MODELS AND KEY FACTORS OF MAINTENANCE IN PRINTING INDUSTRY

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SUMMARY

Maintenance planning practices largely rely on the information or objective description of the characteristics of the given servicing work demand. Nevertheless, very little information is available on today's state-of-the-art printing machines. The author hereunder collects, adds to and systemizes the associated information. He sums up the standard times in relation to the small, medium, large and CCP servicing for the various types of printing machines, on the basis of the standard times originating from the servicing practices. These data consist of information that has never been published, and cannot be found in such an uniform compilation. Due to the variety and complexity of printing machines, the maintenance data and experience – that would offer assistance in the planning and management of maintenance – are rather slow to accumulate. The application of a standardizing indicator based on generally accepted estimation can potentially broaden and make the so far cumulated maintenance experience widely useable. The author is proposing the introduction of an indicator – complexity factor –, and at the same time presenting the examples with contents. The proper determination of time and work demands in preparation of various planned servicing projects is a key issue. The standards, factors and time demands described in this publication can considerably support the planning of the preventive maintenance tasks for printing machines with appropriate accuracy.

Key Words: maintenance of printing machines, cycle times, lifetimes, complexity factors

1 APPLICATION OF THE MAINTENANCE-ORIENTED OPERATING MODEL OF PRINTING MACHINES

In spite of the potentially large differences between individual printing machines, it is expedient to evaluate and discuss them with the use of a standardized approach, on the basis of their fundamentally common characteristics. The main reason of such a need for synthesis is rooted in maintenance practices. Printing houses perform their tasks typically with small headcounts. Consequently, there is little room for specialization, the parceling of maintenance approaches and practices. From the perspective of operations and maintenance, due to the given printing applications there are a number of such common properties of machines featuring fairly different structures and technological functions that would allow a standardized approach.

Formulated towards this end, the simple model presented in *Figure 1* well reflects the general structure of printing machines, including their sectioning and details that are need for the analysis of the specific elements of the organization of maintenance.

The technological units of today's printing machines combine two basic operations carrying equal importance. The main operation for information-related work on the products in general is based on the forwarding movement of the material to be processed (typically paper) with high accuracy. For this reason, the key elements of printing machines are the discharging and feeding units. These elements also provide for the construction of combined machine systems. In other words, if large systems are broken down to the individual elements, one will invariably arrive at the three-part division indicated in blue. Drive, control and supply units pose the same demands in structural set-up, complexity and especially maintenance as technological units.

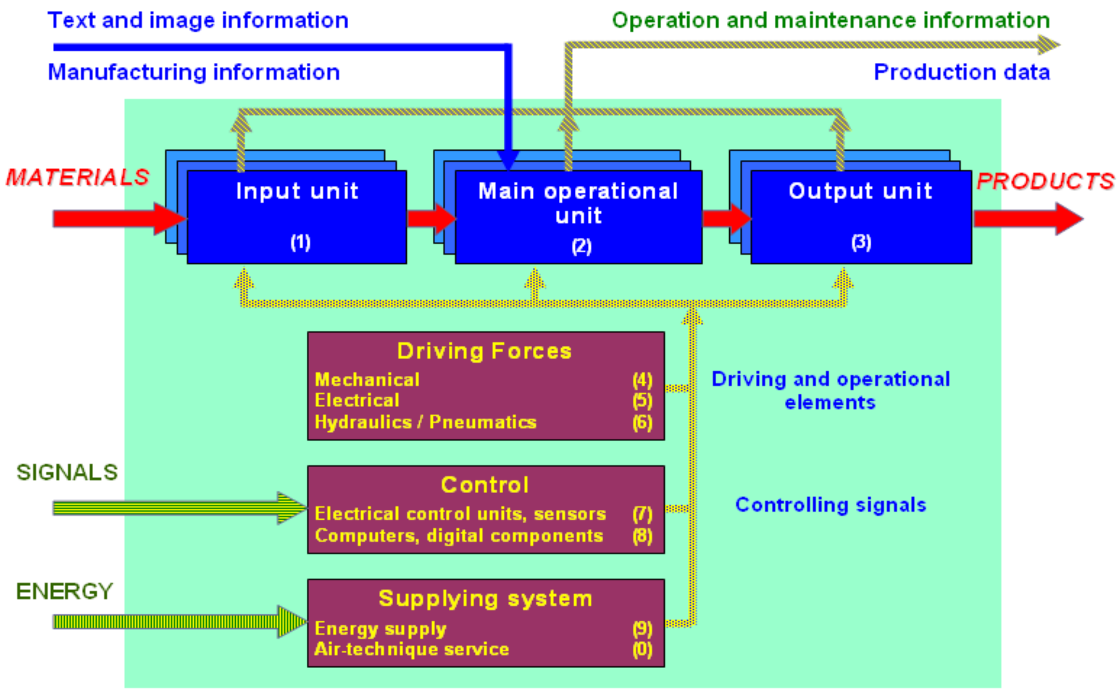

Figure 1: Operating maintenance model for the printing machines

2 DETERMINATION OF THE SERVICING WORK DEMAND IN RELATION TO PRINTING MACHINES

Today, more than 90% of modern printing machines operated in Hungary originate from Western European manufacturers, mainly from German suppliers after the integration of the printing machine manufacturing of the former GDR into German industry. Our accession to the European Union and the liberalization of these economic activities ha just strengthened this trend.

