A Study of Maintenance Practice in the Printing Industry

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Keywords

Management, Productivity, Manufacture, Maintenance

Abstract

Good maintenance practice is one of the keys to achieving increase machine utilisation and hence better productivity. While well established in the engineering manufacturing industry, it adoption in the printing industry has yet to be fully measured. A study was undertaken to establish the current position of maintenance in the UK printing industry. An on-line web survey was undertaken in parallel with selected company visits to develop case studies. This paper presents a detailed analysis of the results of the survey set against the background maintenance practice in manufacturing and highlights best practice.

While all the respondents to the questionnaire recognised that having a maintenance plan was essential for good quality production, less than 65% had a plan and less than half of these were satisfied with their maintenance. 90% of those who had a maintenance plan found that it reduced their press down time while 60% found it produced less waste. A range of other statistics showed that many small printers do not implement maintenance, even though they all believe it was a good concept. The main barriers were pressures of production and lack of understanding of engineering maintenance management. There were a number of printers who have condition monitoring fitted to their presses but only use it for fault finding. While many were using key performance indicators, the focus appeared to be on the measurement of the cost of consumables / parts, e.g. for use in litigation, rather than improving process performance.

Introduction

Maintenance is frequently a given a low priority or even neglected in printers

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because it is perceived to waste valuable production time, especially when there is a need to meet customer delivery deadlines. However, good maintenance practise can improve machine availability, speed and productivity.

Although there awareness of the importance of maintenance to productivity of the printing industry has been raised (Claypole, Wells), it is still perceived to be behind other similar sized manufacturing industries. This paper reports the findings of a web-based survey of maintenance practise in the UK printing industry. The objective of this survey was used to establish the extent and sophistication of the maintenance provision. The work identified ingredients for successful maintenance strategies, such as planning maintenance as part of production, and top priorities for implementing it in the management and by Operator Involved Maintenance (OIM).

Methodology

The questionnaire was grouped into four sections. The first section had classifying questions to derive basis information on the respondents such as their size, principal business segment and what processes they used. The second section explored their current maintenance status, what procedures and maintenance plans they had in place and how effective these were. It also gave some economic impact information such as the frequency of the occurrence of breakdowns and the speed at which the presses are operated. Section 3 sort to explore the extent to which the workforce were integrated into the maintenance/productivity process. The fourth and final section explored the extent to which the company monitored Key performance Indicators as a way of managing productivity. The web-based survey was designed to be completely on line in approximately 20 minutes with questions that could be answered from their knowledge of the operation of their company. The survey was completed predominantly by senior or line management. The position of the respondents reflects the size and independence of the companies, i.e. the majority were small independents.

The decision as to what maintenance strategy to adopt for a particular piece of equipment is determined by its economic and safety impact on the process. There are four competing strategies:

1. A fix it when it breaks approach. This can be cost effective to run the where there are many identical units performing the same task and thus the company can cheaply accommodated spare capacity.
2. Restorative maintenance. At a regularly intervals the plant is taken out of service and completely overhauled to return it to as new condition.
3. Preventative Maintenance. This works on the precept that the life of components can be predicted accurately on a statistical basis. Thus, enabling components to be replaced before they were likely to fail.

However, this strategy results in serviceable components being scrapped.

4. Conditioning monitoring. Monitoring key parameters of the equipment (e.g. temperature, power consumption, vibration) and identifying trends can enable the point of failure to be predicted and the unit serviced at a convenient time before failure.

In order to create a profile of their performance in terms of the maintenance, the responses in the second section were scored and the points accumulated in bins for fix it when broken, restorative, planned preventative and condition monitoring. As the company progresses from non maintenance plan through to productivity based maintenance, then there will be a shift from the scores being solely in the fix when broke (i.e. no strategy), to a set of results that spreads across all three categories. It is not necessarily incorrect or not financially appropriate to use the fix it when broken approach for some processes. One would expect the company to have more of a distribution across the four categories as becomes more enlightened with regard to maintenance.

