

# Preventive maintenance features specific to offset printing machines

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**Abstract.** In the printing industry, where production never stops, it is very important to continuously maintain machine performance. If a machine breaks down, the production will stop and it will disturb the production process. Therefore, the maintenance system must be managed efficiently to solve those problems. The paper presents the study results on continuous quality improvement of offset printing using preventive maintenance features. Offset printing is a process that involves a multitude of variables, independent and interdependent factors. The offset printing process was analyzed and the factors that have a significant influence on the quality of the process and the products made were identified. The defects that may occur during the printing process and the causes thereof have also been identified and the types of non-conformities of the end products were established. The experimental method was used. The case study was conducted on Manroland 508. For the planning of preventive maintenance activities, the duration of the maintenance works necessary to ensure the proper functioning of the offset printing machines was established. Finally, maintenance activities that would guarantee and continuously improve the quality of the printing processes and the printed products were issued.

## 1 Introduction

Maintenance is one of the areas of modern management used to increase machine productivity and to achieve quality products. This obviously improves equipment efficiency rates and reduces costs [1].

The maintenance strategy of a factory's equipment is crucial for production efficiency. It becomes extremely important to reduce downtime to increase the productivity of each particular type of equipment [2].

The quality and continuous improvement of products and production processes is the main objective of all managers of printing houses, out of the desire to market high quality and competitive end products, able to compete with other similar products.

Due to the lack of generalized performance models with reference to the quality of printing products, manufacturers are interested in developing for each offset printing

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machine working instructions and procedures which can help to achieve this objective, considering all the factors involved in the offset printing process [3, 4].

The paper presents the results of the study conducted in a medium-sized printing house, which works in 2 shifts of 8 hours each, starting from real problems derived from the production environment and analyzing the factors that influence the offset printing process. Non-conformities and defects were identified by the experimental method (direct observation method) on the end print products included in the study. Non-conformities and defects specific to offset printing machines and their causes were analyzed. Preventive maintenance activities that would guarantee and continuously improve the quality of the printing processes and the printed products were issued.

The results of the study can be implemented directly within the company, to increase the quality of processes and products or can be taken as reference models for planning the activities of other printing processes and designing new products.

## **2 Non-conformities and defects specific to offset printing**

Offset printing is the most economically suitable technology for producing large volumes of high quality prints compared to other printing technologies. Four distinct elements are required to perform the offset printing process [5]:

- the object used to print; this is called the printing plate;
- the material used to print; it is always printing ink;
- the material on which it is printed; this is called the printing substrate; for example, paper and / or cardboard;
- a device used for applying pressure to the contact between the printing plate coated with ink and the printing substrate (paper); as a result of this pressure, the transfer of ink from the printing plate to paper occurs.

The printing process can be divided into the following steps:

- rubbing ink using the ink form rollers from the printing unit and ink deposition on the printing plate;
- feeding the machine with paper and bringing it over the printing plate in a position that ensures correct printing;
- the printing in fact, which is performed during the passage of the paper through the device that presses it to the printing plate;
- removing the printed sheets, while the ink sticks to the printing substrate.

Offset machines are equipped with electronic devices for setting the parameters of the operations of the technological process, such as: the accuracy of the overlap register, the thickness of the ink layer, composition and temperature of the dampening solution, the temperature of the ink form rollers, etc.

For the technical evaluation of the sheets resulting from the offset printing process a great variety of quality characteristics are used. These are found in standards, internal norms of the printing house, in the job specifications or they are stipulated by the beneficiary in contracts or by signing the printing proof.

In the event of any deviation from the rules established as a reference, a defect or a non-conforming product may be discussed.

Depending on the severity of the defects, they are distinguished as:

- critical defects - sheets with serious printing defects that can no longer be remedied;
- primary / major defects - sheets that have serious defects, but which can be remedied;
- secondary / minor defects - sheets with minor defects that do not affect the end product.

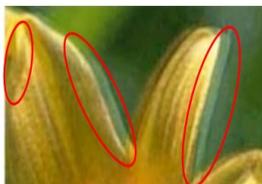
Table 1 shows some of these types of defects and in Fig. 1 can be seen examples of defective print sheets.

