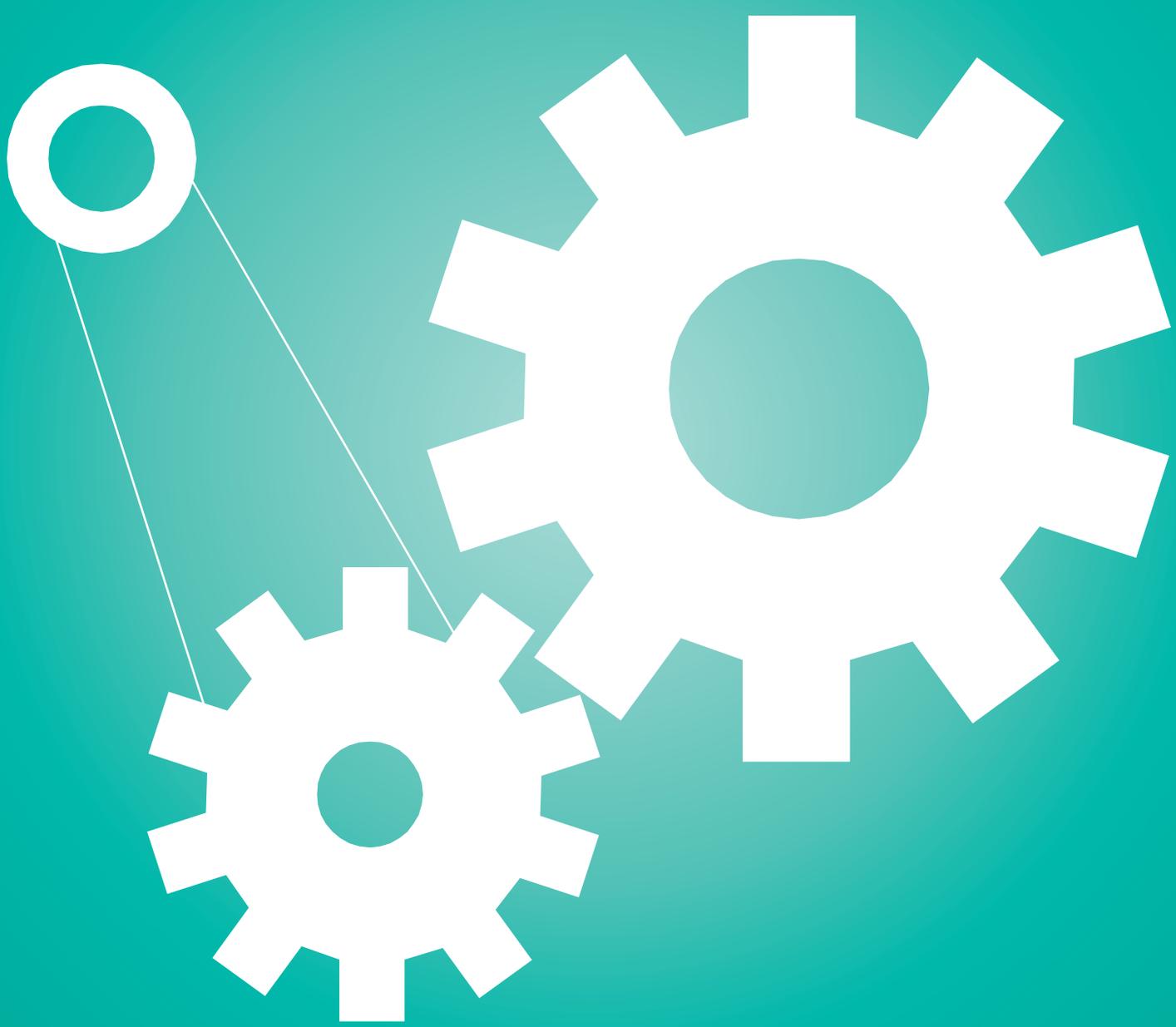
Maintenance

BEST PRACTICE STUDY

Productivity Maintenance in the UK Printing Industry



Final Report
Contains full analysis and data
March 2005

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Department of Trade and Industry

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Productivity Maintenance in the UK Printing Industry

A cross-industry survey from Vision in Print

by Dr. Tim Claypole and Nigel Wells

March, 2005

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Acknowledgements

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Director of studies for BSc and MSc programmes in Printing and Coating Technology, that are delivered by multi-media distance-learning for those in full time employment. Author of over 70 published papers on printing technology. Invited contributor to the Web Offset Champion Group Best Practise Guides "Productivity Maintenance" and "How to get colour approved and maintain it". Relevant manufacturing activities include: Co-supervised PhD research for Trostre Strip Mill on reliability centred maintenance. Dr. Claypole also teaches manufacturing at undergraduate level and has previously taught risk and reliability, maintenance strategies and quality control modules for the "Condition Monitoring" and "Design for Manufacture" MSc programmes at the University of Wales Swansea. Dr Claypole is active in the international printing research organisations TAGA and iarigai.

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Nigel Wells, Managing Director, Virtual Industrial Marketing, Paris, France. Manager, Web Offset Champion Group

Entered the printing industry in 1965 with a five-year apprenticeship in the UK, followed by nearly 20 years in Australia working in printing production, sales, marketing and management positions for sheetfed, heatset and coldset printing companies. In 1988, returned to Europe to work for the Eurografica consultancy company (subsidiary of MAN Roland) in Munich and Madrid. From 1993-1998 he was business development director of MEGTEC Systems based in Paris. In 1998, founded Virtual Industrial Marketing to provide specialised industrial services. This included the creation of the Web Offset Champion Group (international cross-functional best practice group of 10 companies) for whom he is managing editor and has published five best practice guides. Since 2000, he has been a principal consultant to the PrintCity alliance of international printing industry suppliers. Activities include facilitating cross-functional multi-company project groups; editing and publishing technical documents, guides and magazines; strategic and operational marketing. Formal education includes printing techniques in the UK, management in Australia and marketing in Paris (Economiste en Marketing Industriel de CNAM).

www.wocg.info

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Preface: Vision in Print

Vision in Print - The Print Industry Forum

ViP was established in April 2003 and is still part-funded by the DTI as a part of the Government's manufacturing strategy. The Board is made up entirely of executives from companies in all sectors of the UK printing industry, large and small business' plus two senior officials of the print union, the GPMU. The mission is to implement a programme of practical activities to benchmark and improve competitiveness of individual companies and over time raise the performance of the whole industry. There are nearly 20,000 print companies in the UK, across sectors as diverse as newspapers to food packaging.

Vision in Print make no sectoral distinctions and introduce companies to lean manufacturing techniques by applying the Industry Forum 'hands-on' approach. The in-company performance improvement activities are delivered by ViP's highly skilled engineers. These activities usually focus on manufacturing, however customer service, customer added value services, business processes and creating the right team and continuous improvement cultures are all areas tackled with clients. Vision in Print are also conducting a series of Best Practice studies using experience from both Print and other industries; it will publish reports on key topics, the aim being to raise productivity and highlight key issues for the whole industry.

Current Products

Masterclass

Kickstart 1-3-1

Operations Assessment

Manufacturing Diagnostic

Management Awareness Training

Value Stream Mapping

Lean Champion mentoring

Partners

Constructing partnerships was a key task in the first year of operation, with active links forged with all the main trade bodies and research associations serving the printing industry:

British Printing Industries Federation, Print Education &Training Forum, GPMU, EFTA, SPEF, SPA, BAPC, PICON, IOP (now called IP3), Pira

More information about ViP can be found on the website www.britishprint.com

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VISION IN PRINT
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Foreword — The cross-industry maintenance challenge

Overview

Cost effective maintenance is a key success factor for all manufacturing businesses. However, it is often perceived as a hidden cost and not as a productivity benefit with an important business impact. The result is that many printers still have a reactive approach responding to breakdowns as they occur whilst at the other extreme some printing companies are using Total Productive Maintenance (TPM) to optimise equipment performance from integrating management, workforce and suppliers. However, getting to that level of sophistication is not easy and dangling the immediate goal of TPM to many printers may cause more problems than it solves.

To help address this range of needs, Vision in Print have initiated an industry-wide maintenance best practice project to define a series of proactive steps that all printers, regardless of size or sector, can take to improve their maintenance processes to lift their productivity and competitiveness. Another goal is to identify how suppliers can help printing companies improve their performance. Effective maintenance is a cross-industry challenge that requires suppliers, printers and specialists to identify and implement a pragmatic range of solutions.

Objectives

- Assess the current effectiveness of print companies maintenance practices.
- Raise the awareness of good maintenance practice within the print sector.
- Identify generic, practical principles relevant to all print companies that help improve maintenance practices across the sector over time.
- Demonstrate what makes effective planned maintenance programmes in print and understand how equipment performance can be optimised through more effective maintenance.
- Identify opportunities from using technologies to help predict equipment failure.
- Demonstrate through case studies both the practical and financial case for better practice.
- Communicate best practice to both printers and suppliers

The research project was conducted by Dr. Tim C. Claypole, director of Swansea Printing Technology Ltd. and director of Welsh Centre for Printing and Coating in the School of Engineering, University of Wales Swansea. He is a specialist in risk, reliability, quality and maintenance strategies. The other principal consultant is Nigel Wells, manager of the cross-industry Web Offset Champion Group who recently published the best practice guide *"Productivity Maintenance — how to run longer, leaner and faster".* The Group was formed in 1998 to 'champion' generic best practice in the web offset printing industry as a tool to improve productivity, quality and safety. Its members include Aylesford Newsprint, Kodak Polychrome Graphics, MacDermid Printing Solutions, MAN Roland, MEGTEC Systems, Müller Martini, Nitto-Permacel, QuadTech, SCA, Sun Chemical — www.wocg.info. Extracts from this guide are reproduced with the kind permission of the Group (all rights reserved).

Andreas Schillinger

Managing Director, Müller Martini UK

& Chairman of ViP Maintenance Study Steering Group

Richard Gray

Chief Executive, Vision in Print

Companies participating in the survey

VIP would like to express their strong appreciation to the companies and their staff who participated in the survey.

*Denotes companies who also shared their time and expertise at on site interviews with the researchers.

Company	Contact	Location	Sector
Abbey Press Ltd*	Ann Owen	Abingdon	commercial
Acorn Press Swindon Ltd*	Shaun Starkey	Swindon	commercial
Acorn Web Offset	Robert Fletcher	Wakefield	commercial
ADS Worldwide Ltd	Anne Lasckey	Hull	packaging
Alden Press*	Ken Webb	Oxford	publications
Amberley Labels	Steve Oliver	Blandford	packaging
AQA	Bridget Walford	Guildford	publications
Arvin Meritor*	Ian Fox	Pontypool	auto brakes
Avalon Print Ltd*	Tim Vernon	Northampton	commercial
BemroseBooth	Steven Moverlay-Brown	Derby	other
Biddles Ltd	Bruno Lavorgna	Kings Lynn	publications
Blackmore Ltd	Nigel Hunt	Shaftesbury	commercial
Boxstar Taylowe	Lee Dalby	Maidenhead	packaging
BP Labels*	Keith Postle	Cardiff	packaging
Brands*	Mark Worthington	Salford	packaging
BSC Print	Roger Severn	Wimbledon	commercial
Cambrian Printers Ltd*	Roger Carroll	Aberystwyth	publications
Caradon District Council	Andy Matthews	Liskeard	other
Celloglas	Graeme Rose	Leicester	other
Chevler Packaging Ltd	Mr Joe Kaplicz	Princes Risborough	packaging
CIT Brace Harvatt Creative Print*	Steve Astins	Haverfordwest	commercial
Communisis Gateshead	Ray Wilkinson	Gateshead	packaging
Cooper Clegg	Craig McBurnie	Tewkesbury	commercial
Copyprint UK Ltd	John Perrott	Vauxhall	commercial
Denny Bros ltd	Colin Hunt	Bury St. Edmunds	packaging
Eclipse Colour Print Ltd	Paul Winfield	Kettering	commercial
Emballator*	Martin Fairburn	Bradford	packaging
Friary Press	Terry hawkins	Dorchester	commercial
Galloways Printers Ltd	D Robson	Poynton	commercial
Garnett Dickinson Print Ltd	Geoff Gramlick	Rotherham	publications
Haven Print*	Andrew Forrest	Pembroke Dock	commercial
Hawthornes	Mike Marriott	Basford	commercial
Headley Brothers Ltd	Tony Smith	Ashford	publications
Hendi Systems Ltd	Peter Hamill	London	publications
Howard Hunt City Ltd	David Fleck	Dartford	commercial
Howitt Ltd	Ian Bower	Sutton in Ashfield	commercial
Impress Print Services Ltd	Michael Kille	London	commercial
Irvin GQ*	Ian Cameron	Bridgend	parachutes
J. W. Northend Ltd.	Roger Oldfield	Sheffield	commercial
Joseph Ward Colour Print Ltd	Garry Brattan	Dewsbury	commercial
Kappa Packaging*	Andy Marshall	Yate	packaging
Label Apeel Ltd.	Stuart Kellock	Leicester	packaging
LinneyPrint	Steve Straw	Mansfield	commercial