Over 80 companies completed the questionnaire. These were predominantly small to medium enterprises. There were sufficient respondents to allow a comparison between those companies with and without a formal maintenance programme. The majority of the companies operated as independent sites, 64% of the companies were independents, a further 21% although part of a larger group were financially independent. Just over half the companies had maintenance staff (55%).

Results

Most of the companies (97%) had post press finishing equipment. The majority (75%) operated this off line. This would enable the press and the finishing to function independently and lessen the impact of any catastrophic failure. It also negates the need to operate the printing press and the finishing line at the same speed. The three most popular pieces of finishing equipment were the guillotine, folder and saddle stitcher. 70% had a guillotine, over a third of which had a folder and a further third a saddle stitcher as well. This reflects the number of commercial printers in the survey.

The maintenance scores of both groups of respondents (figure 1) are indicative of companies who have an interest in productivity and are developing a maintenance strategy. There is a strong emphasis on preventative maintenance, with a developing strand of condition monitoring. Very few of the companies relied on an “as and when” approach. However, this probably is biased by the attitude to maintenance expressed by the respondents in the opening section of the survey. The group of companies that have a maintenance programme have a strong emphasis on preventative maintenance; with virtual no fix when it breaks,

but a surprisingly lower score in the predictive area. The development of a strategy would appear to be at the predictive point.

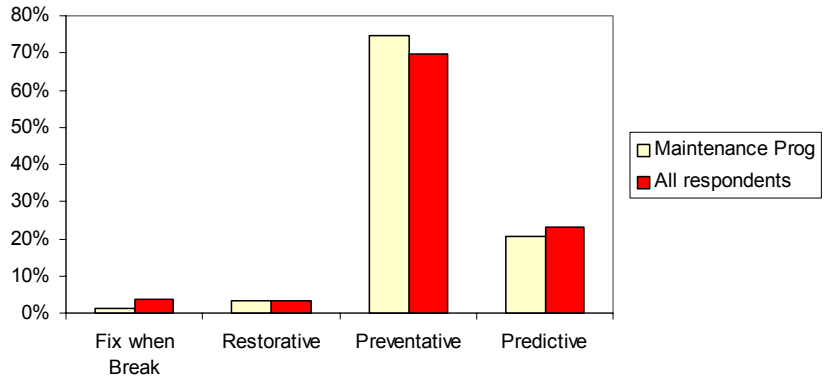

Figure 1. Maintenance Scores

However, very few replaced components at the interval recommended by the manufacturer (10% or less). This suggests both the frugal attitude of the printers and also implies the manufacturers recommended intervals are different to what is found in practise. This is perhaps not surprising, as within the scope of both this and the case studies the same equipment was found to be on very different duty cycles both in terms of run length and speed. Therefore the expected life of components would vary quite significantly. The group with a maintenance programme placed a greater store on inspection and monitoring output to decide when to replace components (Fig. 2).

In order to gain a better insight into whether they printers were following the manufacturers instructions or were developing their own approaches, a graded question was asked that focused on the extent to which they followed the equipment manuals recommendations. These were combined arithmetically, the highest score being where the most machines were maintained using that philosophy. Thus, although the printers would suggest they disregarded the makers' instructions, following the recommendations received the highest score. The interesting fact is that there were a number who for some pieces of equipment did more than was suggested in the manual (Fig. 3). It is quite likely feed back from end users could assist the suppliers in developing effective maintenance procedures for all customers. The maintenance system group did more than was recommended by the suppliers.

