

Operating Maintenance Model for Modern Printing Machines

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Abstract: The authors outlined a model to examine the modern printing machines' unexpected breakdowns. They had been analysing the different downtimes for years. The results of the researches help to organize the pro-active maintenance at the graphic arts industry.

Keywords: printing machines, predictive and pro-active maintenance, breakdown

1 Introduction

The problems of maintenance have accompanied and 'threatened' the working people ever since the application of equipments. It was experienced from the beginning that equipments could go wrong and machines could break down. Humans have been and still are working on solutions to these problems, so it is not an exaggeration to say that maintenance is the same age as humanity and manufacturing activities. [1]

Maintenance techniques have changed over time from correction (breakdown) to prevention to prediction and pro-active continuous improvement. Effective maintenance is a series of progressive steps to improve operational effectiveness and the key step in this process is the transition of pro-active working. Companies that optimise their maintenance select and combine the techniques that match the needs of their equipment and operations.

Moving up the maintenance stairway requires a planned approach that brings together the right procedures, tools, training and the knowledge the feature and history of our machines' breakdowns. [2]

2 Maintenance Characteristics and Requirement of the Modern Printing Machines

The user of printing industry machines and any other operating systems, expects the machine or system to stand a heavy-duty use during a given period. This period is not constant. It depends on the construction, the nature of use, the mode of operation and the quality of maintenance as well. However the analysis of these technical systems, the profound knowledge of the characteristics of building elements and the operating indices are essential to establish an adequate operational and maintenance concept. [3]

Following this approach this chapter summarizes the technical, technological features, handling and maintenance characteristics of printing industry machines from the *maintenance point of view*.

3 Operating Maintenance Model for Printing Machines

Despite the possible big differences between printing machines we treat them with a united approach based on their fundamentally common characteristics. One of the major reasons for the synthesis originates from maintenance practice. Generally, the printing offices perform the maintenance duties with staff small in number. Consequently, there is a little chance to gain special knowledge and subdivide the maintenance approach and practice. The machines, which are different in structure and technological tasks, have a lot of common characteristics from the operational and maintenance point of view in case of printing office applications, which makes the united approach acceptable.

Consequently, we developed a simple model (*Figure 1*) that reflects the general structure of printing machines (divisions and detailing are included), which is needed to analyse the features of maintenance and maintenance-management.

The technological elements of modern printing machines unite two equally important operations. The major operation, which performs informational types of formation on the product, is based on a highly accurate transmitting operation of the processing material (mostly paper). Therefore, the input and the output units

are very important elements of printing machines. These elements ensure the assembly of machine systems. Moreover, if the bigger systems were divided into elements we would always get division three, in the model. The units of operation, management and supply set the same claims up for the technological units regarding their structural form, complexity and especially their maintenance requirements.