Company	Contact	Location	Sector
Louis Drapkin*	John Hartley	Birmingham	commercial
Mackay and Inglis Limited	Brian Inglis	Glasgow	commercial
Masons Print Group	Dan Jones	Saltney	commercial
MGP Chromocraft Ltd	David Burgess	Maidenhead	commercial
Mirror Colour Print (Oldham) Ltd	Brian Isley	Oldham	other
Modern Packaging	Bernard Woods	GL51 8PL	packaging
Multisets Limited	Steve Lee	Swindon	commercial
New Jarrold Printing	Paul Allard	Norwich	publications
News International Newspapers	John Rafferty	Prescot	publications
Newwnorth Print Ltd	Garry Hardy	Bedford	commercial
Ormerods ltd*	J. Ormerod	Rochdale	packaging
Parallel	Ian Bushby	Guernsey	commercial
Park Communications Ltd	Michael Cassidy	London	commercial
Parkside International	R.Day	Normanton	packaging
Pensord	Mick Charlton	NP12 2YA	publications
Pindar	Ken Johns	Scarborough	
Polestar	Bob McLellan	MK14 6DY	publications
Polestar Chromoworks	Peter Greaves	Nottingham	commercial
Polestar Colchester	Gary Morton	Colchester	publications
Polestar Colchester	David Loughlin	Colchester	commercial
Polestar Greaves	Phil Stott	Scarborough	commercial
Polestar Taylowe LTD	Andy Lewis	Maidenhead	packaging
Polestar Varnicoat	Chris Hunt	Pershore	publications
Polestar Varnicoat*	Mike Eccleston	Pershore	publications
Pragmatique ltd	Barry Watson	EH19 3BX	commercial
Printdirect	Kurt Boulter	Southport	commercial
Printpack*	Adrian Rowbottom	Rochdale	Packaging
Quebecor	Nick Cahm	NN18 9EX	commercial
RCS Plc	Tim Bradburn	Retford	commercial
RR Donnelley UK	Colin Fletcher	Knaresborough	publications
Sherwood press	Colin Edis	NG8 4GP	other
Simpson Label Company	Iain Anderson	Midlothian	packaging
Simpson Group	Mr W McNally	Washington	
Skymark Packaging Ltd	Barry Dalton	Leominster	packaging
Staedtler UK	Mike Williams	Talbot Green	pens
St Ives (Roche) Ltd*	Bill Kent	St Austell	publications
Stralfors	Paul Tuckfield	Redruth	commercial
Streamline Press	Alan Squire	le4 1aa	commercial
T.J International Ltd*	Michael Wickett	Padstow	commercial
Thanet Press	Doug Gray	Margate	commercial
The Production Company	Richard Green	Sheffield	commercial
TL Visuals Ltd	Rod Tibbert	Yate	commercial
Urbis Lighting*	David Hurst	Basingstoke	street lighting
Vertis DMS	Graham Smith	Leicester	commercial
W G BAIRD	Diarmuid McGarry	Antrim	commercial
Walkers*	Dave Marshall	Manchester	pos
Waterstons (Security Printers) Ltd	Jim Gulland	Newbridge	commercial
Wirralco	Mr. D Graham	Wirral	commercial
Wm Sinclair & Sons (Stationers) Ltd	David Hainsworth	Otley	other

Bibliography

"Optimising Productivity in Newspaper Press Lines", IFRA Special Report 3.33, Ulf Lindquist, VTT for IFRA, Darmstadt, Germany, 2001.

"Productivity Maintenance — how to run leaner, longer, faster", The Web Offset Champion Group, Nigel Wells, Paris 2002. Extracts from this guide are reproduced with the kind permission of the Group (all rights reserved).

"Total Production Maintenance, A guide for the printing industry", second edition, Kenneth E. Rizzo, GATF Press, Pittsburg, 2001.

Glossary

Breakdown, Sporadic: Infrequent, sudden and unexpected failures

Breakdown, Chronic: Frequent small failures and stops

CBM: Condition Based Maintenance

CMMS: Computer Managed Maintenance Systems

KPI: Key Performance Indicators

LCA: Lifecycle Cost Analysis

MBP: Maintenance Best Practice

ME: Manufacturing Effectiveness

MIS: Management Information System

MTBF: Mean Time Between Failures

MTF: Mean Time to Failure

MTR: Mean Time to Repair

OIM: Operator Involved Maintenance

PCU: Programmable Control Unit (central equipment control)

PM — Preventive Maintenance: Tasks to minimise breakdowns

PM — Predictive Maintenance: Monitor equipment condition to predict maintenance

PM — Productivity Maintenance: Maintenance to maximise productivity

PPM: Planned Preventative Maintenance

Productivity: Amount of production (time, copies, value, etc.) compared to input to produce it

OEE: Overall Equipment Effectiveness

RCA: Root Cause Analysis to identify cause(s) of failure

RCM: Reliability Centred Maintenance

Spare parts
Proprietary parts: Manufactured only by the OEM equipment supplier.
SIC (Standard Industrial Components): Electric motors, belts, electrical boards, PLCs, etc.
Re-manufactured parts: Component that is repaired rather than replaced.

SMP: Standard Maintenance Procedures

SOP: Standard Operating Procedures

TPM: Total Productive Maintenance

TQM: Total Quality Maintenance

Executive summary

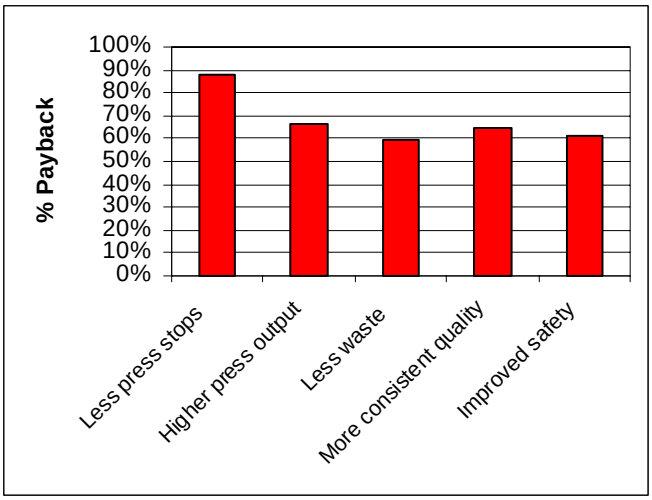
Overview

Good maintenance practice is one of the keys to increasing productivity and profits — there is a clear relationship between productivity, reliability and maintenance.

- The companies surveyed for this report are almost certainly the most proactive part of the UK printing industry in relation to maintenance.
- These companies all report business benefits resulting from improved maintenance.
- However, these “best case” companies demonstrate a wide variation — only 65% have a formal maintenance plan and less than half are satisfied with what they have currently achieved.
- Those companies with a maintenance plan consistently outperform other companies.
- This implies that most of the UK printing industry is under performing in maintenance which is therefore undermining their productivity and competitiveness.

Business benefits

The primary dividends from effective maintenance are reduced total operating costs, on-time delivery and consistent product quality. In addition, it preserves expensive equipment assets and reduces lifetime operating costs by minimising wear and replacement of parts. Good maintenance is also environmentally friendly (reduced energy, waste, cleaning materials, noise) and facilitates health and safety compliance.



The surveyed printers with proactive maintenance systems report significant performance improvements. Those companies with a maintenance plan have a higher performance in all areas compared to those companies without a formal plan — 90% found that it reduced their press down time and 60% found they produced less waste.

(see also pages 17 and 20)

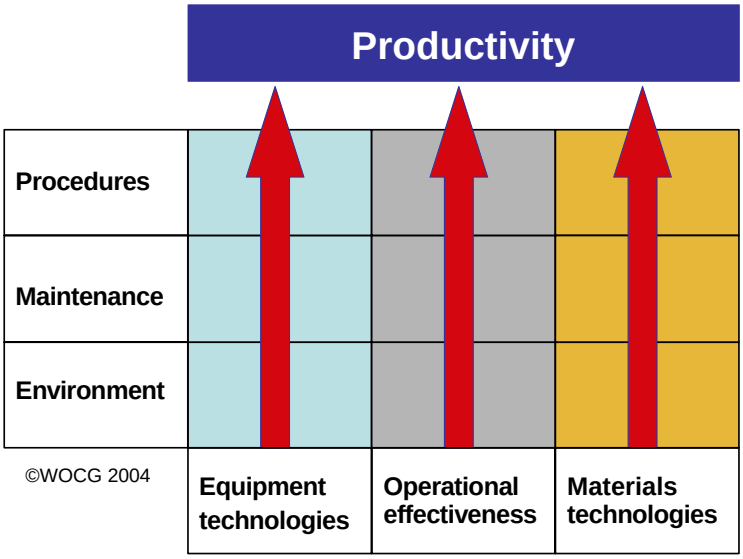
However, many printers continue to operate “fix it when it breaks” because “maintenance is an additional cost” or “I need proof that it pays” or “it’s not a priority”. This is nonsense, as the evidence of this, and other research, shows that good maintenance contributes tangible business results. Perhaps the unconvinced should analyse how much money they are losing by not maintaining their production systems adequately — including total costs, unsatisfied customers, lost business and opportunity costs? At the other extreme, Total Productivity Maintenance (TPM) is a complete but complex manufacturing strategy that only a few larger printing companies are in a position to implement because it requires a fundamental change in operating culture. There is also some negative perception of TPM because some see it as a management fad promoted by zealots as a panacea for all ills.

Achieving a minimum maintenance level is 80% common sense, combined with discipline and standard procedures — this is within the reach of all companies, irrespective of size, if they are prepared to make a small effort.

Productivity Maintenance

Maintenance by itself will be ineffective unless it is fully integrated into a company's manufacturing strategy. Productivity Maintenance is maintenance to maximise productivity.

Therefore, in this report we use "Productivity Maintenance" as a key component of a manufacturing strategy to optimise productivity. This approach was developed by the Web Offset Champion Group (WOCG) as part of their international maintenance best practice project (*"Productivity Maintenance — how to run longer, leaner and faster")*. Their research findings are extremely close to those of this VIP report.



Manufacturing efficiency is largely determined by how effectively the three pillars of productivity work together. Each pillar— Equipment and Materials Technologies linked by Operational Effectiveness — includes elements of Standard Procedures, Maintenance and Environmental issues. Poor performance in any one, for example maintenance, will negatively impact overall performance.

(see also pages 29-31)

Maintenance — a cost or an investment?

Effective maintenance should begin with some fundamental financial management questions: Is maintenance regarded as a "necessary evil" or as an investment to increase productivity and reduce total operating costs? Are malfunctions only accounted for as direct repair costs, or is their total loss calculated (repairs, plus the costs of lost production, increased materials consumption and consequential costs such as overtime)? Progressive industrial companies incorporate maintenance as a total production cost variable and include downtime and consequential costs in their calculations. This financial management approach can provide substantial opportunities to reduce costs and increase profitability. A further benefit is that more saleable production capacity becomes available that can be converted into either increased sales or reduced capital investment — fewer machines to achieve the same

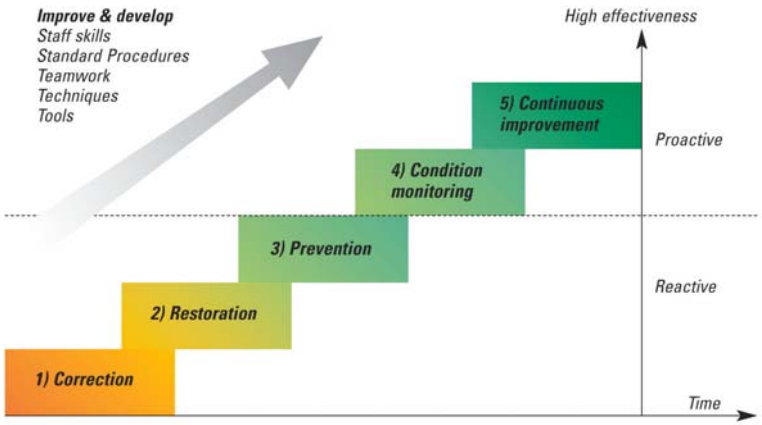
The payback from a successful proactive maintenance strategy is improved productivity. Experience of implementing systematic programmes is that they need about three years to become fully established as part of a company's operating culture. Some users report improvements of over 20% longer running time between press stops, around 25 % higher net average printing speed and up to 50% reduction in waste.

Measure it to move it

It is not possible to reliably assess manufacturing or maintenance efficiency to identify where improvement action is needed unless appropriate and consistent KPI data is available. The majority of printers surveyed do not measure enough of the right data. For example, the cumulative effect of multiple chronic short production stoppages is significant, but are they all recorded and classed correctly? eg. if a press is stopped to re-set the inking rollers or repack a blanket — normally routine operator maintenance — then this is an unscheduled stop due to lack of preventive maintenance. See also page 33

Evolving maintenance techniques (see also page 28)

Maintenance techniques have changed over time from breakdown to preventive to predictive and pro-active. New maintenance technologies allow low cost condition monitoring and remote-site assistance.

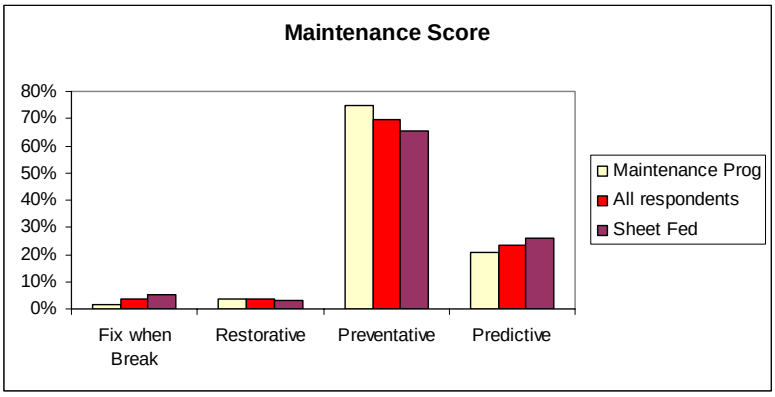


The Maintenance Staircase

Maintenance is a series of progressive organised steps over time to improve operational effectiveness. The key step is the transition to proactive working. Source WOCG.

(see also page 34)

The survey shows that as companies improve their maintenance they shift from only "fix when broken" to restorative, planned preventative and condition monitoring (see page 38). Companies with a distribution across all categories have the more enlightened maintenance approach. Note it is not necessarily wrong to use the "fix it when broken" approach for some processes (see page 23).



The three groups in the survey all show strong emphasis on preventative maintenance, with a developing strand of condition monitoring. Very few of the companies rely on "fix it when it breaks" approach.

The application of maintenance needs to be adapted to the age and technology of equipment, operating hours, type of work and company organisation. Printing plants have highly variable operating conditions and "one size does not fit all" — the same machine in different plants will frequently have different service, cleaning and maintenance needs.

Operator involved maintenance (OIM)

Operators know their machines better than anyone else. OIM is a standard industrial approach used by many of the printers surveyed. Operators are their primary maintenance prevention resource. Successful implementation requires a series of steps over time, encouraging "ownership" of the machine, delegation of responsibility, recognition and teamwork with maintenance and scheduling staff. Their responsibilities include: regular cleaning, inspection, lubrication; monitoring; understanding and application of standard maintenance and operating procedures. Training is essential for success. See also page 41.