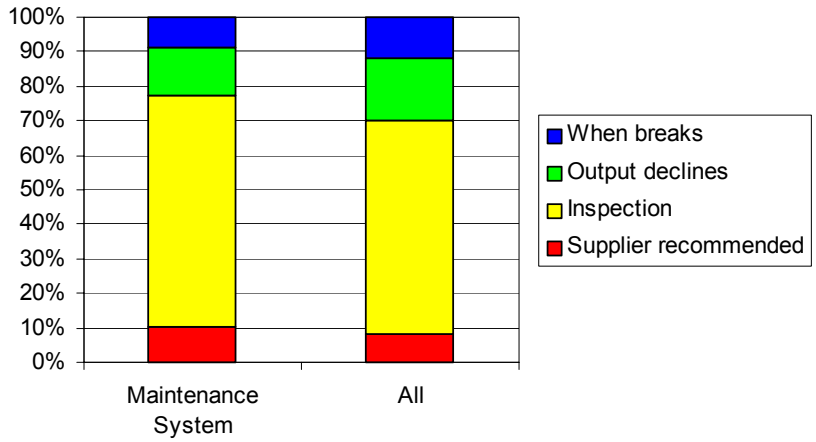

Figure 2 Replacement of components

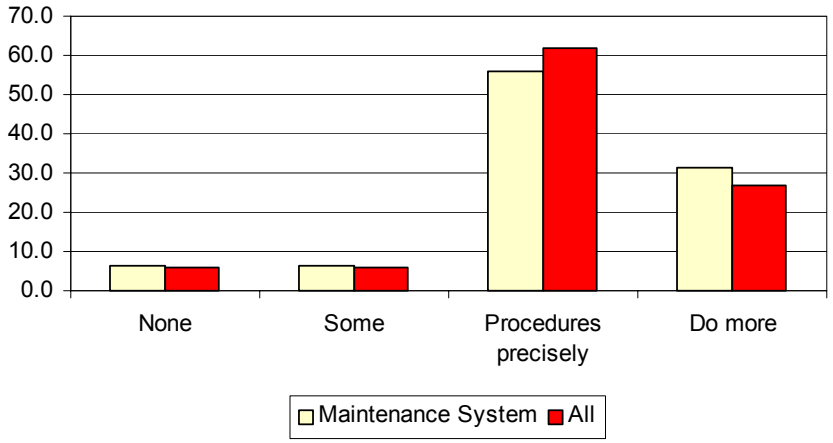

Figure 3 Follow Manufacturers maintenance procedures

Despite views expressed informally that the printing industry was not advanced enough to use condition monitoring, over half of the printers felt that the operators used biological condition monitoring, i.e. looked and listened for changes that indicated the condition of the plant was deteriorating. Even some of the most advanced systems used by the military accept that the operator can frequently provided best early warning of failure, due to the ability to compare multiple inputs simultaneously, something that neural network technology is only barely able to mimic. The overall group tended to believe their operators would notice extremes, while both groups felt their operators would detect

changes, encouraging because they were both vigilant and aware (Fig. 4). In the group with the maintenance programme, their score is highest in these two categories, reflecting that the training and general involvement of the staff is raising their awareness.