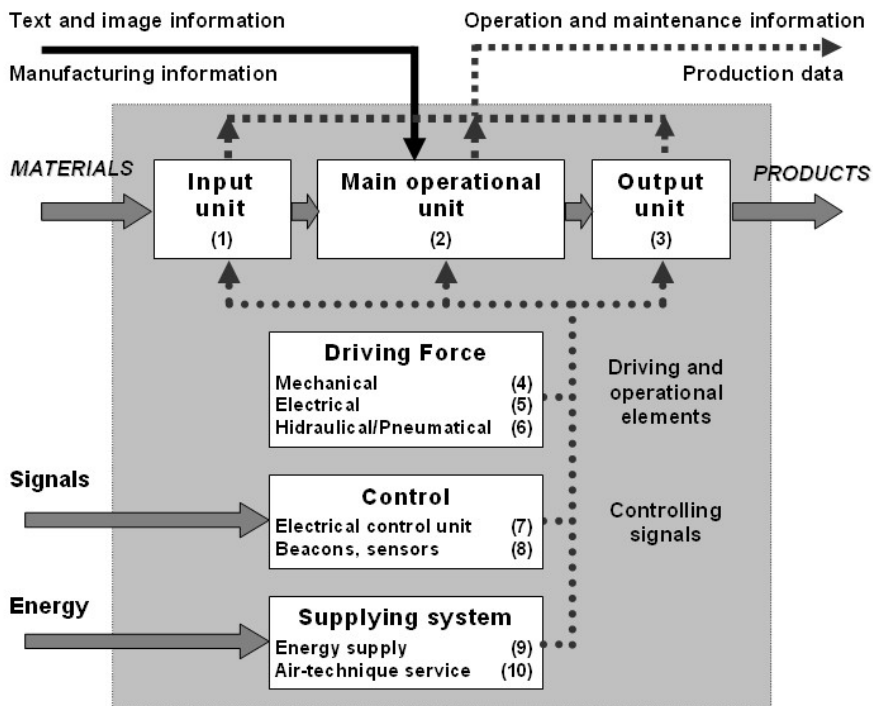


Figure 1

Operating maintenance model for the printing machines

3.1 Maintenance Features of Printing Machines

The similarities between the manufacturing processes, raw materials and products of printing machines result in similar defective, corrective and maintenance features, which should be considered during management and organizational tasks. Therefore I thoroughly analysed those sources of faults and damaging processes, with which we struggle during the operation of printing machines.

At present, according to the results of our survey – carried out among 25 leading Hungarian and 5 significant printing offices – the major cause (46%) of maintenance events is the unexpected breakdown. This big proportion also means

that this is the most influential factor of designing and managing tasks. Therefore, the knowledge about unexpected breakdowns, as a phenomenon, is extremely important for the maintenance management. [4]

The authors could collect data on unexpected breakdowns of printing machines for a long period of time at Alföldi Printing Plant Plc., Hungary's largest book printing plant. A computer-assisted system could continuously record the basic data of the important processing machines. The historical datasets were set as the starting point for our analysis. The continuous data collection was carried out on the most important processing machines of Alföldi Printing Plant Plc. During the monitoring the machines were replaced from time to time following the technological development. We monitored 65 printing machines. These represent the previous, current and following generations. Their age varied between 1 and 27 years and 22 completely new machines were purchased during our monitoring. Every machine was operated at a specific site, the centre site of Alföldi Printing Plant.

We used the data of unexpected breakdowns from a wide period of time (data of 17 years of full operation between 1988 and 2004).

The extent of generalization based on the characteristics of printing machines might obviously raise a few questions from the reader. The printing machines and the relatively complex technology of Alföldi Printing Plant and their loading give an extensive cross-section of today's typical printing machines. It was a limiting factor that there were only a few similarly detailed and accessible historical databases even for a shorter period of time. However we could make a comparison with the data of similar Hungarian printing plants; Szikra Lapnyomda., Révai. and Petőfi Printing Plant. The data on downtime and reparation time showed similarities with the calculations from our database.

<i>The calculated mean values</i>	<i>Mean</i>	<i>Standard deviation</i>
Time of troubleshooting [working hours]	1.80 hours	0.47 hours
Reparation time of a breakdown	2.24 hours	0.54 hours
<i>Characteristic data of printing machine</i>		
Operational time in a year	2 883 hours	617 hours
The expected number of unexpected breakdowns during the operational period (rounded values)		
yearly	87 occasions	24 occasions *
monthly	7 occasions	3 occasions *
weekly	2 occasions	1 occasions*

* Rounded values for the easier understanding

Figure 2

Most relevant data characterising the unexpected breakdowns of printing machines
(Examination period: 1 January 1988 – 31 December 2004)

Figure 2 shows the major conclusions and the calculated characteristics. The 65 printing machines ran nearly 1.7 million operating hours, while 58317 maintenance events originated from unexpected breakdowns were recorded. The reparation of the machines caused more than 105,000 operational hours of dropout in the production and more than 130,000 reparation hours.

The first and the most important conclusion of the calculated values is that the average value of the reparation times of unexpected breakdowns is low, in other words dropouts from production due to downtime are short. The average value is 1.80 hour.