New technologies

New equipment technologies have reduced maintenance in some areas (automatic lubrication, self-cleaning sensors, roller and blanket wash-up devices). However, a pre-condition to deliver efficient results from CIP3 press pre-setting systems is that the inking and dampening systems are regularly and rigorously maintained.

Some smaller printers have replaced multiple machines with a single new high productivity machine that often runs 24 hours a day to maximise ROI. However, a consequence is that if there is a breakdown there is no production backup — making prevention of unscheduled downtime vitally important.

A lot of useful service information is available from equipment PCU central control systems. However, this report finds that the potential benefit of using the condition monitoring functions of these systems is under exploited — despite their availability since the early 1990s. Remote equipment monitoring by the suppliers has been available for web offset since the early 1990s and is now becoming available for sheet-fed. These offer significant opportunities to provide remote services particularly using Internet connections, rather than the high cost dedicated ISDN lines previously required. Other low cost communication technologies are increasingly being used. The Internet and digital cameras offer significant potential to improve speed and quality of response to predict, diagnose and fix problems; to identify and order parts over the Internet 24 hours/7 days a week. Computer analysis can help identify maintenance priorities, costs and benefits. Digital diagnostic tools allow effective low cost condition monitoring to avoid unplanned downtime.

Spares (see also pages 54-55)

Printers prefer to minimise the amount of money tied-up in spare parts. The minimum inventory for each machine depends on availability of back-up equipment, customer sensitivity to late job delivery and the time for urgent spares to arrive. Most companies hold a minimum level of parts that are required regularly. This inventory should be labelled and binned with systematic re-ordering to maintain stock level. Some printers have arranged to stock parts on consignment, taking responsibility to store them, and if required, send them to another printer at the supplier's request. Printers are sensitive to the prices of replacement parts, in some cases their concerns may be justified, whilst in others this is not the case. Over 85% of respondents purchase parts from third party suppliers as well as the OEM supplier. This is related to the two types of spare parts on all equipment — proprietary and standard industrial components.

Proprietary parts: Manufactured only by the OEM equipment supplier who is usually the sole source of supply. Purchase prices of these parts tend to be high because most machines have a large number of different parts with high capital and storage costs over a long period of time with a low stock turnover.

Standard Industrial Components (SIC) — electric motors, belts, electrical boards, PLCs, etc
Replacement parts can be sourced either from the OEM equipment supplier or directly from the SIC manufacturer (generally large international companies with local outlets). Many printers purchase directly from SIC suppliers for cost and delivery time reasons. However, there is a risk that non-equivalent components may cause unpredictable problems and jeopardise warranty. Not all products with the same reference number are in fact identical. Some risk analysis is needed to decide which components to purchase directly — for example, substitution of bearings would have a very high risk. Direct SIC purchase is recognised by some OEMs who provide customers with easy to access reference lists; some are lowering their prices; whilst others do not facilitate this process which frustrates their customers.

Re-manufactured parts: Some OEM equipment suppliers prefer to replace rather than re-manufacture parts. Alternative sources are available, for example, to rebuild a circuit board for around £50 instead of purchasing a new one for £500; rewinding motors is another. There is a trade-off to establish between reliability, time and cost. In the UK there are many small mechanical engineering shops with skilled staff that remanufacture some original parts for a competitive cost and in some cases improve their specification. It should be noted that the experience of many equipment suppliers is that when they offer higher specification long-life components as an option, very few printers are prepared to pay for them. Manufacturers could benefit from some customer innovations and should consider how to encourage communication and rewards (and also to avoid unrealistic and dangerous modifications).

Service contracts from equipment suppliers

Most prepress and digital printing equipment is covered by maintenance contracts, but few printers take up service contracts for press and post-press equipment. There appears to be several explanations:

- Prepress and digital machines are seen to be “technology black holes” where printers do not feel confident to intervene — unlike “heavy metal” press and post-press where there is a wider availability of internal expertise plus external service providers. This continues in spite of more and more electronic components being incorporated into the “heavy metal”.
- OEM service contracts are perceived to be too expensive. This may be due to a lack of communication (or understanding) of total cost of ownership, of which maintenance is an integral part to optimise productivity — rather than just an added cost.
- Service contracts may not be fully adapted to the needs of different printing companies.
- Under utilisation of new technologies, e.g. remote condition monitoring and Internet services.

Major suppliers are continuing to make efforts to improve the attractiveness of their service offers and may need to address these issues more proactively with their customers. A small number of printers are using OEM press and post-press maintenance contracts and report business benefits from them.

Consumable suppliers

Some consumables suppliers are bundling sales of their products with a range of services. One example is an ink supplier who can provide colour matching, ordering, stock keeping, environmental services and maintenance assistance as part of a supply contract. Staff from the ink supplier provides different functions for the printer — as almost “virtual employees” — through a combination of planned site presence, call-out and remote assistance over the Internet.

This business model offers significant potential for both printers and suppliers to improve their productivity and business performance. In this case, a single source of responsibility for inking, dampening and cleaning products and their efficient use — particularly important in offset that is a chemically intense process. Other application areas for this approach includes: rollers and blankets; prepress processing; colour management. Successful implementation requires the printer and supplier to establish an effective partnership that recognises the mutual responsibilities and challenges of this approach.

The consultants observe that many cleaning agents used in maintenance lack clear and practical selection and use information. What product for what task? How to use it effectively and economically? Printers should not hesitate to insist on more practical communication for these products.

‘We’ rather than ‘Them’ and ‘Us’

Good partner relations between printers and their suppliers was cited by many respondents as a valuable resource to improve their businesses. However, as a generalisation, there appears to be a gulf between many printers and their suppliers. Suppliers are often seen to provide expensive products, parts and service. This is partly due to their business constraints that require making available highly skilled staff at all times in all places and maintaining comprehensive spares inventory; many suppliers also provide technical help services at little or no cost. These operations carry high running costs and overheads that are not borne by small local service suppliers. Some suppliers are perceived to be arrogant in their relation to customers. This is not helped by some printers who try to transfer more than a fair share of problem responsibility (and financial claims) to their suppliers of equipment and consumables.

There are no magic solutions

The payback from a successful maintenance strategy is improved manufacturing productivity that provides a competitive advantage. However, experience and research shows that there are no single, simple magic solutions. An effective programme will need about three years to become fully established as part of a company’s operating culture although benefits should begin to flow within months of implementation.

Developing a strategy (see also pages 34-37)

The difference between better and poorer performing companies is that the best “do it”. It is no good having good plans and strategies unless they are put into operation. Strategy objectives should be results oriented with a “product” (improved equipment reliability, productivity and assets preservation) delivered through maintenance services in co-operation with production. The desired results should be defined along with measurements of target improvement e.g.:

• Maximise production capacity and quality consistency.

• Minimum scheduled downtime and no unscheduled downtime.

• Minimise total production costs, materials waste and accidents.

• Optimise maintenance costs.

A basic strategy should begin with an audit to define current plant status and identify the factors that limit performance. Prioritise the key performance gaps to be reduced over a time period.

Key success factors to improve maintenance (see also page 37)

1. Clear strategy with a senior management champion to improve manufacturing performance.

2. Staff motivation, supervision and training is an absolute requirement to optimise performance.

3. Plan maintenance time as part of production scheduling and respect times, priorities and procedures.

4. Monitor and analyse Key Performance Indicators (KPIs). These are currently an under used tool.

Implement actions one step at a time — only when success has been established with one should the next step be taken.

People

Management, motivation, training and selection of people are the single highest success factor. Changing staff attitudes and behaviour is important to promote team spirit, stable staff and equipment “ownership”. Many of the companies interviewed for this report are attempting to get the most from their staff because everyone benefits. In the last 20 years there have been over 100 studies demonstrating that companies with long-term success are those that optimise employee involvement — some studies identify up to 30% higher productivity, less absenteeism, fewer accidents etc. Investment in people is the primary criteria for success and not just in maintenance.

Training

The research shows that there is no difference between skill levels of printers operating with or without a maintenance programme. However, those with a programme systematically place staff training as a higher key success factor.

Effective maintenance requires appropriate training. Current solutions appear to be fragmented between employers, suppliers and training institutions. There is a cross-industry need and opportunity for:

- Pragmatic workshops for managers and production supervisors, to improve their interest, understanding and knowledge of Productivity Maintenance.
- Practical and cost-effective operator maintenance programme using remote learning and local workshops to provide the understanding and basic skills required.

Summary of maintenance survey findings

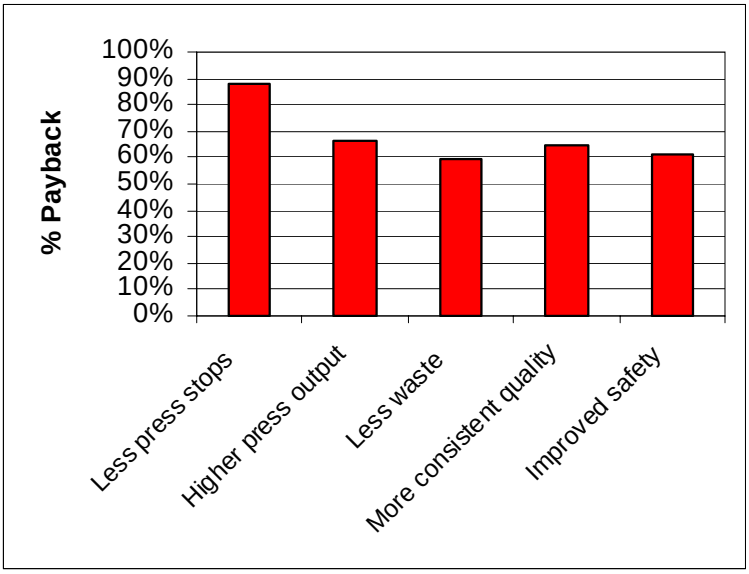
This study used a comprehensive on-line Internet survey combined with selected follow-up visits to obtain an overview of printers with proactive maintenance policies. It was completed by almost 100 companies. Half of the companies are small printers with less than 50 employees who mostly operate sheet-fed and the balance broadly represent the industry spectrum. About half of the companies have maintenance staff.

The survey attracted managers who have an interest in maintenance because they all stated that effective maintenance improves production. This probably does not reflect the industry as a whole, as those with no interest in maintenance probably did not respond; therefore, the survey reflects the views of the more enlightened side of the industry. See page 43 for full analysis of questionnaires.

The high number of respondents has allowed separate analysis to be made for (a) sheet-fed printers and (b) those who have a maintenance system. In general, the results of the sheet-fed group reflect the tendency for them to be smaller companies. The companies who have a maintenance system were evenly divided across all sizes of companies and all processes. Companies with a maintenance system do better than other printers, running faster with fewer breakdowns and higher returns.

Does maintenance pay?

Yes — according to the companies that replied they have seen productivity improvements from fewer unscheduled press stops, better quality, higher throughput and more consistency. All companies believe that maintenance provides business benefits but only 65% currently have a formal maintenance plan and less than half were satisfied with what they have currently achieved. Of those with a maintenance plan, 90% found that it reduced their press down time and 60% found they produced less waste.

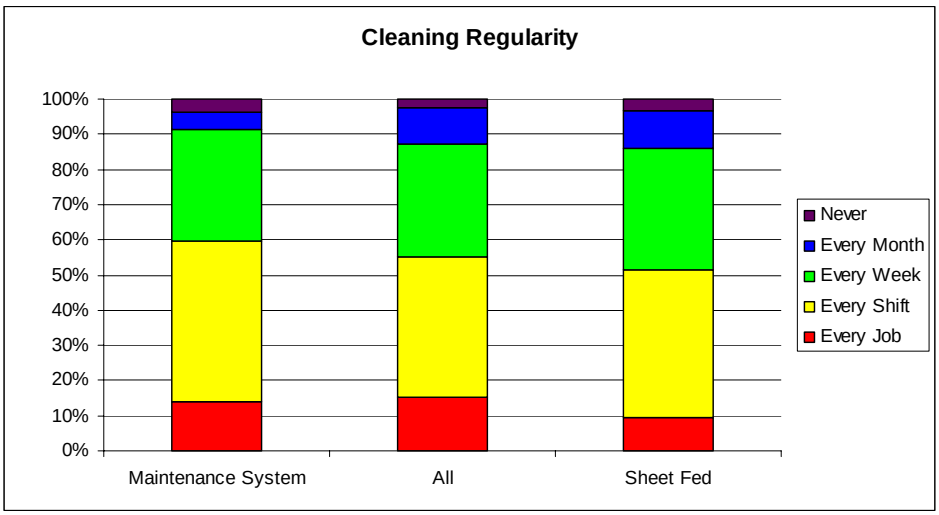


The current maintenance status in participating companies shows that most are actively using preventative planned maintenance and some are beginning informal predictive maintenance. Few now rely on a “fix it when it breaks” approach.

Breakdowns still remain an issue with over 50% experiencing regular short production stoppages (10 minutes to 3 hours) every week and 15% every day. However, an extended loss of production time taking more than a shift is relatively rare.

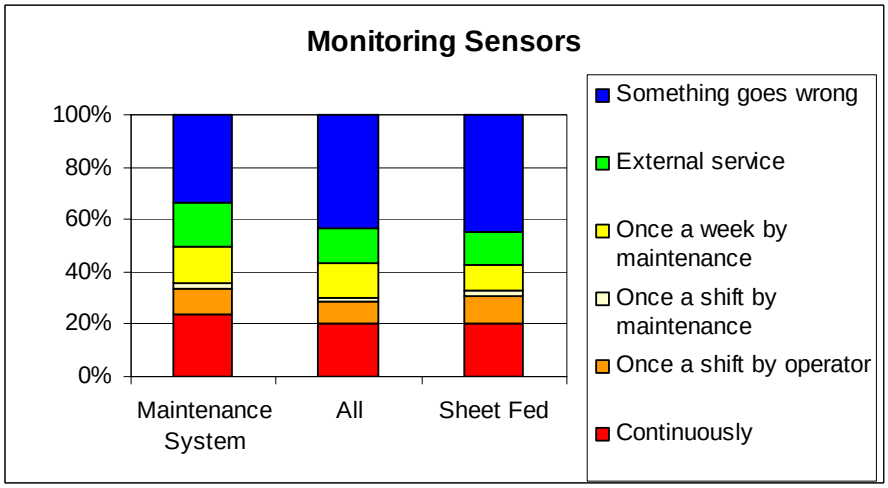
Cleanliness is a sign of good maintenance

There is a strong correlation between the quality of housekeeping and the quality of maintenance. Cleaning is made by operators daily or weekly by over 75% of respondents and lubrication made weekly or monthly. Again, companies with a maintenance system clean more frequently. Most companies have standard operating procedures for maintenance and keep a logbook for their major pieces of equipment.