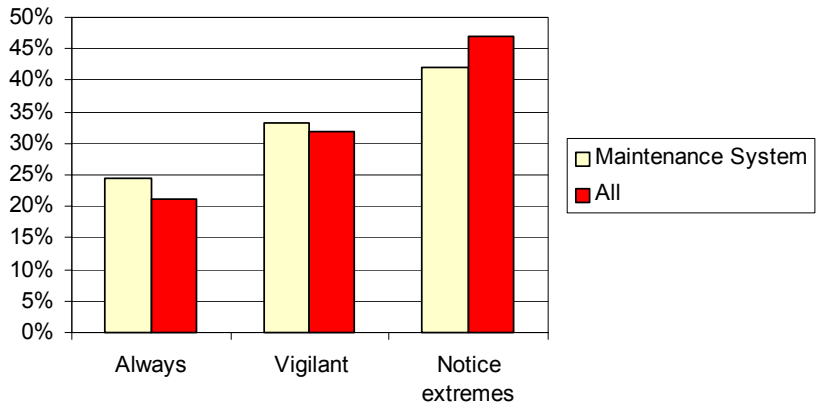

Figure 4 Operator based condition monitoring

A number of the companies had basic condition monitoring of power, temperature and quality. Little use was made of vibration monitoring. While vibration monitoring is well advanced in other industries, this is primarily in situations where the plant is rotating continuously, e.g. in pumps or fans. However, the shock loads that the passage of sheets in sheet fed printing would impose on the plant would generally swamp the more subtle changes that can be detected by changing vibration. While there is different emphasis between the groups of respondents, all did have some form of condition monitoring. Although some information was monitored continuously, the use made of the data provided by these sensors in over 70% of the group without a maintenance system and the overall group was not the prediction of failure, but once failure had occurred to identify the cause (Fig.5). However, the group with a maintenance system tended to check the sensors more frequently and in 70% of the companies use them to monitor performance and predict failure.

The respondents despite their belief that maintenance was critical to improving performance were still experiencing loss of production due to breakdowns. Those with a maintenance system were experiencing less significant stops where over a shift of production was lost due to unplanned stops (Fig. 6). The group with the maintenance programme would appear to be less effective at preventing short stoppages (10 minutes to 3 hours). Although this perhaps reflects better record keeping.

Production occasionally is stopped due to a lack of spare parts. 82% of the respondents occasionally suffered a production stop as a result, while 6% frequently experienced losses of production. All of the respondents occasionally used third party consumables. The group with a maintenance system appeared more confident to use third party products. This reflects a side benefit of the knowledge and confidence generated by the maintenance system.

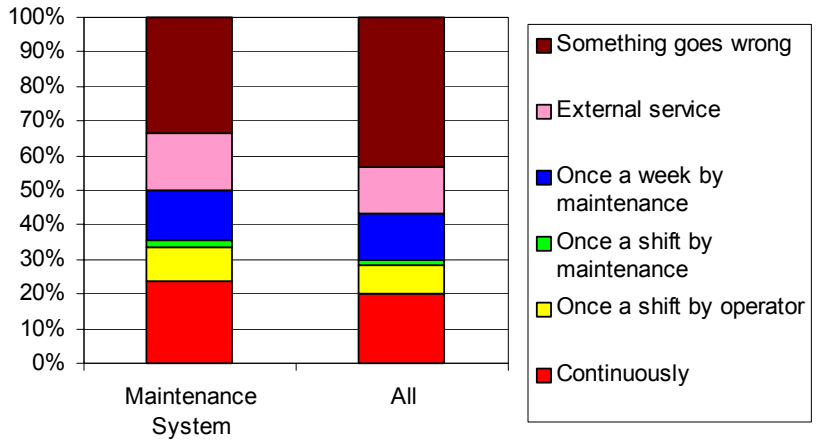

Figure 5 Monitoring Machine Sensors

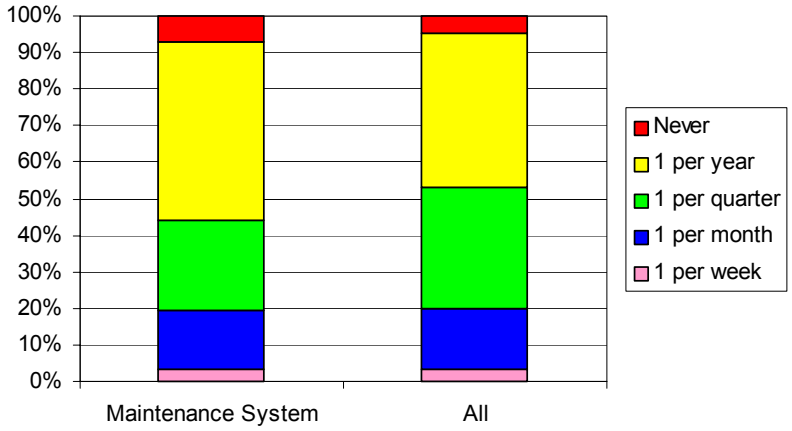

Figure 6. Frequency of Long breakdowns (>1 shift)

In terms of productivity, the majority of both the presses and the finishing equipment were operated at between 40 and 80% of design speed. There is

considerable scope for improving the productivity by increasing the operating speed. In this aspect the group with a maintenance system were tending to operate at higher speeds. These higher speeds may be a benefit of the maintenance system being used or the need to have a maintenance system could be because of the higher speeds these printers are operating at.