**Table 1.** Examples of defects classified according to their severity

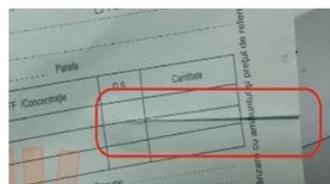
critical defects	major defects	minor defects
torn sheets sheets with folds sheets glued together text illegible dirty sheets	fuzz on printing substrate inappropriate colors spots of ink scratch too much anti set-off powder	small color variations differences matching front/back less than 2 mm lightly embossed sheets sheets glued in the area of the side lay



correct sample



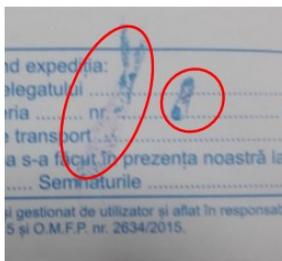
duplicate image



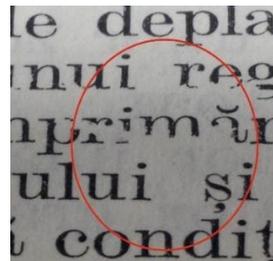
sheets with folds



unclear contour (seen with a test magnifying glass with magnification factor 9x)



presence of foreign elements (impurities)



lack of printable items

**Fig. 1.** Defects specific to offset printing

In order to highlight the non-conformities and defects specific to the offset printing a sample of 500 prints was examined. In tables 2 & 3 the results of the case study are presented. The sample included in the study represents the sample of printed sample sheets recommended for offset printing machines in order to ensure the matching of the printing until the print runs started up in accordance with the print job.

**Table 2.** Types of non-conformities and defects specific to offset printed products [6]

No	Defects and non-conformities	Number of pieces recorded
1	improper overlap of the printing pattern and print colors	60
2	deformation of the register	30
3	stripes on the printing pattern	20
4	excess water in print	60
5	duplicate image	40
6	ink-loaded image	50
7	lack of printable items	30
8	toning of the printing pattern	40
9	dirtying of the printing pattern (from insufficient ink drying)	45
10	ink transfer on the back	35

11	fold	50
12	emulsification of ink in printing units	60
13	paper with non-conformities	30
14	printing pattern from the previous job	40
15	lack of raster	60
16	fracture	20
17	cyclic non-conformity in the printing pattern	40
18	impurities	35
19	spots	35
20	oversizing (widening) raster points	65
21	tearing the fibres from the paper and taking them on the rubber	55

**Table 3.** General causes of non-conformities and defects specific to offset printed products [6]

No	Defects and non-conformities	Number of pieces recorded
1	insufficient pressure	40
2	overstressing rubber	55
3	improper entry in front limiters	30
4	scratches on the printing plate	35
5	defective offset rubber	60
6	defective printing plate (incorrect bending, creased, damaged, burned (exposed and/or developed incorrectly), improper mounting in computer-to-plate device)	7

It is found that the following non-conformities have the largest share: improper overlap of the printing pattern and print colors, excess water in print, emulsification of ink in printing units, defective offset rubber and oversizing (widening) raster points.

### 3 Preventive maintenance of offset printing machines. Case study

The high costs of offset printing equipment cause many manufacturers and printing service managers to ensure a qualified maintenance, through various methods and means, throughout their lifetime. Among the weaknesses of the maintenance activity in a printing house we can mention: management based only on experiences; lack of maintenance databases, rules, planning data and specific features; low level of maintenance information systems; low level of professional training; insufficient private maintenance infrastructure [3].

Preventive maintenance consists of a well-defined action plan aimed at preventing defects. This plan is delivered, usually by machine supplier along with the instructions for use of the machine. All machine damage results will be noted in the machine's logbook. The repair of the fault (with or without replacement of components) will be considered completed only after returning the equipment to the nominal technical parameters of operation and performing performance tests.

At the end of the diagnostic, repair and maintenance activities, a report will be presented that will contain (at least) the following information: equipment type and series, the nature of the fault and the causes of its occurrence, duration of the intervention, operations performed, parts replaced, the condition of the equipment after the intervention, recommendations. A list of recommendations will also be drawn up to ensure a safe stock of spare parts with the part name according to the manufacturer's documentation, the part manufacturer's code.

For offset printing machines, studies [1, 4, 7-9] mention that the failure probability distribution function can be parameterized by Weibull distribution. Maintenance performance indicators are: machine breakdown time, Mean Time between Failure

(MTBF), Mean Time to Repair (MTTR) and breakdown time percentage of available time. The most important subsystems included in the maintenance policy are: ink fountain roller, transfer roller, ink form roller and wash-up device.

The conclusions of the case studies are specific to some types of offset printing machines and to their own conditions of use. Therefore, they do not have a general character, but only indicative. For example, for a Goss Universal web printing machine, maintenance interval for ink fountain roller is 25.19 hours, transfer roller is 96.42 hours, ink form roller is 27.16 hours, and wash-up device is 38.47 hours [1].

It is important that each company carefully monitors its equipment and maintains permanent contact with their manufacturers for their correct and long-term use.