Condition monitoring

A surprising number of printers have equipment with sensors that could be used for condition monitoring but are often only used for fault-finding after a breakdown had occurred — this is an area for improvement. Again, companies with a maintenance system make the best use of PCU systems for regular monitoring. Over half of the respondents have operators who use their senses (sight, smell, touch) for condition monitoring to identify potential failures early to help “fix it before it breaks”. (see also pages 38)



Implementation of maintenance

Even though many small printers believe in planned maintenance many have difficulty in satisfactorily implementing it. The main barriers are production pressures and lack of understanding of maintenance management and techniques. This is an area that requires training assistance.

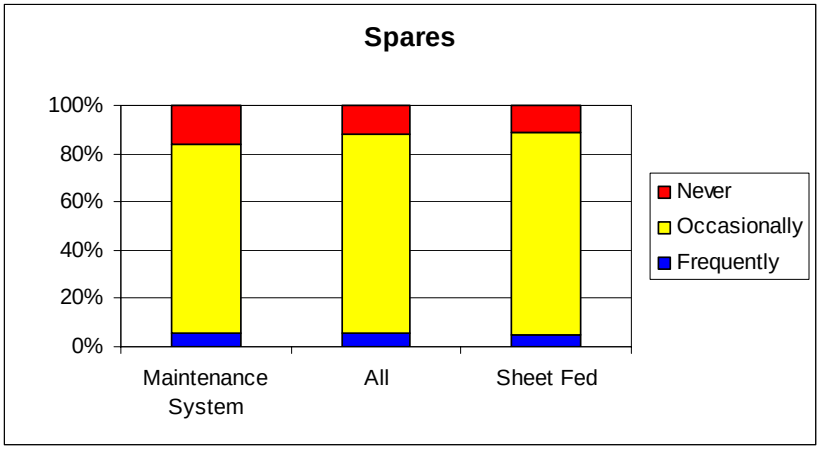
While many printers have Key Performance Indicators (of production data), the focus on its use appears to be more on the measurement of the cost of parts for use in litigation, rather than to improving manufacturing performance. This is an area for improvement. (see also pages 62-64).

Spare parts

The majority of companies have planned maintenance programmes for their major equipment. However, very few replace components at the intervals recommended by the manufacturer. This suggests both the frugal attitude of the printers and also implies the manufacturers recommended intervals are different to what is found in practice.

Stocking key parts is the least important aspect of a successful maintenance strategy. Those companies with a maintenance system experience the least stops due to a lack of spares and almost 20% never experience a delay because of a lack of spares. In view of the small amount of time lost through the unavailability of spares, this suggests that most printers in the survey had effectively identified critical spares to keep in stock.

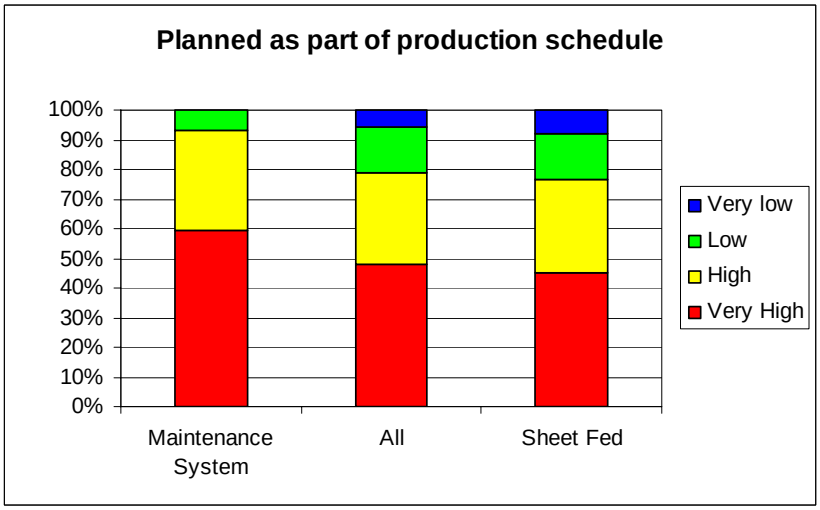
Most companies (85%) purchase from third party suppliers as well as from the OEM supplier. Only 15% never use third party consumables, while 26% frequently use them — 97% ensure their compatibility before use most of the time, 77% all of the time.



Parts from third party suppliers are purchased by most printers

How to achieve good maintenance?

Responding companies prioritise the most important factors to improve performance is to plan maintenance as an integral part of production; use checklists and standard operating procedures to facilitate maintenance and productivity; operator training is highly essential and the results indicate that the basic cleaning, lubricating and monitoring skills can be successfully taught to most operators.



Planning maintenance as an integral part of production is a high priority for success.

Summary of mini case studies — what printers say

The information in this section originates from non-structured interviews with printing companies that have been analysed and organised subject-by-subject along with comments and implications from the authors. *See page 68 for individual company reports.*

Maintenance results

Only some larger companies formally track the costs and results of their maintenance. However, all surveyed participants agree that there is a good ROI from it. Their individual assessment of benefits is based on what is important to them, cited examples include:

- "Significant increase in available production time with big impact to reduce total operating costs. Five year ago around 40% of operating hours lost to unplanned stoppages this has now been reduced to 4%."
- "Assures reliable just-in-time delivery that is essential to meet demanding customer/competitive needs."
- "Improved understanding of machine operation has improved printing quality."
- "Single source ink supplier reduced purchase costs by 30% and includes regular maintenance service without cost including 24-hour call-out."
- "30% reduction in unscheduled press stops since introduction of PPM and OIM, and 27% reduction in waste and web breaks from combined maintenance, paper qualities and best practices."
- "Major unscheduled stops are rare with breakdown reduced to 2-4 % of operating hours."
- "In spite of very old presses there are few unscheduled stops, consistent production and minimum quality defects. Service helps extend UV lamp-life and printing from FM screened plates using film processing."
- "Condition monitoring has reduced cost of spares and unscheduled downtime."
- "Improved control of effective production time with better control over maintenance costs and results."
- "Improved motivation of production staff to make maintenance."
- "OEM Maintenance contract has paid dividends from reduced overall maintenance cost."

Keys for success

The significant factors are a maintenance strategy combined with positively involving people at all levels:

Strategy : A top-down decision is essential to improve productivity of which maintenance is an integral component. Initiatives range from formal strategies where maintenance is an integrated into a formal manufacturing strategy, to informal "common sense'" approach where maintenance is seen as an obvious necessity. Maintenance is often treated in isolation to company operations but respondents believe it is now essential to integrate it as a key productivity element within a manufacturing strategy. "Strategy" can be an over-used word that is off-putting for many people. The essential is a policy on paper that is communicated to all staff on how maintenance can be improved to lift the company's performance.

People : Motivation, training and selection of people is the single highest success factor. "Ultimately everything is related to people who need to work together effectively". "Each team member needs to be challenged to get the best from them". "Inform and motivate production staff". Training is a key factor of success for more effective maintenance. Changing staff attitudes and behaviour is important: team spirit, stable staff and equipment "ownership". "Two-way exchange of information with suppliers, maintenance and production staff is essential". Barriers to change include some older staff who hold entrenched views —" the retirement of baby boomers seen as an opportunity to change working practices". Hiring staff with the right skills and attitudes is a high priority. Most of the companies interviewed are attempting to get the most from their staff because everyone benefits.

Maintenance approach

Breakdown maintenance or “fix it when it stops” is in transition to restorative, preventive and condition maintenance. Some companies are working in two areas simultaneously — the ‘maintenance staircase’ (see page 13) is a convenient organisational theory not a rigid procedure. Principal maintenance focus is on printing equipment because of its cost, complexity, the traditional separation of operation and maintenance in press rooms and operator training. Pre-press tends to rely more on external service and post-press is generally handled by operators.

Scheduled maintenance — Biggest problem is time

Most respondents have regular planned maintenance slots for each machine. Many book maintenance into their schedule using job cards — maintenance is generally made by operators. There is a high risk that maintenance slots are cancelled under sales pressure. One company solved this by requiring the manager to sign-off permission to abandon a maintenance slot. Other companies plot downtime against cause to identify hot spots addressed by a pit-stop maintenance strategy. A few companies have OEM supplier maintenance contracts to check the equipment every month and carry out 6 monthly servicing, they all report good results.

Maintenance staff

Production staff: Operators working without documentation, training or supervision is inefficient. The challenge is to get them to understand why they need to work systematically — this requires motivation, education and supervision — which can usually be achieved. The optimum approach is Operator Involved Maintenance (OIM) within a Planned Preventive Maintenance (PPM) system and the use of Kaizen for continuous improvement. “Stable crews on each machine are a significant factor that encourages ownership and responsibility for routine maintenance, housekeeping and cleanliness”. Some companies assess operator skills to best use resources on different maintenance tasks.

In-house specialists: These range from none, to some, to a complete department. A common approach is to have a minimum in-house competence (even one person) complimented by external services.

External services: Outsourcing usually starts with OEM suppliers and/or independent service providers on a call-out basis that can progress to complete maintenance contracts.

- Many companies use small, local suppliers with specialist skills because they are seen to provide time and cost efficient services — some are former OEM technicians — service from OEM technicians is required only for complex tasks.
- OEM supplier services are often perceived to be expensive. Service satisfaction was reported to be highly variable ranging from excellent to barely acceptable. In a few cases, all equipment is maintained by the OEM supplier. One printer described this as expensive but necessary because their customers require it; another states that it has paid dividends from reduced overall maintenance costs. Some suppliers also use local contractors to provide a rapid response.
- Some consumables suppliers (like ink) successfully bundle product contracts with provision of effective services on a regular basis. This is a model with a high potential impact on productivity that may offer significant benefits to the industry.
- It may be useful for companies to develop a risk-cost benefit matrix to assess what is their best maintenance resource solution for their needs: internal skills, external local or OEM suppliers.

Spares

Inventory: Most companies keep a minimum of consumable parts and only order other spares when equipment breaks down — availability and delivery are then often under crisis conditions. Ideally the parts in the inventory are labelled and binned, and controlled by a stock data system.

Spares substitution: Printing equipment uses a large number of standard engineering components (motors, belts, pumps, etc) that many printers prefer to buy directly (rather than from OEM suppliers). The Internet is used to identify specifications and search for availability and price. Small mechanical engineering shops are sometimes used to manufacture parts.

Documentation

Equipment manuals: Most printers adapt maintenance procedures from suppliers manuals to their own operating experience. This is particularly the case of regular routines for lubrication and cleaning.

Some companies observe and record OEM techniques so that they can be performed internally next time. Others create intranet “idiot sheets” on how to make certain repairs accompanied with digital photos.

Internal maintenance: Maintenance is recorded by companies to (a) provide a record of what has been done (b) helps prove that Health & Safety risks are managed. Accurate downtime cost should include the hidden costs of reduced speed and increased waste as a result of under-maintenance or while waiting for repairs. This data also provides a basis to evaluate cost benefits of maintenance products offered by suppliers.

Organisation of maintenance ranges from purely intuitive (no system); through planned and documented check sheets; using a “maintenance card” in the same format as a “job card”; intranet for internal communication and intervention requests; and the centralisation of available information in a data base. Keeping a maintenance logbook on each machine is a simple and effective way to record breakdowns, particularly if combined with a white board to “post” items for attention and action.

The challenge for most printers is that they have multiple equipment suppliers with different manual styles. It may be useful to produce a generic maintenance logbook for each equipment class in a single style that can be adapted (under the printer’s responsibility) for all of their equipment adding essential information (cleaning solvents, lubrication types, etc) used by the company.

Condition monitoring

Predictive maintenance tools are used mostly by larger companies who report good results from thermal imaging, vibration and oil analysis using either in-house staff or external services. Digital condition monitoring tools are becoming progressively cheaper and easier to use including infra red guns for temperature monitoring, and acoustic equipment to detect bearing failures and trace air leaks. A pragmatic and low cost approach from several companies is to encourage their staff to uses their senses (smell, touch, hearing) to detect unusual temperature, vibrations, smells or noises that are early indications of impending failure.

Although many presses have monitoring functions within their PCUs, few are currently used for condition monitoring — this is an under-used resource. Remote monitoring is also under-used, this may partly be due to the requirement of a dedicated and expensive ISDN line (use of Internet can now overcome this).

Application of new technologies in maintenance

Many responding printers are using new low cost technologies to improve their maintenance operations. These include: Intranet maintenance requests, ‘how to do it’ notes; Internet to source parts; mobile phones and digital cameras to help identify parts or diagnose a problem; computer analysis of maintenance data against production KPIs to identify priorities, costs and benefits; and low cost diagnostic tools.

Comparison with other industries

The precept of preventative maintenance is that the life of components can be predicted accurately on a statistical basis and can be replaced ahead of the failure. However, in environments like petrochemical plants this does not guarantee continuity of production, as one of the most likely times for sudden failure is during the start up period. Therefore, condition monitoring has become the norm.

The development of effective maintenance strategies began in industries where a breakdown could bring the process to a catastrophic halt. Therefore, risk and reliability research has been a priority in the aerospace, military and process industries who have implemented predictive maintenance and are the leading developers of conditioning monitoring. These approaches have now been adopted by terrestrial transport because of the risks and consequences of unplanned failure — cars now have preventative maintenance with increasingly sophisticated predictive algorithms. This is also extending into mainstream manufacturing, as unplanned breakdowns and undetected failures within a process can cause both economic loss and increase product liability.

Which maintenance strategy?