In order to get an overall impression of the management aspect a management score was derived as follows. The KPI score related to the number of indicators that the company routinely recorded, the frequency at which they were recorded and the management involvement. This was simply an arithmetic total based on one point per box ticked and a weighted scale for the frequency (Fig. 7). The people power was scored on key questions to judge the extent to which the whole work force is involved in the process. Similarly, the questions on availability, speed and failures were used to produce an indication of economic impact of breakdowns. Those with a maintenance system did better in the "people power" analyses. The implementation of a maintenance programme would require significant operator involvement and this implies a culture of employee involvement.

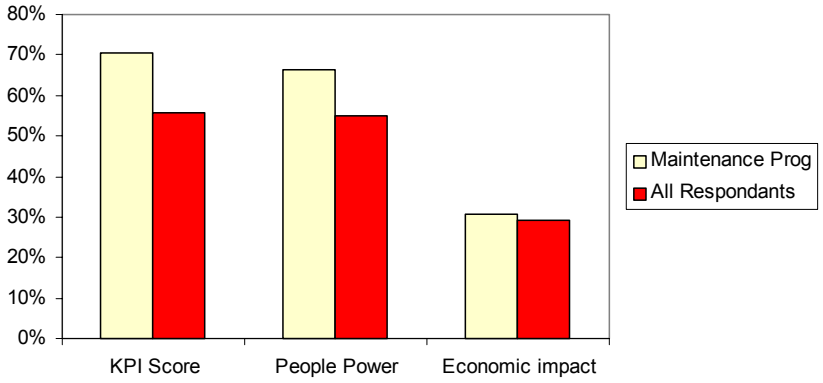

Figure 7 Management Score

The respondents were asked to access using a graded score (Very high to very low) the importance of different aspects of the management system on the successful implementation of a maintenance programme. These are plotted to show the percentage of each response to the questions (Fig. 8). Of most importance is that maintenance should be planned as part of the production process. The need to have standard procedures is highlighted by the importance given to check lists to ensure everything is performed, as well as the need for standard operating procedures per se highlighted in the survey. Although not seen as one of very highest importance for the successful implementation of a maintenance programme, the need to match "tasks to skill levels" when

considered as the sum of those who thought it was either high or very high importance, is second only to the need to "plan it as part of production". Thus, matching skill levels is perceived to be quite critical. Yet earlier in the survey, the respondents stated that there was little maintenance training provide to operators.

Holding stocks of spares was seen to be the least critical. In view of the small amount of time lost through the unavailability of spares, this suggests that most of the printers in the survey had effectively identified the critical spares to keep in stock. It is surprising that such a low score is attributed to the monitoring of KPI's, as these would provide the documentary evidence of the benefit of maintenance and help to identify where opportunities for improvement lay. The KPI's are regularly monitored, at least quarterly, but in most cases monthly or weekly. Only 23% bench mark KPI's. The production manager would normally review these. The head printer would also be involved in this monitoring activity in some of the companies.