According to the Alföldi Printing Plant's instructions the reparation time is the period between the report of breakdown and the short check of operation after the troubleshooting. The troubleshooting takes about 2.24 working hours on average. We only took those reparation times into consideration that didn't last more than 24 hours. On one hand the number of longer reparation times are negligible, on the other hand these breakdowns are not considered to be unexpected by the maintenance strategy applied at Alföldi Printing Plant.

The machine monitoring system identifies the operation hours of the machines with the 'on' position of the main switch. The identified annual average operating time is 2.883 working hours, which is equal to nearly 1.5-shift production. The inequality of technologies and capacities – even within Alföld Printing Plant – should be considered. There are continuously running basic machines and there are several other machines performing special technological steps working with identical speed as the server machines, but these are poorly utilized.

The development of maintenance efficiency obviously has a great impact on unexpected breakdowns. The change in average values during the past few years show a slightly decreasing tendency as shown on *Figure 3*, conforming that the maintenance efficiency has also improved at Alföldi Printing Office Plc. The slowly changing tendency of downtimes however proves that the fundamental maintenance characteristics are originated from structures and technological conditions. These are independent from the quality of maintenance. The number of machines used after 2000 didn't modify the average values of downtime and reparation times significantly.

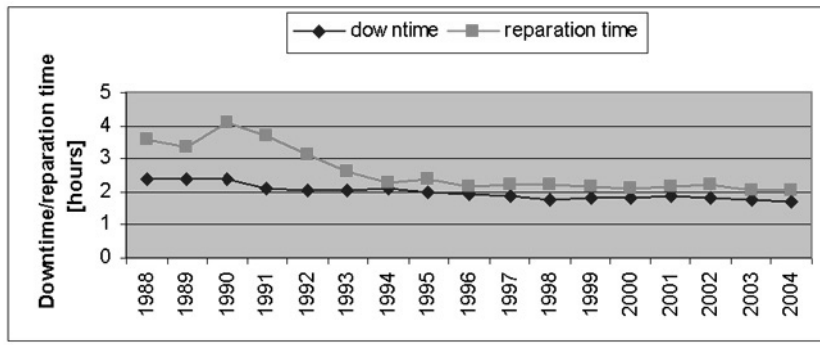


Figure 3

Time dependence of the average downtime and reparation time

The data also show that the maintenance characteristics of pressing and bounding machines didn't differ significantly. The values (shown at *Figure 4*) confirm the correctness of the principle; these should be treated together, like we didn't distinguish them in the maintenance model either.

Calculated mean values	Pressing machines	Bounding machines
Time of troubleshooting:	<i>1.84 hours</i>	<i>1.77 hours</i>
Reparation time of a breakdown:	<i>1.97 hours</i>	<i>2.38 hours</i>

Figure 4

Characteristics related to the troubleshooting of unexpected breakdowns for different types of printing machines

The unexpected breakdowns of printing machines are quickly reparable; these generally require small maintenance events. The downtime, which is not more than two hours, caused by operational failure is more than 80%, which generates more than 50% of this kind of troubleshooting. The originated reduction of losses requires concentration to details and predictive organisation. The relatively low average value might just well have a great influence on the future developmental concepts of maintenance systems. The relatively short reparation times typically contain several elements that are not actual professional work (reaction time, approaching the reparation scene, information transfer, etc.). The relative frequency of values characterising the reparation times of unexpected breakdowns is shown on a histogram of *Figure 5*. These data contain extremely important information for maintenance managers.