The decision as to what maintenance strategy to adopt is determined by its impact on the process. An in depth study in the pharmaceutical industry concluded that it was more cost effective to run the plant until it failed ("fix when broken") as they have a large number of identical production units allowing manufacturing to be switched whilst the failed production unit is repaired. This applies in all cases where there are many identical units performing the same task and if there is cheaply available spare capacity. This is used for office printers and could extend to printers using multiple digital print units as their sole means of production. However, this philosophy is unlikely to extend to traditional printing because of the very high variability of printed products and few plants have multiple identical equipment lines.

The non-print companies surveyed as part of this study represent the potential extremes of maintenance philosophy.

Pencil and ball-point pen: Manufacturer is very similar to a small printing company. The company introduced a maintenance system and is now seeing the economic benefit. Documenting the system was of prime importance.

Automotive: Although, an automotive component manufacturer has been recognised to Q1 for the quality of its products, its customers are now expecting it to move to higher standards that includes documented maintenance.

Parachutes: It might be perceived that a manufacturer of parachutes would be critical on every part of the process, but the criticality is in final inspection and quality assurance — maintenance is a productivity issue for the production department. Only for the cutting table that is the heart of the process and where there is only one, so availability is critical to the whole of production, was there a defined maintenance strategy.

Implementation

The problems faced by introducing maintenance into these companies is the same as observed in the printing industry — to convince the operators of the need for maintenance, and the problems of obtaining time from production to service manufacturing equipment. Frequently the latter has to be driven by a top down management decision. The benefits are improved productivity, availability and quality.

Although the case studies tended to feature slightly larger companies, all with dedicated maintenance staff, there is shift of the responsibility for routine maintenance, servicing and repair onto the operators. The maintenance department then concentrates on major breakdowns and on improving the maintenance plan.

Conclusions and Opportunities for Improvement

State of the industry

The principle finding is that much of the UK printing industry is under performing in maintenance that is undermining its 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.

Opportunities for Improvement

1. Raise the relative importance of ‘Productivity Maintenance’ to the entire printing industry.
   It is a cross-industry subject of importance to all players.
2. Stress the financial and business benefits from doing so — success requires a top-down commitment from owners, CEOs, directors and managers.
3. Stop treating maintenance in isolation! This has not worked for decades. Maintenance is a key component of manufacturing and impacts on productivity, safety, health and environmental issues.
4. De-mistify maintenance from a ‘necessary evil’ to an integrated business component.
   4.1 Use this report to communicate to the industry as a catalyst for discussion and improvement.
   4.2 Make the report available to all printing associations in the UK to communicate to their members.
   4.3 Utilise opportunities at industry events, conferences, exhibitions and seminars to raise the profile of ‘Productivity Maintenance’.
5. Develop seminars, workshops and training to better understand maintenance and improve techniques, especially those outlining cross-industry solutions and presenting case study examples of improvements by printers.
6. Consider extending the Vision in Print project by continuing the on-line questionnaire.
7. Consider a survey with suppliers to compliment this research with printers.
8. Consider carrying out some detailed case studies with printers to fully assess the economic and other effects from implementing an effective maintenance programme.

Recommended improvement paths

Cross-industry implications

Focus the energy and common interests of the key players in a cross-industry approach that help provides "our" solutions rather than "them" and "us". A tripartite approach involving:

- Print industry associations to provide suggestions on maintenance improvement programmes and how to introduce them to their members.
- Engage print industry suppliers — equipment manufacturers, consumables and independent service companies.
- Involve education and training institutions where appropriate.

Training

The research shows that there is no difference between skill levels of printers operating with or without a maintenance programme. However, those with a programme systematically place staff training as a key success factor.

NVQs are work-related, competence-based qualifications based on National Occupational Standards with five levels: 1/2 give skills for an operative or semi-skilled task; most printers would be at level 3; levels 4/5 are comparable to an MSc (where maintenance is part of some post graduate course such as Engineering Design). To add a formally accredited NVQ specifically for printing maintenance for operators would be a major undertaking. This is probably best addressed via short courses and workshops, without formal recognition (equivalent level 3/4 NVQ).

There is a need and an opportunity to develop a cost-effective operator maintenance programme using remote learning and local/regional workshops to provide the understanding and basic skills required of Operator Involved Maintenance (learning outcomes include effective cleaning, sensory maintenance techniques, use of diagnostic and monitoring tools).

National/Regional Productivity Improvement Seminars

These would be for companies wishing to move higher up the maintenance staircase. Programme should focus on how to consolidate and improve Productivity Maintenance. It is also important to include another productivity-related subjects (such as how to improve physical workflows, reducing waste, etc.) because it is important not to isolate maintenance from manufacturing.

Maintenance documentation & check lists

The challenge for most printers is that they have multiple equipment suppliers with different manual styles. It may be useful to produce a maintenance logbook for each equipment class in a single style that can be adapted (under the printer's responsibility) for all their equipment adding essential information (cleaning solvents, lubrication types used by the company etc).

Recommendations for Printers

Effective maintenance helps provide a competitive advantage by ensuring a stable and consistently high level of production with reduced total operating costs.

Managers and owners of printing companies have a choice: either adopt and integrate Productivity Maintenance within their company's manufacturing strategy to provide them with short, medium and long term benefits; or, continue to operate "fix it when it breaks" crisis manufacturing that does not build value or competitive advantage with the attendant risks of poor quality, late delivery and excessive waste and re-work costs?

Decide on a strategy

Achieving a minimum maintenance level is 80% common sense combined with discipline and standard procedures — this is within the reach of all companies, irrespective of size, if they are prepared to make a small effort. The difference between better and poorer performing companies is that the best "do it". It is no good having good plans and strategies unless they are put into operation.

"Strategy" can be an over-used word that is off-putting for many people. The essential is a policy on paper that is communicated to all staff on how maintenance can be improved to continually lift the company's performance

20 Pragmatic best practice actions to for printers to improve maintenance

1. Decide to make "Productivity Maintenance" a key component of a manufacturing strategy to optimise productivity. Communicate the decision to all staff and appoint a person be responsible for it and provide adequate resources.
2. Invest in people to get staff to understand why they need to work systematically — this requires motivation, education and supervision.
3. Actions must start with the recognition of the problem and that it takes money, motivation and time to fix. Benefits are significant and some measurement is needed to keep the company motivated.
4. Use Key Performance Indicators (KPIs) to help prioritise and plan maintenance resources to address specific needs. Start by selecting a few KPIs that are appropriate, accurate and consistent. Regularly monitor them to evaluate progress and communicate to all staff. There is no point accumulating data if it is not used or communicated.
5. Begin with an audit to define current plant status and identify the factors that limit performance. Prioritise the key performance gaps to be reduced over time. The emphasis here is to identify the 20% of the issues responsible for 80% of the problems (dampening systems, roller settings, machine settings, routine cleaning, inspection, lubrication).
6. Establish programmes for prepress, press and post-press equipment that are adapted to the age, technology and conditions of the plant. Plan and protect regular slots for maintenance. Implementing a policy that requires the managing director (or his delegate) to sign-off permission to abandon a planned maintenance slot.
7. Adapt the strategy to also reflect operating hours, type of work and company culture.
8. Implement actions one step at a time — only when success has been established should the next step be undertaken. Eliminate reactive maintenance in 3-steps: Correction, Restoration, Prevention. These should be in a steady state as a pre-condition to introduce Condition Monitoring and Continuous improvement.

9. Success requires teamwork between management, supervisors and staff; with rewards and incentives (these are not necessarily financial – more recognition and appreciation). Include appropriate suppliers within your team.
10. Give operators easy-to-use maintenance checklists and procedures adapted to your equipment and operating conditions.
11. Keep a maintenance logbook for each major piece of equipment. Add essential information (cleaning solvents, lubrication types used by the company etc).
12. Introduce Operator Involved Maintenance by providing motivation, training and supervision. Start with housekeeping and cleaning routines. Ensure cleaning techniques are adapted to the tasks required and use the optimum cleaning products (taking into account HSE factors). There is considerable scope to minimise materials cost.
13. Consider putting white boards next to each piece of equipment to note problems as they occur and to communicate them to the next shift. Prioritise which malfunctions to fix on an opportunity basis when there is a break in production. Put emergency service contact numbers here.
14. Introduce an effective way of communicating maintenance requests to the right person. An intra net system is a simple electronic solution. Alternatively, a white board to 'post' maintenance requests centrally.
15. Ask your equipment and consumables suppliers for assistance. Discuss with them what maintenance services they can supply (on site and remote assistance/monitoring), consider the cost benefits on total operational performance.
16. Consider negotiating supply contracts that provide service (and other) resources to your company. This is particularly appropriate to the chemical part of the offset process. eg. ensure optimum combinations of ink, fount and cleaning agents.
17. Each company is unique in the resources it has available. Assess the available skills in the company to best use resources on different maintenance tasks; decide if dedicated maintenance staff are required; what mix of external services from OEM suppliers and independent companies are needed?
18. Establish a minimum inventory for spares for each machine. The extent of spares carried depends on the availability of back-up equipment, customer sensitivity to late job delivery and the time for urgent spares to arrive. Ideally the inventory should be labelled and binned with systematic re-ordering to maintain stock level. If you directly purchase Standard Industrial Components (electric motors, belts, electrical boards, PLCs, etc) make absolutely certain that you have the right reference number. Assess the risk of substitute parts to the consequences of any malfunction. The same applies for remanufactured parts.
19. Consider application of new technologies in maintenance: Intranet maintenance requests and "how to do it" notes; Internet service connections; mobile phones and digital cameras to help identify correct part or diagnose a problem. Condition monitoring and diagnostic tools.
20. Use the capacities of equipment control systems fully. Most PCU-controlled equipment has the ability to help identify faults and more importantly continually condition monitor for emerging malfunctions. Review with your supplier how to organise this in-plant or by remote service.

Recommendations for Suppliers

1. Participate in cross industry initiatives to improve industry maintenance performance. This is one of the best opportunities to build long-term customer relationships on a “win / win” basis.
   1.1 Reinforce at all appropriate industry events to raise awareness and understanding;
   1.2 Consistently promote best maintenance practices and standard operating procedures.
   1.3 Support an industry-wide Operator Involved Maintenance training programme and other pragmatic initiatives that improve awareness and performance.
2. Help improve the understanding of the importance and use of KPI data; and total cost of ownership.
3. There is a perception that OEM service contracts are too expensive. This may be due to:
   3.1 Lack of communication (or understanding) of the total cost of ownership, of which maintenance is an integral part rather than just an added cost?
   3.2 Are service contracts fully adapted to the needs of different company profiles?
   3.3 Under utilisation of remote condition monitoring systems. How can this be improved?
4. More creative use of the Internet to provide better and more cost efficient services.
5. Identify new business models. What services can be bundled with products to offer significant potential for printers and suppliers to improve their productivity and business performance? This particularly applies to suppliers of consumables (ink, chemicals, rollers, blankets, cleaning agents, plates, colour management).
6. Address the issue of SIC purchase that many printers directly source from their original manufacturers for reasons of cost and delivery time. The reason for the large price differential probably originates from them being treated as proprietary parts (high value parts held in stock over a long period of time with low volume that require high margins). Direct purchase of SIC components is recognised by some OEMs who provide their customers with easy to access reference lists; some are lowering their prices; others do not facilitate this process which frustrates their customers. Suppliers should help printers understand the risk from using non-equivalent components that may cause unpredictable problems and jeopardise warranty. Perhaps establish a list of high-risk components that should preferably only be supplied and fitted by the OEM equipment supplier.
7. Manufacturers could benefit from some of the innovations of their customers and should consider how to encourage communication and rewards (and also to avoid unrealistic and dangerous modifications).
8. Some suppliers work with local third party service contractors to provide faster response. Extending this practice may allow better structured service contracts to be provided. It may be worthwhile to consider franchising some as “authorised service providers” in the same way as automotive and other industries.
9. Some cleaning agents used in maintenance seem to lack clear and practical user information. What product for what task? How to use it effectively and economically? Consumable suppliers should review that the right information is available to the people who choose to use their products — in addition to mandatory HSE requirements.
10. Suppliers, through their industry association, may like to evaluate the implications of changes to the technology and business environment that impact on service, e.g. transition to intensive use of digital technologies and higher automation in all machines; the Internet as a service tool; availability of competent staff; response times; chemistry and environment. The goal of improved industry-wide maintenance has positive implications for suppliers, this should allow development and acceptance of their services; reduced warranty issues; avoidance of unnecessary service costs; delivering higher customer satisfaction; and improving industry profitability.

Productivity Maintenance report

Section 1

Maintenance approaches

The Web Offset Champion Group was formed in 1998 to 'champion' generic best practice in the web offset printing as a tool to improve productivity, quality and safety. Its members include: Aylesford Newsprint, Kodak Polychrome Graphics, MacDermid Printing Solutions, MAN Roland, MEGTEC Systems, Müller Martini, Nitto-Permacel, QuadTech, SCA, Sun Chemical — www.wocg.info.

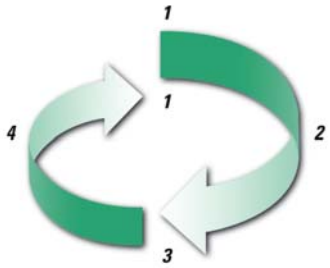
Evolution of maintenance

Maintenance strategies and techniques have significantly evolved during the last 50 years progressing from breakdown to preventive, then predictive and pro-active.

Period	*Strategy*	*Human health care*	*Machine health care*
< 1950	Breakdown	Heart attack	Large budget, correct when broken
< 1970	Preventive	By-pass surgery	Periodic component replacement
> 1970	Predictive	Heart disease detection	Condition monitoring, fix early
> 1980	Pro-active	Cholesterol & blood pressure monitoring Root cause diet control	Performance monitoring Contamination control TPM (Total Productive Maintenance)

The evolution of industrial maintenance compares well to the development of health care techniques. However, many printers seem to prefer that their equipment has a heart attack rather than use preventive and predictive care.

Nevertheless, the 1950's "Fix it when it breaks" approach is still prevalent in the printing industry and no company can optimise its productivity within a "spiral of breakdown despair".