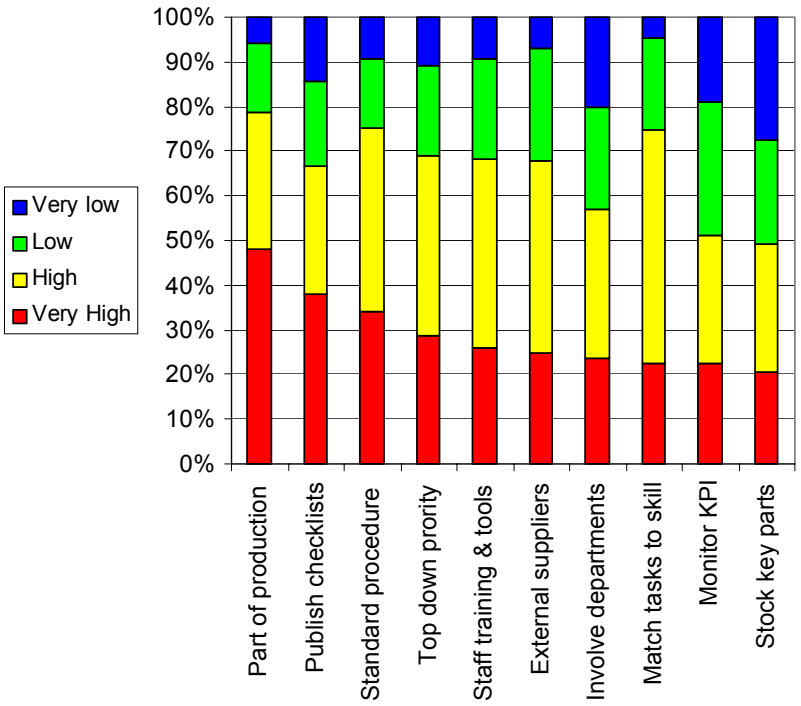

Figure 8 Relative Importance of different aspects of management

Thus, having maintenance as an integrated activity is the most important aspect of a successful maintenance system, with it planned as part of production with

priority from senior management. It also requires a Management System with publish check lists and standard procedures. Finally, Operator Involved Maintenance (OIM) is being developed with staff training, appropriate tools and matching tasks to skill levels.

The majority of the companies evaluated the KPI's that relate to production availability and output. Although the amount of waste produced would effect productivity, this was not as popular measure. When it comes to the maintenance specific KPI's, those that relate directly to chargeable costs, i.e. machine downtime, unplanned stops and costs of consumables where frequently monitored (Fig. 9). This perhaps reflects an ability to reclaim the costs. However, the Mean Time Between failures and the repeat of previous maintenance were not often monitored, whereas these would be critical for improving reliability and availability while reducing maintenance costs. Those companies with a maintenance system monitor their KPI's more frequently.

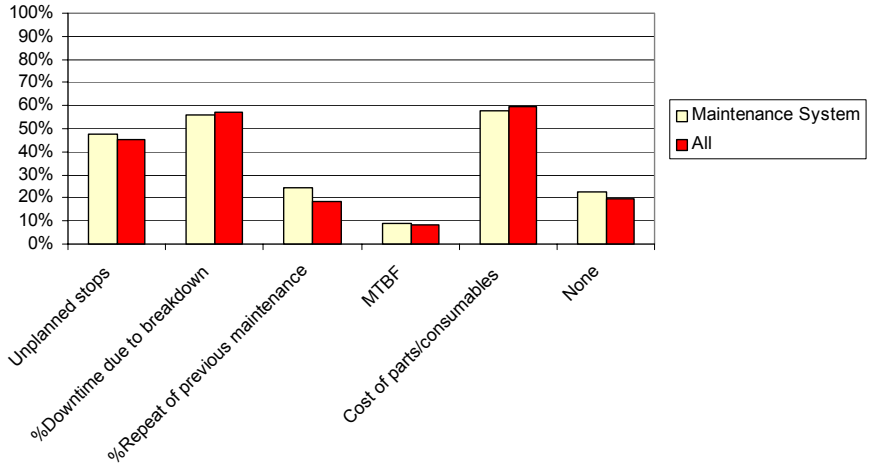

Figure 9. Monitoring of Maintenance KPI's

Discussion

Most UK printers are under performing in maintenance and this is undermining their productivity and competitiveness. The companies surveyed are all proactively implementing maintenance and their businesses are benefiting from the results. The printers responding to the survey are representative of companies that are taking some proactive steps to improve their productivity by improving their maintenance. (There were almost no respondents using only "fix it when it breaks" maintenance). It is highly probable that these proactive

companies do not represent the majority of the industry. This implies that “fix it when it breaks” maintenance is probably the norm. Even these “best case” companies demonstrate a wide variation in the application of maintenance. Only 65% currently have a formal maintenance plan and less than half were satisfied with what they have currently achieved.

