour/day/year ○ Yield ○ kWh/t ○ O₂/t ○ Electrode kg/t ○ P₂/R₂/FFT ○ BBC rate ○ ... | <ul style="list-style-type: none"> ○ Availability ○ Planned downtime ○ Delays ○ Frequency of incident ○ Duration per incident ○ ... | <ul style="list-style-type: none"> ○ Conversion cost - volume related ⇒ €/US \$ per ton - time related ⇒ €/US \$ per time |



 Many different KPI's exist but it is difficult to find indicators for an efficient maintenance strategy

Table 1: KPIs in operation

The planned scheduled downtime and unplanned delays should also be reported as lost tons (metric)/h respectively lost contribution margin Euro/US\$. The complexity of mea-

suring the efficiency of maintenance is expressed in figure 3. Besides the mere maintenance cost types (like costs for personnel, subcontractors, and spare parts) production figures like operating time and productivity determine the most common efficiency figure for maintenance: cost per ton. To achieve real efficiency the maintenance strategy needs to be adapted to the market situation, which means to manage both direct and indirect costs.

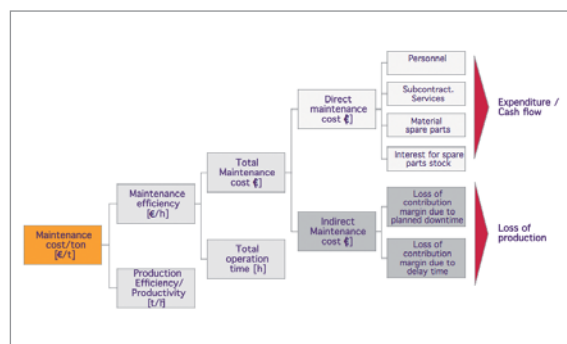


Figure 3: Cost drivers in maintenance

Generally speaking two different scenarios exist:

- In case of a limited market it becomes crucial to reduce expenditures for maintenance in order to reduce direct costs.
- Whereas in a strong market it might be worthwhile to spend more money for maintenance in order to obtain a higher availability and therefore an increase of production (see figure 4).

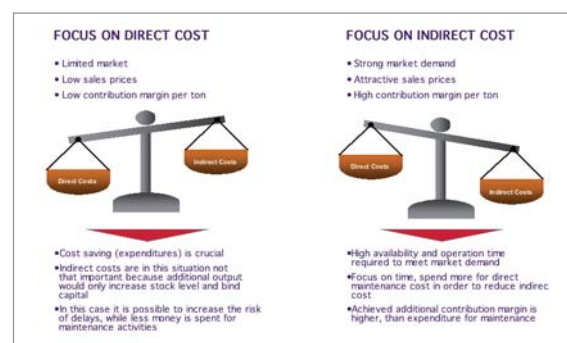


Figure 4: Levers of maintenance cost

is more focused with a decentralized maintenance structure. Based on our experience we decided to establish a matrix organization which combines the advantages of both systems. As a consequence we reduced our shift maintenance personnel from 11 to 6 (mechanics and electricians) and introduced a day shift pool. The 6 people on shift are responsible for two production lines from scrap yard, EAF, LF to CCM.

The main target of pooling the former shift personnel is to organize most of the work on day time more efficiently. We also see the potential to in-source more subcontracted work. It is our experience that our own people are doing the work more efficiently and better controlled.

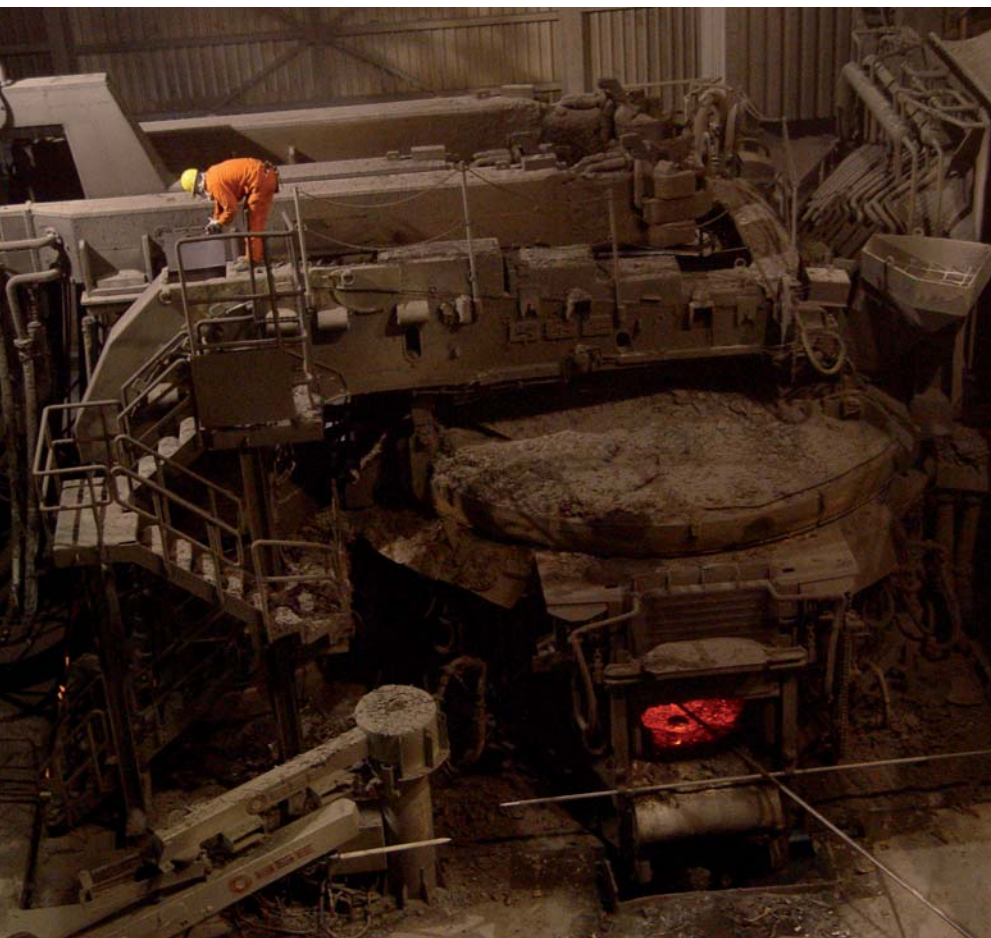
Therefore a cost reduction is possible by just organizing the work in a different way. This is of course not applied to cleaning work. We understand maintenance as a core process in steelmaking and hence our staff has more responsibility and accountability on the maintenance tasks.