The case study is performed for the Manroland 508 offset printing machine which has the following characteristics [10]: 8 printing inline units; varnishing unit; infrared dryer; the sheet is transferred to the next printing unit after it has left the printing area in fact; the maximum size of the print sheet: 530×740 mm; the print format used: 520×740 mm; the plate size: 605×745 mm; the rubber size: 730×760 mm; the minimum thickness of the printed paper: 60 g/m<sup>2</sup>; printing speed: 16,000 sheets/hour. The printing speed is chosen depending on the type of paper, ink and print job specifications.

The case study was conducted in a medium-sized printing house, which works in 2 shifts of 8 hours each. The type of printing production is "on-demand". This requires random changes in the sizes and thicknesses of the printed papers, frequent changes in the printing plate, frequent adjustments of the printing pressure and speed, and, frequently, changes in the work schedule (depending on the delivery deadlines imposed by customers). All these factors lead to the situation where the recommendations regarding the in operation durability of the parts and subassemblies (which require periodic maintenance or replacement) no longer match the actual situation in the printing house. The frequency of maintenance work or replacement of critical parts, for operating in normal parameters, has to be adapted to the specifics of this type of exploitation.

Table 4 presents some of the non-conformities and defects specific to Manroland 508 machine, as well as their causes established by the experimental method (the information was collected during the operation of the machine; the moments of occurrence of the faults were established; the elements replaced or put back into operation were identified; the time needed for these operations was recorded). Also, the necessary times for the preventive maintenance activities that can eliminate these causes are mentioned as recorded in the machine's logbook.

**Table 4.** Types of non-conformities and defects specific to offset printing machines

No	Defects and non-conformities specific to offset printing machines	Causes and time required for preventive maintenance activities	Defects specific to printed products
1.	Non-conformities at inking units / 10 hours 30 min 	<ul style="list-style-type: none"> <li>- wear of the variable speed device of the drive unit / 3 - 4 hours;</li> <li>- blocking of one of the inking rollers due to bearing wear / 2 hours;</li> <li>- roller with bent shaft / 1 - 2 hours;</li> <li>- bearing failures, broken bearing / 2 hours;</li> <li>- defective fixing of inking rollers in bearings / 30 min;</li> <li>- wear of the roller;</li> </ul>	<ul style="list-style-type: none"> <li>- ink-loaded image;</li> <li>- low ink flow;</li> <li>- high ink flow;</li> <li>- duplicate image;</li> </ul>

<p>2.</p>	<p>Bad timing of the suction cups for the sheet feeder / 8 hours 50 min</p> 	<ul style="list-style-type: none"> <li>- clogging of the transport suction and separators sheet suction / 1 hour;</li> <li>- failure of the feeder table lifting sensors / 20 min;</li> <li>- wear of the feeder table lifting chains / 4 - 5 hours;</li> <li>- non-conformity of the air pressure in the sheet separation blowers, at the air suction, due to the failure of the compressor / 30 min;</li> <li>- improper operation of the control desk panel / 2 hours;</li> </ul>	<ul style="list-style-type: none"> <li>- wrinkled sheets;</li> <li>- friar;</li> <li>- double sheets (glued sheets);</li> </ul>
<p>3.</p>	<p>Lock the side lay roller/5 hours 50 min</p> 	<ul style="list-style-type: none"> <li>- failure of the shaft of the vacuum conveyor belts / 20 min;</li> <li>- defective bearing / 20 min;</li> <li>- blocking by clogging the paper separating holes with paper dust / 10 min;</li> <li>- the grippers of the sheet conveyors are unregulated or incorrectly adjusted, resulting in the tearing or bending of the sheets / 4 hours;</li> <li>- improper operation of the control desk panel / 30 min - 1 hour;</li> </ul>	<ul style="list-style-type: none"> <li>- strips on the printing pattern;</li> <li>- broken sheets;</li> <li>- creased sheets;</li> <li>- folds;</li> </ul>
<p>4.</p>	<p>Wear of ink rollers / 7 hours 15 min</p> 	<ul style="list-style-type: none"> <li>- accumulation of paper dust and remains of dry ink in the pores of the rubber rollers / 1 hour;</li> <li>- paper dust deposition between rollers / 25 min;</li> <li>- setting contact strip between rollers / 2 hours;</li> <li>- wear of some bearings of the paper guide rollers, leading to the blocking of the rollers / 1 hour - 1 hour 30 min;</li> <li>- roller with bent shaft / 2 hours;</li> <li>- broken bearing / 20 min;</li> </ul>	<ul style="list-style-type: none"> <li>- improper overlap of the printing pattern;</li> <li>- stripes on the printing pattern;</li> <li>- excess water in print;</li> <li>- ink-loaded image;</li> <li>- emulsification of ink in printing units;</li> </ul>
<p>6.</p>	<p>Non-conformities at dampening unit / 6 hours</p>	<ul style="list-style-type: none"> <li>- wear of the dampening rollers below the tolerance limits, leading to high flow of dampening solution / 30 min - 1 hour;</li> <li>- breaking one of the adjusting screws by idle rotations / 2 - 3 hours;</li> <li>- non-conformity of the dampening solution cooling system leading to</li> </ul>	<ul style="list-style-type: none"> <li>- uneven dosing of the dampening solution on the printing plate;</li> <li>- poorly visible</li> </ul>