The most critical aspect of implementing a maintenance system is the need to integrate it into the production schedule. In the face to face interviews, the need to ensure any maintenance was performed in a timely manner and not delayed by production demands was deemed most important. The companies with a maintenance system tended to have much more operator involvement.

Although this survey is in essence the impression of the line management, it would appear that those who have implemented a maintenance strategy are seeing real benefits. However, the reluctance to measure key performance indicators indicates that there is still plenty of scope for improvement
The survey attracted people who had an interest in maintenance, as 99% thought that effective maintenance improved production. This probably does not reflect the industry as a whole, as those with no interest in maintenance probably did not responded. The general attitude of the company is also typified by the number (54%) who were accredited with ISO9000. Thus, the survey reflects the view of the more enlightened side of the industry. Even though almost all of the respondents thought that it improved production, only 61% had a planned maintenance system. This reflects the hurdles to implementing a maintenance system in small companies, probably due to a lack of resources.

There was little correlation between the size of the company and whether it had any maintenance staff, although all companies with more than 85 staff had dedicated maintenance staff. Small companies who had a dedicated maintenance staff would appear to have a disproportionately high staff effort of maintenance. The survey did not quantify if the effort was part time or whether the maintenance staff also performed other functions. As the companies became larger the proportion of human resource dedicated to maintenance tended towards 5 to 9%. There is quite a wide range as few companies were totally self-reliant and would bring in additional resources, such as suppliers or sub contractors on a needs basis. For those companies with no maintenance staff, 57% had a maintenance system.

There was no correlation between number of shifts and company size or between numbers of shifts and having a maintenance staff. This reflects the diversity of the markets that the companies are serving. Over 40% of the companies in the survey employed no maintenance staff. Nearly 75% employed 5 or less. Thus, to maintain the equipment print companies have a reliance on a few internal specialists and the part time resource of their operators supplemented by sub contract work.

Conclusions

Even the printers in this survey, who probably represent best practise, could further improve their performance in terms of equipment operating speed and availability and thus realise the full economic potential of their investment. This group is starting to implement preventative maintenance and some condition monitoring. However, this implies the rest of the industry is still in the "fix it when it breaks" maintenance regime.

The following main conclusions can be drawn from the survey:

- Maintenance system has to be fully integrated into the production schedule
- Operator involvement is key
- Improved maintenance improves performance
- Companies need to gather the KPI's critical to improving machine availability
- Many companies are implementing strategies without quantifying their impact
- Most companies have both operator and instruments that undertake condition monitoring. However, there is little evidence that this data is used in the prediction of failures.

The majority of companies surveyed had adopted a preventative maintenance strategy. Use was also being made of informal condition monitoring by the operators using their senses, such as hearing, to detect the onset of potentially disastrous changes in the presses and to instigate repair. However, this observation has to be tinged with the comment that with adoption of this strategy, there was a tendency if developing faults were not detected to have to use a fix it when broke approach.

Those companies with a maintenance system tended to run faster and have fewer major breakdowns, although it has to be questioned as to whether they run faster because they have a maintenance system or need a maintenance system because they run faster. The maintenance regime had to be adapted to suite diverse operational demands.

Acknowledgements

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References

Claypole, T.C.
2002 “Implementing Condition Monitoring” TAGA ATC Workshop, San Diego

Wells, N. (Editor)
2002 "Productivity Maintenance - How to run leaner, longer, faster" Web Offset Champion Group Best Practice Guide N° 4, ISBN 2-9518126-1-2.