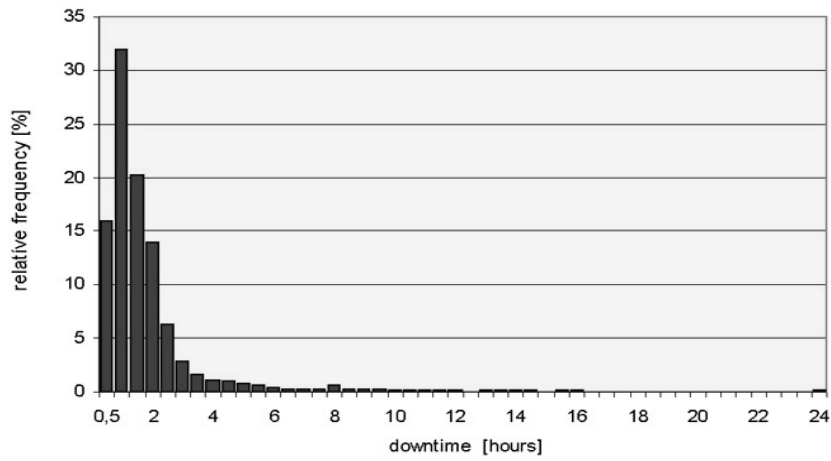


Figure 5

Histogram of the relative frequency of time needed to troubleshoot the unexpected breakdowns of printing machines

Values of *Figure 6* give information about the time expected to be needed for the repair of the consequences of unexpected breakdowns for printing machines. Special attention should be paid to these data when designing because the relatively rare breakdowns require longer repair time, which need considerable labour input as shown in the table of *Figure 6*. More than 8 hours of repair time, which appears with less than 3% probability, is the 18% of the overall repair expenditure. Whereas the 50% of the repairs resulting less than an hour of downtime is only 20% of expenditure.

Repairment within a given time period	Probability	Proportion of the required repair time to the total repair time
1 hour	47.75 %	21.05 %
2 hours	81.84 %	51.76 %
3 hours	90.84 %	64.39 %
4 hours	93.49 %	69.58 %
6. hours	96.04 %	76.43 %
8 hours	97.50 %	81.92 %

Figure 6

Probability values of time needed to troubleshoot the unexpected breakdowns (based on the histogram)

3.2 Typical Breakdowns of the Printing Machines

There is another important approach in this chain of thoughts. What breakdowns are typical for printing machines? The classification of breakdowns is carried out according to the 10 big structural groups characterising the printing machines mentioned in the maintenance event log system, based on the previously presented model.

Figure 7 shows the breakdown proportion of the distinguished parts. The input and output units – the units of the above-mentioned transmitting machines – give the 39% of all breakdowns.

There is a high occurrence of breakdowns due to failures of mechanical propulsion, sensors and beacons. Units performing technologically important operation have relatively smaller breakdown proportion compared to their importance in the machinery. The breakdown proportion of the electrical parts is 20% as shown on the diagram. The proportion of the electrical type of unexpected breakdowns is 29% including electrical faults of any part.

The knowledge of proportions is especially interesting when preparing for condition-assessment and modernisation.

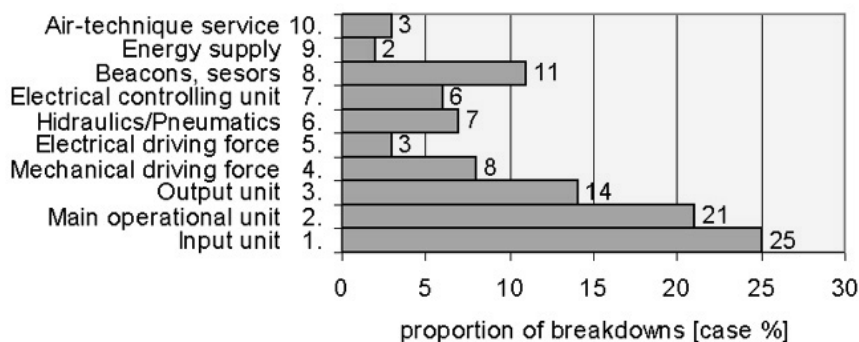


Figure 7

Distribution of unexpected breakdowns of printing machines between given main units

Conclusions related to unexpected breakdowns mainly refer to equipments of printing and further processing. It is also notable that the planned reparations and the proportion of troubleshooting at the maintenance of Alföldi Printing Plant correspond to the average in the industry. Characteristics related to prepress equipment corresponds to the characteristics of computer technology.

Conclusions

For the productivity maintenance of printing machines the detailed knowledge of relations of failures are crucial. Reparation of unexpected breakdowns generally requires management of short/reactive reparation. Knowledge about the typical

failure rates of major parts of printing machines is the fundamental pillar to apply pro-active maintenance management.

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