"Spiral of breakdown despair"

1) Production loss from breakdowns and low productivity

2) Work equipment harder to recover lost production

3) Increased breakdowns and more lost time

4) Increased production pressure reduces maintenance time

Several overlapping techniques are available to improve performance.

1) Total Quality Maintenance

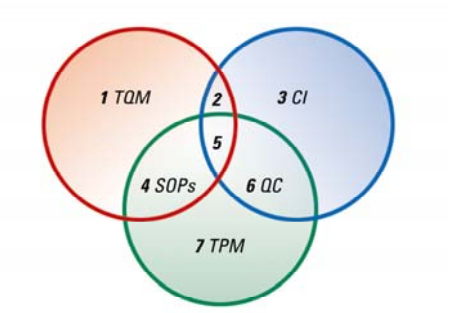
2) Cross-functional teamwork

3) Continuous improvement

4) Standard Operating Procedures

5) 5Cs (Clear, Configure, Clean & Check, Conform, Custom & Practice)

6) Quick Change development



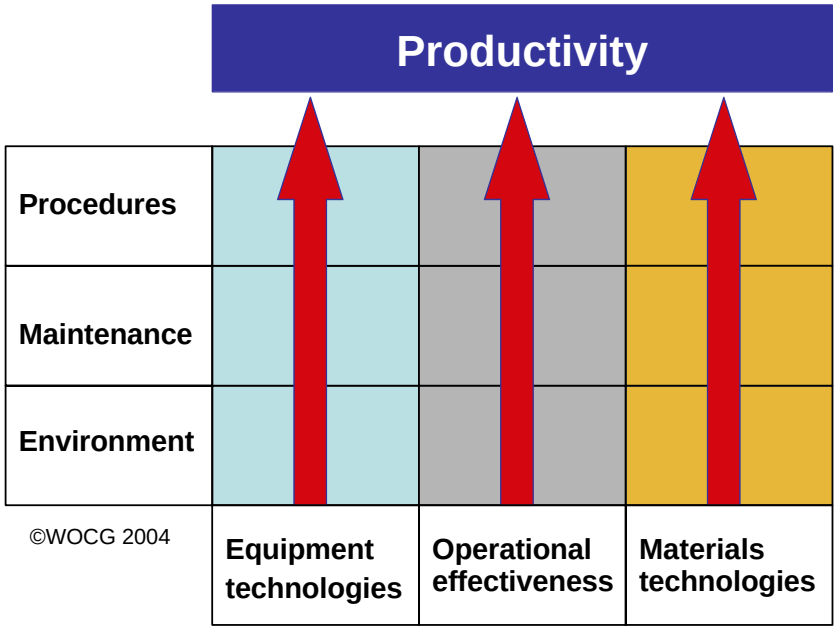
Maintenance alone, without reference to the entire operating environment is ineffective. At the other extreme, Total Productivity Maintenance (TPM) is a complete but complex manufacturing strategy that only a few large companies are in a position to implement in the printing industry, partly because it requires a fundamental change in operating culture and attitudes. Some people's perception of TPM may be poor because it may be seen as the latest management fad that some zealots propose as a panacea for all ills.

For the majority of printers, the pragmatic path to improve their maintenance and productivity lies between these extremes. An important factor for success is to choose the technique(s) suited to the company's environment.

Productivity Maintenance

Productivity Maintenance describes the result ‘Productivity’ and the action ‘Maintenance’. This is a more flexible and pragmatic approach than TPM.

The Productivity Maintenance matrix shows that productivity is supported by three pillars — Equipment and Materials Technologies linked by Operational Effectiveness. The level of productivity is determined by how effectively these elements work together. Each pillar includes Standard Procedures, Maintenance and Environmental issues. All of these elements help form a manufacturing strategy. Poor performance in any one, maintenance for example, will impact overall performance.



This matrix* provides a useful tool to overview a company’s manufacturing environment to identify areas of strengths and weaknesses to address. It also allows effective communication between employees and suppliers to better work together and can be adapted to all company sizes and levels of complexity.

It is essential to prioritise actions and to improve productivity one step at a time — only when success in has been established one area should the next step be undertaken.

*(This approach was developed by the Web Offset Champion Group (WOCG) as part of an international maintenance best practice project *“Productivity Maintenance — how to run longer, leaner and faster*” — reproduced with permission of WOCG all rights reserved).

Why maintain?

There is an intrinsic relationship between productivity, reliability and maintenance. The primary dividends from effective maintenance are reduced total operating costs, on-time delivery and consistent product quality. In addition, maintenance preserves capital assets and fulfils safety, insurance and regulatory obligations. A further benefit is to reduce the stress on production staff generated by breakdowns. Printers who have introduced pro active maintenance systems unanimously report significant performance improvements from fewer unscheduled press stops, higher press net output, less waste, more consistent quality and fewer accidents. The preservation of expensive equipment assets is another economic factor. Good maintenance both preserves these assets and reduces their lifetime operating costs by minimising wear and replacement of parts. Good maintenance practices also minimise energy consumption and waste of cleaning materials. However, many printers continue to operate only breakdown maintenance despite the strong reasons to integrate effective maintenance.

Regular chronic problems

The loss of substantial productivity is rarely due to acute problems — the most frequent source is a collection of regular chronic problems that companies live with in order to keep presses running. The consequences are undermined productivity and profitability from:

1. **High equipment failures:** Sporadic or Chronic.

2. **Slow job changeover and make ready:** Total time and waste to good copies.

3. **Frequent idling and minor stoppages:** A major cause of lost time is from bad materials, re-adjustments, cleaning plates or sensors, etc. External causes include late and incorrect plates, missing proofs, missing job instructions, waiting for the customer.

4. **Reduced speeds:** From poor materials and machine condition, drying or registration problems.

5. **Excessive quality defects:** Time, materials and cost of handling non-conforming products and re-runs.

6. **Slow start-up and reduced yields:** High waste and low speed from printing problems e.g. colour variation, plate scumming, folder register and maintenance related problems eg. folder jam.

According to Kenneth E. Rizzo (GATF “Total Productive Maintenance”) the main causes of these productivity losses are ‘fix it when it breaks’ maintenance combined with operational inefficiency (inadequate control, training and operating procedures). An accelerating competitive climate requires working leaner, faster and smarter by adapting best industrial practice techniques and tools. TPM integrates preventive, planned and condition maintenance with quality management and continuous improvement to provide a total manufacturing system. Its discipline is a foundation for the development of lean and flexible manufacturing.

IFRA’s “Optimising Productivity” observes that improved productivity comes from avoiding disturbances during production that consume time or increase waste. Disturbances can be sudden that stop the press; cumulative, like blanket piling; or those that reduce speed or quality. Among IFRA’s findings were:

• People (and their training) have the biggest single impact on productivity

• Allocation of adequate time and resources for systematic maintenance

• Optimize materials according to the press and quality requirements.

New equipment technologies

New press technologies reduce maintenance in some areas (automatic lubrication, self-cleaning sensors, roller and blanket was-up devices). However, a pre condition for CIP3 press pre-setting systems to deliver efficient results is that inking and dampening systems require regular and rigorous maintenance.

There is also considerable information available from equipment central control systems. These allow equipment status to be monitored by the supplier and for the printer. However, it seems that the potential for condition monitoring is not yet fully exploited. Some smaller printers have installed a single high productivity new piece of equipment to replace multiple machines, but the consequence is that there is no longer back-up if there is a breakdown — this makes failure prevention even more important.

Maintenance — a cost or an investment?

Effective maintenance should begin with some fundamental financial management questions: Is maintenance regarded as a ‘necessary evil’ or as an investment to increase productivity and reduce total operating costs? Are malfunctions only accounted for as direct repair costs, or is their total loss calculated (repairs, plus the costs of lost production, increased materials consumption and consequential costs such as overtime)?

Progressive industrial companies incorporate maintenance as a total production cost variable and include downtime and consequential costs in their calculations. This financial management approach provides substantial opportunities to reduce costs and increase profitability. A further benefit is that more saleable production capacity becomes available that can be converted to either increased sales or reduce capital investment (fewer presses) to achieve the same output.

The gap between 'poor' and 'best' practice can be substantial. The experience of companies who significantly cut costs by reducing maintenance is that their reliability and efficiency gradually decline over the first year and then drop away dramatically with higher costs for breakdown (spares, lost production, materials waste and overtime). The inertia of poor reliability means it takes much longer to recover lost productivity than it does to lose it, even when substantial resources are added back.

The industry’s diversity does not allow a simple time-cost formula to define ‘adequate’ maintenance resources. This is a function of equipment type, age and operating hours. In 24-hour per day production, the experience of press manufacturers and the US Graphic Arts Technical Foundation is that about 5 % of total operating hours is needed for a solid maintenance programme. The most important issue is not the time or budget allowed, but the effectiveness of the maintenance investment to improve productivity and reduce total operating costs. Secondly, that the time and budget are measured and monitored for their effectiveness.

The payback from a successful proactive maintenance strategy is improved productivity. Experience of implementing systematic programmes is that they need about 3 years to become fully established as part of a company’s operating culture. Some users report improvements of over 20 % longer running time between press stops, around 25 % higher net average printing speed and up to 50 % reduction in paper waste.

Measure it to move it — KPIs

Key Performance Indicators (KPIs) should be developed and evaluated by the staff who will use them. Regular weekly review allows maintenance resources to be prioritised and planned to address specific areas needing improvement. KPIs should be distributed to staff at all levels so that they can see the evolution of performance over time. This helps encourage joint ownership and responsibility for assets maintenance.

Production line output KPIs :

Available press time for production

Average net copies per hour

Average make ready time

Average waste (quality related)

Web break rate

Maintenance indicators KPIs :

Non-scheduled/unplanned repair stops

% Downtime due to breakdown

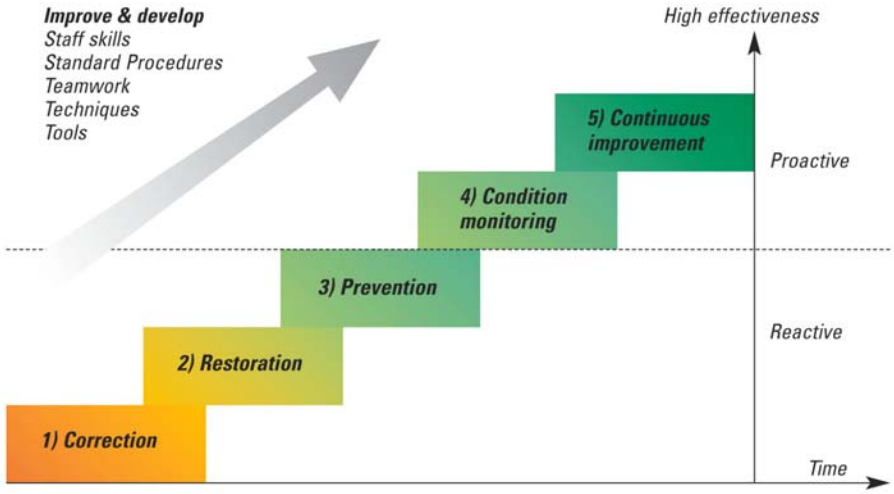
% Re-work (a major symtom of poor maintenance),

Mean time between failures

Cost of parts and consumables used

These two sets of data should be regularly evaluated to make the effectiveness of production and maintenance transparent. Coherent and clearly presented data provides operators, maintenance, managers and suppliers with an objective assessment of performance gaps and results.

Maintenance strategy



Maintenance is a series of progressive organised steps over time to improve operational effectiveness. The key step is the transition to proactive working. Source WOCG.

1. Corrective maintenance: Safety is the highest priority to prevent accidents. Most resources at this level are devoted to fixing emergency and chronic problems to keep presses running ("fix it when it breaks").

2. Restoration maintenance: Return equipment to its original condition so it can be maintained normally. Firstly focus on chronic minor breakdowns that collectively often total the highest amount of lost time. A sudden sporadic breakdown with long down time is usually the result of deterioration over time — restoration is the main way to reduce this.

3. Planned preventive maintenance: Routine cycle of scheduled maintenance using standards, procedures and reporting to minimise failures. Track failure rates of wear parts, build a repair history database and develop a parts inventory from it. Introduce autonomous Operator Integrated Maintenance (OIM).

> **OIM** is a standard industrial approach to give crews a better understanding to prevent problems and release maintenance resources. Implementation requires a series of small steps over time, delegation of responsibility, continuous improvement and teamwork with maintenance and scheduling staff. Basic work includes: — Regular cleaning and inspection. — Routine lubrication and fastener checks (nuts, bolts, and lockdowns). — Regular monitoring of equipment condition. — Understand and apply correct maintenance and operating procedures.

4. Condition monitoring : Few components have a specific lifetime. Usually there is a long failure development period before a breakdown occurs. Condition monitoring uses different tools to identify deterioration earlier to initiate maintenance sooner so that remedial action is cheaper, faster and without unplanned production stops.

5. Continuous improvement: Best practice is a virtuous circle of evaluation, development, instruction, monitoring, management and improvement. The objectives are to focus on high cost priorities to simplify systems, increase efficiency, provide cost effective maintenance, extending equipment reliability and productivity. Each issue needs a champion responsible to set objectives, document actions and results and lead a cross-functional team. A wide variety of techniques are used including Kaizen, Six Sigma and Root Cause Analysis.

Comparison with similar industries

The development of effective maintenance strategies emanated from industries where a breakdown could bring the process to a catastrophic halt. Thus, the major thrust of risk and reliability research has been in the aerospace, military and process industries. These industries develop the predictive maintenance algorithms and are at the forefront of developing conditioning monitoring for more accurate prediction of failure. This philosophy has been adopted by terrestrial transport because of the risks and consequences of unplanned failure; thus, even individual road vehicles have preventative maintenance with increasingly sophisticated predictive algorithms, e.g. as first seen in the BMW service warning lights, commercial road and rail vehicles have adopted condition monitoring. This is now extending into mainstream manufacturing, as unplanned breakdowns and undetected failures within a process can cause both economic loss and increase product liability.

The precept of preventative maintenance is that the life of components can be predicted accurately on a statistical basis. Thus, knowing when a component was due to fail would allow a replacement to be brought on stream ahead of the failure. In situations such as petrochemical works even with a stand by system such as a reserve pump, this does not fully guarantee continuity of production as one of the most likely time for sudden failure is during the start up period. Generally though condition monitoring has become the norm.