Gutenberg's invention is associated with the German city of Mainz. The surroundings of this city in a 250-km range has always remained a traditional zone of state-of-the-art printing machine manufacturing. This area concentrates more than half of such manufacturing processes in the world. The other, historically traditional area of manufacturing is in England, around Leeds. Companies involved in the reconditioning of printing machines tend to settle in the same areas, on the available industrial background and professional traditions. The author of this study has succeeded in establishing contacts with several such businesses, which has allowed insight into their – otherwise not public – data and design methods. The information provided in relation to lifetimes and maintenance standards mostly rely on the experience accumulated by these companies. Leading Hungarian printing machine service companies have also contributed to the establishment of servicing work demands.

3 CYCLE TIMES, LIFETIMES

Nowadays, key *printing machines* making up the technological lines *are planned for lifetimes of cc. 20 years* with respect to the two-shift work order that is customary in Western Europe. In actual practices, reaching half of this lifecycle (first cycle) machines are subjected to full-scaling reconditioning and modernization. The underlying reason is that in comparison to other industries this sector sees a large turnover of used machines. Printing houses tend to plan the financial return of any printing machine for a single cycle, and instead of general reconditioning they rather sell the equipment, and buy a new or reconditioned one for the following reasons.

(1) It is difficult to spare these large-capacity machines for the duration of reconditioning.

(2) In general, printing houses find it difficult to create proper circumstances for expert reconditioning.

(3) Machines are replaced to follow technical, technological development.

The associated examples show that the above statements are true for all the printing machines, and not only technological lines. In recent years, Hungarian practices have followed these tendencies. It is to be also noted that Hungarian printing industry seems to be an enthusiastic buyer of equipment that has been over the first phase of their lifecycles, and thus dismounted in Western European printing houses.

In the light of the foregoing, the cycle structure shown in *Figure 2* can be planned for the equipment of printing and finishing (binding) operations:

P – R – M – R – S – R – M – R – G – R – M – R – S – R – M – R – D(G)

2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18.

> > > > > > > > > > > > sequence of years > > > > > > > > > > > >

P – procurement, guarantee period	R – review, quick servicing
G – general servicing	S – small repairs
D – scrapping, de-commissioning	M – medium repairs

Figure 2: Servicing cycle structure of printing machines

In the field of the distribution of used machines, a less widely known form of servicing being less known in Hungary has emerged – on the basis of its English acronym it is called CCP (checking, cleaning, painting). It means the disassembly of the printing machine to be reconditioned in the service workshop, the cleaning, checking of all the parts, only the replacement or reconditioning of the defective elements, as well as their painting and assembly. As some companies with such a business profile have also been formed in Hungary, the spreading of this form of servicing is foreseen.

4 MAINTENANCE STANDARDS, WORKING TIME DEMANDS

For the establishment of the servicing work demands, the anticipation of the time expenditures of maintenance works, the associated literature [1, 5, 6] describes the following four main groups of methods:

(1) estimation of time values (estimated standards),

(2) standards established with statistical methods,

(3) standards established with the use of work and time studies,

(4) standards established with movement analytic methods.

Workshops reconditioning printing machines are industrial plants with relatively small headcounts. They generally employ 12–25 employees at the maximum. In their approach, they regarded the application of these two latter methods (3–4) to be expensive and too complex. They should engage specific experts or external expert companies for the given tasks. For them, statistical methods yield satisfactory, accurate results for them, because they preserve and keep information in relation to performed works painstakingly. They also have well-established methods for the selection of the bases of reference. As they group their price offers on the same information bases, it can be claimed that life (the market) justifies the correctness of their working methods.

Naturally, the large variety of printing machines has forced companies involved in the reconditioning of printing machines to become specialized, or to be more precise they tend to enter the market with some specialization: not necessarily in terms of particular manufacturers or machines types, but rather on the basis of the basic types of printing machines:

- prepress, reproduction technology,
- sheet-feeding offset machines,
- web offset machines (offset, rotogravure, newspapers),
- specialized printing machines,
- binding equipment,
- equipment for the production of accounting documents,
- equipment for the manufacturing of boxes, packaging materials.

Except for the own reconditioning workshops of factories, everyone else follows this categorization. Reconditioning companies have tuned their own, internal time and performance standards accordingly. The most serious difficulties tend to be caused by the varied designs of printing machines for the same purposes. A particular line of thinking has surfaced to keep order in this "jumble". Good correlation can be detected between the weight of printing machines serving identical purposes and the time demand of servicing. The related reason is that printing machines are typically made up of several identical or closely similar units. [2, 3, 4, 7] Consequently, such an indicator – time demand of servicing in relation to unit weight [working hour/ton] – can be calculated that support planning beneficially and with high accuracy.