The right **risk management** philosophy leads to a high availability and productivity with adequate costs. In the past BSW heavily relied on preventive (time based) maintenance activities.

The big advantage was a top availability of the plant. Since we made good experience with this strategy and with the defined exchange intervals, the optimizing of these intervals was not in the focus.

Our main target was highest productivity and availability. This thinking was one reason for soaring of direct maintenance costs. During the course of the MCM project we changed this strategy.

By using the experience of our people and also applying risk analysis techniques we were able to change from a pure time based strategy to a condition based strategy. Thus we have extended the life cycles of the different parts and also optimized the scheduled downtime due to less maintenance activities (see also procedures).





Besides these changes our spare part philosophy is an essential part of our risk management. Critical spares, which have a long lead time like transformers, special bearings etc., are on stock. We also increased the involvement of our purchasing department for buying spare parts and ordering subcontractors.

This enabled us to reduce the purchasing prices for spares and services significantly. For smaller spares or minor orders we signed master agreements with our suppliers, so that supervisors or warehouse workers can order at special prices on their own without re-involving the purchasing department.

The procedures in maintenance activities are

- planning
- inspection
- repair
- improving
- monitoring

Our experience shows that inspection and repair are the main focus in most of the steel plants. "Get the mill running" is the goal. That may be very effective but is not automatically efficient. Efficiency is only possible with a good work planning, continuous improvement of equipment and monitoring of the processes.

We are convinced that planning is the key to success. Since the planning of the scheduled down-days was and is one of the strengths of our steel plant, we started to change the cycles in 2006.

We had a 10 hour down time every week for cleaning, inspection and repairs. By changing to an alternating cycle (10h -5h-10h-5h weekly down-day) we had no negative impact on availability.

On the 5 hour down-day cleaning and smaller repairs are carried out. A prerequisite for a better planning is the knowledge of the required time for repairs. Therefore we introduced the time recording for our fitters and electricians. The time is predefined in our ERP-system.

The success of the maintenance strategy, the organization, the risk management and the procedures depends on qualified and motivated **personnel**. Therefore we already involved our management team at a very early stage of the MCM project to create commitment.

In the next step we formed two teams, an analysis team consisting of engineers and managers to investigate the cost and maintenance processes and a creativity team consisting of supervisors from shop-floor level to gather information and ideas from the workforce. This enabled us to involve "everybody" from top-management to shop floor.



Of course the communication of all changes and improvement measures was done to the next hierarchy level at an early stage. The communication with our workforce was essential to create awareness and understanding to be successful in this change process.

Due to organizational changes by pooling of personnel, the required skills and capabilities changed as well.

Besides the existing special knowledge of the mechanics and electricians a broader qualification became necessary. On a short term perspective the pool people should serve both the steel plant and the rolling mill, as well as auxiliaries.

Figure 7 shows the expected results of the MCM project. The main cost reduction areas are:

- Improved risk management
- Reduction of planned down time
- Maintenance dayshift pool
- Optimization of maintenance work
- Spare part management

We have already achieved cost savings of 2 million Euros in 2006 and expect the big step when changing the organization in 2007. All measures applied for improving maintenance cost went without losing productivity or availability.

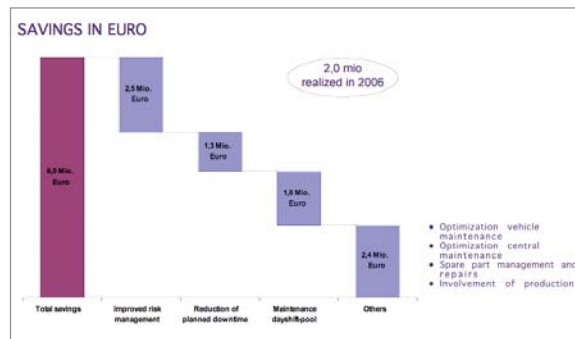


Figure 7: Expected results of the MCM project