What maintenance strategy to adopt

The decision as to what maintenance strategy to adopt is determined by its impact on the process. Even in the pharmaceutical industry, an in-depth study concluded that for a drug manufacture, it was more cost effective to run the plant until it failed as they had a large number of identical production units, so the manufacturing could be switched and the failed production unit repaired. This model applies in all cases where there are many identical units performing the same task and thus the company can cheaply accommodated spare capacity. In printing this is already seen in office printers and may well soon extend to situations where printers use multiple digital print units as their sole means of production. However, this philosophy is unlikely to extend to traditional volume printing, except in situations where the capital cost has already been written off so the equipment is effectively free.

Pencil and ball point pen: The non print companies surveyed represent the potential extremes of maintenance philosophy. The pencil and ball point pen manufacturer is very similar to a small printing company. Although long established, the company has just (during the last two years), introduced a maintenance system. It is already seeing the economic benefit in terms of increased availability, reduced unplanned stops and machine performance. Documenting the system was of prime importance.

Documented maintenance

Automotive components: Although, the manufacturer has been recognise to Q1 for the quality of its products, its customers are now expecting it to move to higher standards. The new standard for automotive component suppliers includes documented maintenance as part of the programme. The automotive manufacturers realise that this improves productivity and hence will ultimately reduce costs and improve reliability, particularly of critical components such as breaking systems.

Parachutes: While it might be perceived that a manufacturer of parachutes would be critical on every part of the process, the criticality is in terms of the final inspection and quality assurance, maintenance is a productivity issue for the production department. Thus, for items such as sewing machines and heated knives where there are many units, more than there are operators, an “as and when” approach can be adopted as production can easily be switched to spare units. However, for the cutting table which is the heart of the process and there is only one, then the availability of this is critical to the whole of production and therefore a maintenance strategy has to be adopted to ensure production is not lost due to unplanned breakdowns.

Commercial lighting: Similarly, for the manufacturer of street and commercial lighting, there is routine maintenance on plant such as spray booths, but for items where there are multiple production units, these are maintained on a breakdown basis. As a supplier, the designers are involved with their customers to ensure the ease of maintenance of the products they supply.

Introducing maintenance

The problems faced in introducing planned maintenance into these companies is the same as observed in the printing industry; convincing the operators of the need for maintenance and the problems of winning time from production in order to service the equipment. Frequently this last one has to be driven by a top down management decision, frequently backed by customer demands. The benefits are improved productivity and availability, as well as quality.

Although the case studies tended to feature slightly larger companies, all with dedicated maintenance staff, there is shift of the responsibility for routine maintenance, servicing and repair onto the operators. The maintenance department being concerned with major breakdowns and with improving the maintenance plan.

World Rally has been at the forefront of developing high-speed maintenance and diagnostics. In the late 1960s, the manager of one of the leading teams realised that it was not the speed of the cars that was causing them not to win a particularly tough long distance rally, but breakdowns. The main thrust of the development that year was to introduce methods of quick diagnosis; such as being able to check timing of wear and tear, being able to spot oil leaks with a single glance under the bonnet and also paying attention as to how servicing was carried out. Every step was noted and tasks that consumed the most time were identified (such as having to disconnect the brake pipes to replace a suspension strut). Where possible these were designed out, so only the component that required replacing had to be removed. The net effect was that not only were their cars quick, but they got to the end of even the toughest rally because they could be maintained effectively in the service stations between rally stages. This proved a vital element in the company's domination of world rallying at that time.

Cautionary tales with regard to the replacement of parts

Nissan, when they opened up their manufacturing plant in the North East of the England, would not allow the first car to be released for sale from the new factory until they were sure the quality matched that achieved in Japan. During a production check it was noticed that the windscreen washer pipe was a different colour to the original. Despite being told it was of similar specification, the quality assurance team would not let the car leave the factory until this had been proved. It was found this was a grade of pipe melted at a lower temperature than the original. This would have cause a failure in service if the cars were to be used in the Middle East and Africa where the under bonnet temperatures are higher.

A repeat order for building a bulk ship carrier moved to a lower cost yard. The standard bearing for propeller shafts etc was made in Scandinavia. However, bearings could be purchased from local suppliers that were notionally of the same specification but lower cost. This proved a false economy, as the bearing did not last as long and the propeller shaft bearings failed in service, resulting in the ships having to be dry-docked for repair.

Developing a strategy

Strategy objectives should be results oriented with a ‘product’ of improved equipment reliability, productivity and assets preservation delivered through maintenance services in co-operation with production. The desired results should be defined along with measurements of target improvement e.g.:

• Maximise production capacity and consistent quality.

• Minimum scheduled downtime and no unscheduled downtime.

• Minimise total production costs and materials waste and accidents.

• Optimise maintenance costs.

A basic strategy should begin with an audit to define current plant status and identify the factors that limit performance. Prioritise the key performance gaps to be reduced over time. Adapt strategy to the age and technology of equipment, operating hours and type of work.

Outsourcing of maintenance for standard services (e.g. forklift trucks, compressors, general electrical) is a pure value decision. However, externalising core maintenance of printing equipment requires a serious assessment. In most circumstances it is recommended to maintain core specialist maintenance staff who can be supplemented with assistance from external suppliers as needed.

The difference between better and poorer performing companies is that the best ‘do it’. It is no good having good plans and strategies unless they are put into operation.

Key success factors to improve maintenance

1. Senior management champion: Effective maintenance needs support that is visible, vocal and continuous to motivate staff at all levels for a successful mid to long-term manufacturing strategy.

2. Adequate staff, training and tools: Continuous training is an absolute requirement to optimise plant performance and profitability (use programmes from suppliers). Ensure each department has adequate tools and manuals that are available 24 hours a day.

3. Planned time: Access to equipment is the biggest problem. Maintenance should be planned as part of production scheduling that respects those times, priorities and procedures.

4. Monitor KPIs: Adjust planned maintenance to priorities. Communicate results to all.

5. Involve all key departments: People are more than half the solution. Recognise their efforts and ensure effective teamwork between operations, maintenance, planning and finance.

6. Documentation: Clear maintenance checklists for each equipment line and each time period, that are signed-off by the individual who completes the task. Clear and precise maintenance request procedures.

7. SMP & SOP Procedures: Standard Maintenance and Operating Procedures improve staff effectiveness by making tasks systematic, easier to understand and reinforce safety.

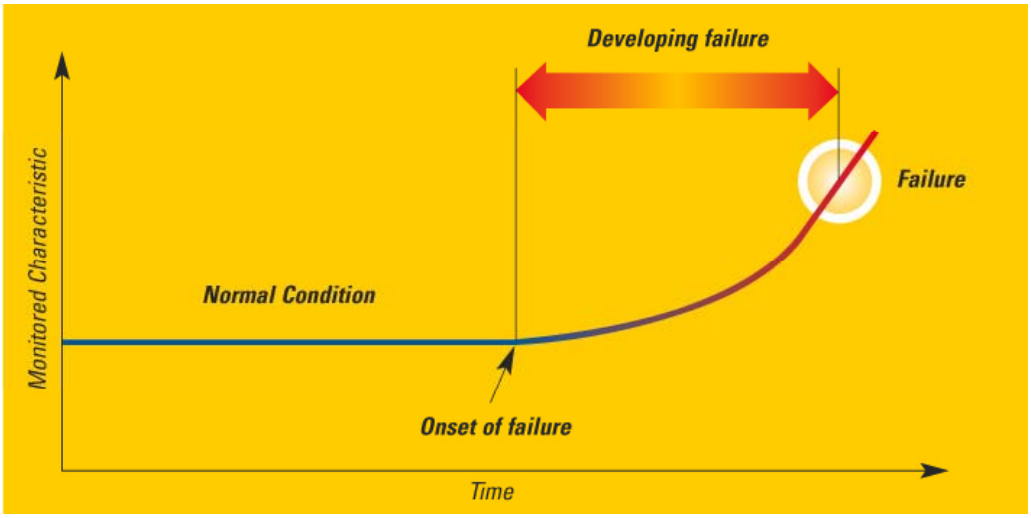
8. Use different skill levels: Allocate tasks to match the best use of operator, maintenance and external suppliers different skill levels.

9. Stock key parts: Anticipate life of wear parts to avoid press time lost from parts not in stock. Build a parts consumption database. Suppliers can also provide parts lists.

How to fail quickly: Lack of long term senior management commitment, work on maintenance in isolation, do not use KPIs, abandon allocated maintenance slots.

Condition monitoring

Many of the printers contacted during the VIP survey are using some condition monitoring devices with good results — ranging from training operators to use their 'built-in sensory systems' to the use of dedicated tools. The cost of digital monitoring devices has fallen and most allow measurements to be recorded and exported to a computer system to simplify trend analysis. Regular condition monitoring helps detect faults early where their time and cost of remedial action is lowest.



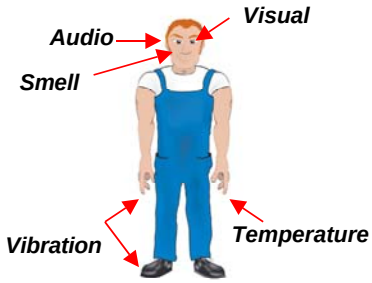
Monitoring components and detecting the onset of failure characteristics (higher vibration, operating temperature, power consumption, changed oil condition) allows scheduled repair prior to break down. Source Tim Claypole, University of Wales.

The first step is to establish normal operating levels of component characteristics and the time between detection of abnormal conditions and failure. The keys are:
• **Detection:** At the onset of change to active deterioration.
• **Diagnosis:** Type, severity and location.
• **Decision:** What to do and when.

Condition monitoring methods include using performance data (KPIs), vibration monitoring, power consumption, lubricant and wear debris monitoring, visual and sensual inspection.

Begin with staff. People are the most important maintenance assets who are naturally equipped with built-in sensor devices. If correctly trained, they can identify deterioration in equipment operating condition. Detecting problems is more difficult in plants using sound proof operating booths and some audio symptoms are difficult to hear next to a running press. Staff will become more efficient if suitable monitoring tools are available to them.

Humans have a built-in condition monitoring system that can feel, hear, see or smell small changes. Operators and maintenance staff senses should be trained to identify printing press running condition.



Low tech tools

Condition monitoring tools

Digital technologies can assist in condition monitoring to detect faults before their symptoms become physically apparent. The cost of digital monitoring devices has fallen. Most allow measurements to be recorded and exported to a computer system to simplify trend analysis.

	Operator's senses	Infra Red heat gun	Ultrasonic detector	Accelero-meter	Thermographic camera	Stroboscope
Used by operator if trained	Yes	4				4
Used by trained technician	Yes	4	4	4	4	4
Data export and trending	No	4	4	4	4	
Frequency of use	Continuous	As needed	Weekly	3 months	3 months	As needed
Early warning detection efficiency	Low-Mid	Mid-High	High	High	High	
Cost (approx. range) in Euros	_	1 200	2-4 000	1-12 000	5-30 000	1300

Before buying a tool check with other printers, or suppliers, on which models offer good value, are reliable and easy of use. Some considerations include:

• Select 1 or 2 tools for key needs and work with them for about a year until their utility is demonstrated (introducing too many tools simultaneously often leads to poor use and unrealised expectations).

• Tools must be used correctly with appropriate and on-going user training and tool calibration.

• Use the tools regularly and record their readings into a data format that allows useful trend analysis to help plan future actions and provide feedback to management and staff. Available tools include:

Data records and analysis: There is no point in collecting data unless it is analysed, used in planning and distributed to all people concerned, including press operators. Most monitoring devices can export data in a digital format that allows the data to be trended, analysed on an oscilloscope or stored as sound. Any of this data can then be sent over the Internet if expert help is needed to solve problems. There is enormous potential from an integrated database where ultrasound, vibration and temperature data are all kept together and can be cross-referenced.

CMMS (Computer Managed Maintenance Systems): A wide variety of systems are available for maintenance management, condition monitoring, parts inventory and purchasing, staff management.

Thermographic devices : Temperature variations have a significant effect on press performance. IR (infra red) guns and cameras convert thermal radiation from equipment into data or images of operating temperatures. Benchmark readings (from operator and drive side) should be recorded when the press is running correctly and regular measuring will identify any deviations that are early symptoms of problems.

- IR guns are highly portable and can be tuned to specific wavelengths to measure surface temperatures of components (rollers, fountain pans, plates, blankets, dryer, chill rolls), to localise loose electrical connections, hot motors, bad bearings and indicate the surface temperature of the web throughout the press.
- Thermographic cameras provide detailed temperature images that can be analysed to give an early warning of mechanical wear, insufficient lubrication, broken fasteners, poor ventilation, faulty fuses, etc. (but cannot monitor bearings inside closed gear casings). New thermal imaging software can be interfaced with all makes of camera and high resolution models can give images of an entire machine. Inspection and analysis is often made by specialist suppliers because of equipment cost and expertise needed to interpret data.

Digital ultrasonic scanner : An efficient tool to identify compressed air leaks and assess rolling element bearing condition. High frequency ultrasound is converted into audible sound that can be stored. Data can be trended to optimise lubrication and identify potential failures. When equipped with earphones they allow operators to hear the vibration patterns of different components (a modern version of a stethoscope). Ultrasound is a good technique to determine optimum lubrication. Acoustic vibration is low when a bearing is properly lubricated and increases as the film breaks down. The ultrasound signal changes during greasing and pumping is stopped when the sound level returns to its normal benchmark level.

Accelerometer : Particularly suitable for high frequency vibration (e.g. rotating system bearings). They normally require good physical contact with what is being measured.

Vibration monitoring : Routine measurement with hand-held or fixed devices is a powerful tool to diagnose running problems. This technique requires much more training than ultrasound, but the depth of analysis is considerable for motor, gearbox and bearing diagnostics, misalignment and imbalance.

Monitoring points : Uniquely identifies monitoring positions with a simple coded plastic marker. Emerging electronic tag systems provide automatic identification and the possibility to download data.

Oil analysis : Regular oil analysis indicates the condition of closed lubrication systems, indicates wear (metal particles), oil contamination (silicone, water) and early detection of drive problems. Samples should be taken immediately after a press stop and are usually analysed by a specialist laboratory service.