Data presented in *Table 1* are highly helpful in the planning and preparation of various servicing tasks connected with the lifecycles of printing machines. The Figure sums up standard times in relation to the *small, medium, large and CCP servicing* for the various types of *printing machines*, on the basis of the standard times originating from the servicing practices of the above-mentioned companies. These data consist of information that has never been published, and cannot be found in such a uniform compilation.

Table 1

Typical basic standard times for various types of servicing, on the basis of the practices of reconditioning plants

Type of the printing machines	**Standard time demand in relation to various types of servicing (working hour)**			
	small repairs	**medium repairs**	**large repairs**	**CCP servicing**
plate copier B1	20	60	150	75
plate developer B0	40	100	240	150
sheet-feed offset presses				
B3 one printing unit	40	100	225	125
A2 two printing units	150	600	1200	750
B2 two printing units	200	800	1500	1000
B2 four printing units	350	1200	2000	1250
B1 two printing units	300	1000	1800	1000
B1 four printing units	500	1600	2500	1500
web offset presses				
66 cm; four pr. units	500	1250	2000	1000
96,5 cm; five pr. units	600	1500	2500	1250
perfect binder				
binding head	100	300	500	250
Sheet gatherer station	30	60	250	75
binding equipment				
guillotine	20	60	400	150
three-knife trimmer	60	300	500	200
casing-in line	150	300	750	400
folding machine B1	30	200	300	150
automatic sewing machine	45	300	500	250
cover-making machine	60	150	300	100

5 COMPLEXITY FACTORS

Due to the variety and complexity of printing machines, the above-referenced maintenance data and experience – that would offer assistance in the planning and management of maintenance – are rather slow to accumulate. The application of a standardizing indicator based on generally accepted estimation can potentially broaden and make the maintenance experience having been earned so far widely useable.

For the determination of the work demand of planned servicing actions, the maintenance fields of other industries have already relied on the application of the *complexity value*. This complexity value is handled as the unit of the associated calculations: a reference standard. Usually, it is indicative of the average work required for the general servicing of a machine regarded to be typical [6].

Hereunder, I am proposing the introduction of an indicator – *complexity factor* –, and at the same time presenting an example with contents that are similar to those of the complexity value, yet offer broader potentials of use.

For the determination of the complexity factor, the time demand of the general servicing of a B2 4-colour sheet-fed printing machine is regarded to be 100 units. This equipment is generally known and widely spread, it is one of the most frequent machines in printing houses, which facilitates such a reference. The complexity factors of all the other printing machines should be related to this equipment.

The actual time demand of the general servicing of the printing machine taken as the reference standard is *2,000 working hours*.

Thus, the complexity factor of the given machine (c_f) can be calculated as follows:

$$c_f = 100 \cdot \frac{\text{working time needed for the general servicing of the printing machine [working hour]}}{\text{2,000 [working hour]}} \quad (1)$$

The calculated complexity factor values represent percentage-based values of reference. With the use of these values, one can even determine how many units of printing machines in relation to the given reference standard any given printing house has in view of the organization of maintenance. This approach supports benchmarking, the calculation of maintenance resources and the establishment of incentive systems.

The tables presented in *Table 2* and *Table 3* sum up the complexity factor values of maintenance belonging to typical printing machines.

Table 2

Typical complexity factors of various printing presses on the basis of the practices of reconditioning plants

Type of printing machines	**Complexity factors**						
	Number of printing units						
	1	**2**	**4**	**5**	**6**	**8**	**10**
Sheet-fed offset presses							
A3	30	50	75				
B3	35	55	80	95	130		
A2	45	65	95				
B2	50	70	100	115	160		
A1	55	75	110				
B1	60	80	120	140		200	220
A0		90	140	165			
B0		100	150	175			
Web offset presses							heatset + 20 2nd folders: + 20
8 pages		70	100	110		200	
16 pages		110	150	165		330	
32 pages			200	220		440	
48 pages			250	275		550	
64 pages			300	330		660	

Table 3

Typical complexity factors of various binding machines on the basis of the practices of reconditioning plants

Binding machines	c_f		Other machines	c_f
Perfect binder			Plate copier B1	10
binding head	60		Plate developer B0	15
sheet-gatherer station	20			
			Automatic die cutter	
Guillotine	20		B1	80
Three-knife trimmer	30		A0	100
Casing-in line	120		B0	110
Folding machine				
B2	30		Box-folder machine	60
B1	50			
Automatic sewing machine	40			
Automatic cover-making m.	50			
Saddle stitching line	60			

6 THE APPLICATION OF KEY FACTORS IN THE PLANNING OF PREVENTIVE MAINTENANCE ACTIONS

The proper determination of time and work demands in preparation of various planned servicing projects is a key issue. The standards, factors and time demands described in this publication can considerably support the planning of the preventive maintenance tasks for printing machines with appropriate accuracy.

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