		<p>water heating / 10 min - 1 hour;  - Technotrans device for automatic preparation of the dampening solution: the probe not working, the concentration of dampening solution does not reach the optimal parameters / 30 min - 1 hour;</p>	<p>printing pattern;</p>
	<p>Non-conformity of the wash-up device / 3 hours 20 min</p> 	<p>- defective waterskin / 30 min;  - defective air cushion / 30 min;  - poor quality of the washing roller material / 20 min;  - clogging of the solvent spray nozzles / 30 min - 1 hour;  - failure of the system jack clamping of the wash-up device / 30 min - 1 hour;</p>	<p>- impurities;  - poorly visible printing pattern;  - duplicate image;</p>
<p>7.</p>	<p>Non-conformity of the assembly of the printing plate cylinder and rubber blanket cylinder / 4 hours 55 min</p> 	<p>- low quality of the rubber blanket / 10 min;  - no deep-cleaning of the rubber blanket / 10 min;  - no scheduled rejuvenation of the rubber blanket / 10 min;  - wear of the rubber blanket bar locking screw leading to rubber weakening / 5 min;  - cam failure due to the defective cam roller followers / 1 hour;  - wear of the bearings / 20 min;  - non-conformity of the lubrication / 2 hours;  - improper adjustment of the grippers / 1 hour;</p>	<p>- lack of printable items;  - accidental smash on rubber blanket;  - improperly fitted or calibrated rubber blanket underlay;</p>
<p>8.</p>	<p>Non-conformity in sheet delivery unit / 2 hours 50 min</p> 	<p>- grippers in sheet conveyor set too weak or too strong / 30 min;  - used conveyor rollers / 1 hour;  - the chain is too tight / weak (it delivers the sheet too fast / late) / 1 hour;  - non-conformity of air blowers system in the delivery unit / 20 min;</p>	<p>- uneven placement of sheets in the delivery unit;  - wrinkled sheets;</p>
<p>9.</p>	<p>Defective ultraviolet lamp / 1 hour 20 min</p>	<p>- non-conformity of the lamp closing and opening system / 20 min;  - standard operating hours are exceeded / 20 min;</p>	<p>- dirtying the printing pattern due to insufficient</p>

		<ul style="list-style-type: none"> <li>- failure of the sensor that activates the opening of the lamp for drying the printing pattern, due to condensation, high humidity / 20 min;</li> <li>- reflective surface of ultraviolet rays to print is dirty / 10 min;</li> <li>- failure of the contacts at high lamp temperature / 10 min.</li> </ul>	fixing and drying of the ink.
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## 4 Conclusion

The offset technology offers a very good quality of chromatic reproduction and tonal gradations of a varied tonal spectrum, with fine tonal gradation in comparison to other printing technologies. The quality of offset printing is influenced by a multitude of factors: the printing substrate and ink, the printing machine in use, the skill of the printer, the printing house management.

The results of the case study, extended on the sample of the print matching test until the start of the print run, led to the registration of the types of non-conformities and defects of the printing products. The ones with the highest impact are: improper overlap of the printing pattern and print colors; excess water in print; emulsification of ink in printing units; defective offset rubber; oversizing (widening) the raster points (caused by too much pressure between the rubber blanket cylinder and the pressure cylinder).

The results of the study can be taken as reference models for planning the activities and printing quality policy for other offset printing processes.

In order to ensure and improve the quality of long-term offset printing processes, it is important to ensure the preventive maintenance (focused on monitoring the defects when observing the printing process). This can help minimize remediation costs included in non-quality costs. Case studies are performed for different types of offset printing machines under their own conditions of use. Therefore, they do not have a general character, but only indicative.

Among the defects of the offset printing machine observed which have the greatest impact on the repair times we mention: bad timing of the suction cups for the sheet feeder (8 hours 50 min), wear of ink rollers (7 hours 15 min), non-conformities at inking units of the offset machine (10 hours 30 min), non-conformities of the dampening unit (6 hours), non-conformity of the wash-up device ( $\approx$  3 hours), non-conformity of the sheet delivery unit (2 hours 50 min), non-conformity of the assembly of the printing plate cylinder and rubber blanket cylinder (4 hours 55 min).

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