Stroboscope : Used for rapid inspection of moving parts such as belts, chains, cylinders and folder to detect wear or abnormal performance. Application depends on guards being either transparent or open grills.

Crack detection : Magni-Flux techniques can reveal cracks in shafts, pumps, journals and side frames. Normally used when equipment is dismantled.

Strain gauge : A specialist service to identify local loading of individual components, it can be used to look at the effect of shock loading, e.g. splices passing through the press.

Manometer: Measures airflow restriction to objectively assess when an air filter should be changed (as a function of its resistance). Similar devices can measure pressure drop across water filters.

Laser alignment : Incorrect alignment of press components, rollers, chains, drives belts and pulleys are a major cause of rapid deterioration and operating problems.

Digital camera : Record images of maintenance procedures and problems (images can be sent by Internet to help diagnose complex problems more quickly and reliably). A video camera with electronic shutter is useful to analyse paster and folder operation.

Remote site services: Many suppliers have modem services to monitor equipment running trends and review fault reports to provide an early warning of downtime risk and to plan preventative action. An extension of this is the use of Internet web cams that allow a live link between the press and a remote service centre.

Information availability: Manuals should be available to all staff at all times (with back-up duplicates stored separately). Production and maintenance staffs need access to a broad range of complex and diverse information that is often dispersed, difficult to access and to maintain. The centralisation of all information (including multi media) into a single database allows easy searching and incorporation of any new material.

Test forms: Measures impression performance of a press (FOGRA, Systems Brunner, GATF, and IFRA). Uses include analysing a specific quality problem, monitoring output quality annually and materials testing (assess colour reproduction characteristics and variables between different inks and papers).

Ink & Dampening measurement tools: Digital conductivity meter, pH meter, thermometer ; Hydrometer (IPA %), water hardness tester, Shore hardness meter, roller stripe measuring card, blanket packing and thickness gauges.

Ambient environment conditions

Large and frequent variations in press room temperature, humidity, air flows and dust levels are significant contributors to both accelerated equipment deterioration, poor consumables performance.

Temperature variations have a significant effect on press performance and reduce component life — a dirty electric motor running at a 10°C higher temperature from blocked airways may have its life reduced by 50 %.

• Monitor the condition of air filters. The ambient environment in plants may be ‘dirtier’ or ‘cleaner’ than the average and filter change periods should be adapted if necessary.

• Use an IR gun to monitor temperatures.

Operator Involved Maintenance

OIM is a standard industrial approach to give operators a better understanding to prevent problems and free-up dedicated maintenance resources. It is used by many of the printers surveyed whose operators are their primary maintenance prevention resource.

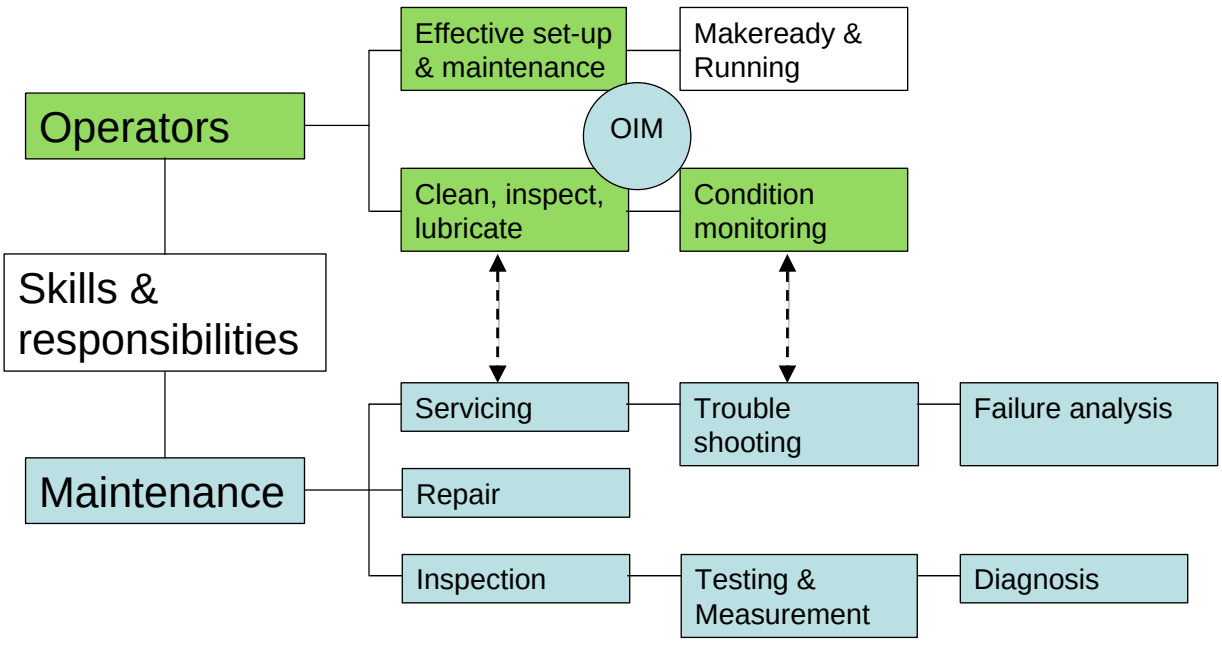
Operators know their machines better than anyone else and the essential goal of OIM is to get them to take “ownership” of certain maintenance tasks and to train them to do so.

Responsibilities usually include:

- Regular cleaning, inspection and lubrication (5 Cs) to slow and detect deterioration.
- Regular monitoring of equipment condition.
- Condition monitoring to detect faults as early as possible.
- Understanding and application of standard maintenance and operating procedures.
- Make small service actions on an opportunity basis and assist maintenance staff for more important interventions.
- Continuous improvement may also be added in the most advanced working environments.

Successful implementation requires a series of steps over time, encouraging “ownership” of the machine, delegation of responsibility, recognition and teamwork with maintenance and scheduling staff. Training is essential for success.

OIM actions are made either at regular planned maintenance periods and smaller tasks carried out during machine stops.



OIM increases operator skills to allow transfer of some maintenance responsibilities to them. This also allows more efficient working with dedicated maintenance resources (internal and external) when required.

Productivity Maintenance report

Section 2

Internet survey of UK printers

On-line web questionnaire methodology

The questionnaire was used to gather data and assess the current status of maintenance in printing companies in the UK. This was to enable assessment of maintenance practices across a much larger group of companies than could be visited by the consultants.

The survey was designed to be completely anonymous. The names of the participating companies were however provided to Vision in Print, but to ensure anonymity of respondents these were linked to the answers by a random code, known only to the research team.

In order to provide a rapid response to those who had completed the questionnaire, the answers to some of the pertinent questions were scored, to provide an instant grading. This is discussed in more detail in the next section on the full analysis of the questionnaire.

The questionnaire was grouped into four sections:

Section 1: Classifying questions

These were to derive information on the respondents such as their principal business segment and what processes they used. The level of activity was derived from the number of hours the presses were operated and information on the size of the jobs. It also included details on the company size, whether they had maintenance staff and whether they were effectively independent. In order to put the answers for the remaining sections in context, this section also established the role of the person completing the questionnaire, whether they were satisfied with the company performance and if the company was ISO 9000 certified.

Section 2: Current Maintenance Status

The first question was to establish the respondents view on maintenance. The remaining questions explored what procedures and maintenance plans they had in place and how effective these were. The intention was to use the questionnaire to establish the company's position on the maintenance staircase. The questions were targeted to explore the company's maintenance strategy with respect to the adoption of the suppliers' maintenance procedures, the use of non OEM components, impact of keeping spares and restorative maintenance. This included additional supportive information, such as the cleanliness of the working environment and the role of the operators in the maintenance process. 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. Some of the questions examined condition monitoring at all levels both formal and informal.

Section 3: People Power

As the WOCG report and other studies have concluded, it is the role of the staff that are critical to effective maintenance, so this section sought to explore the extent to which the workforce were integrated into the maintenance/productivity process. It also sought to reflect the company attitude to maintenance through graded questions on importance of aspects such as top down priority, integration in production scheduling, check lists, etc.

Section 4: Key Performance indicators

This section explored the extent to which the company monitored Key performance Indicators as a way of managing productivity. The respondents were asked to identify which KPI's they used, how often they were discussed and at what level in the company. Finally, the companies were asked if they benchmarked with other companies.

Internet survey results

Profile of the respondents

The on-line survey was completed by 86 companies. The majority were commercial printers (55%) with equal numbers in publications and packaging, a few were from other segments, such as metal decorating.

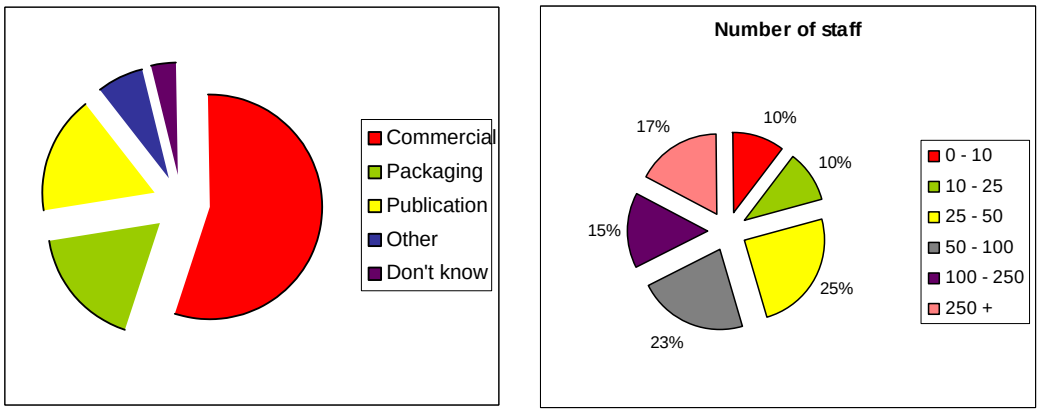


Figure 1. *Nature and size of the companies completing the survey*

The survey was mainly completed by senior or line managers. The majority of companies are small with 45% employing less than 50 people while only 17% employ over 250. Two thirds (64%) are completely independent sites with a further 18% financially independent although part of a larger group. Just over half the companies have maintenance staff (55%).

Printing processes

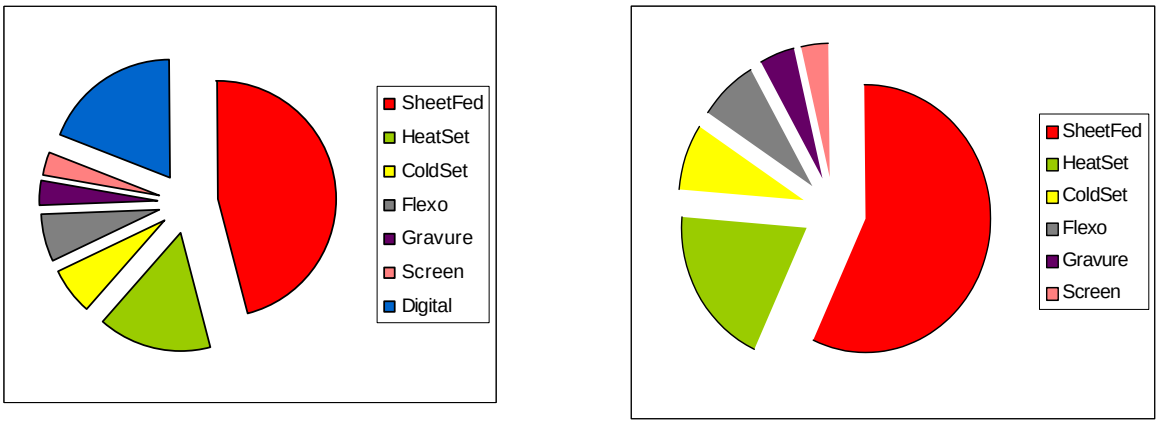


Figure 2. *Printing processes (left includes those with digital printing and or proofing devices).*

The majority of companies use sheet-fed litho (57%) and 19% also have a digital press for either proofing or for short runs — no company operates only digital. Therefore, while figure 2 reflects the overall proportions of each process on the left, the chart on the right shows the proportion of the major processes used by the companies who responded to the survey.

Pre-press

Most companies (91%) have in-house prepress with 77% using CTP (13% of them retain film processing) and only 14% rely solely on film.

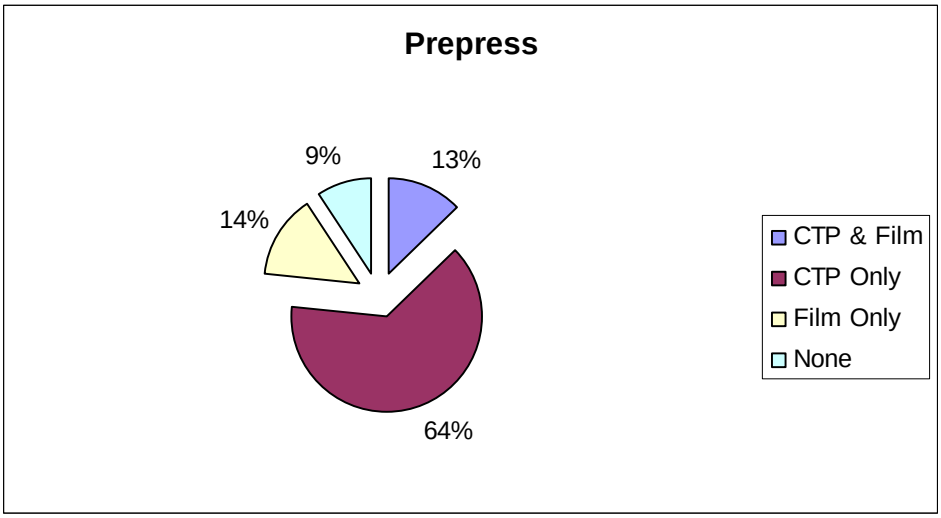


Figure 3. *Pre-press processes*

Post-press

Most companies (98%) have post-press finishing equipment. The majority is operated off-line enabling printing and finishing to function independently and reduce the impact of any major failure.

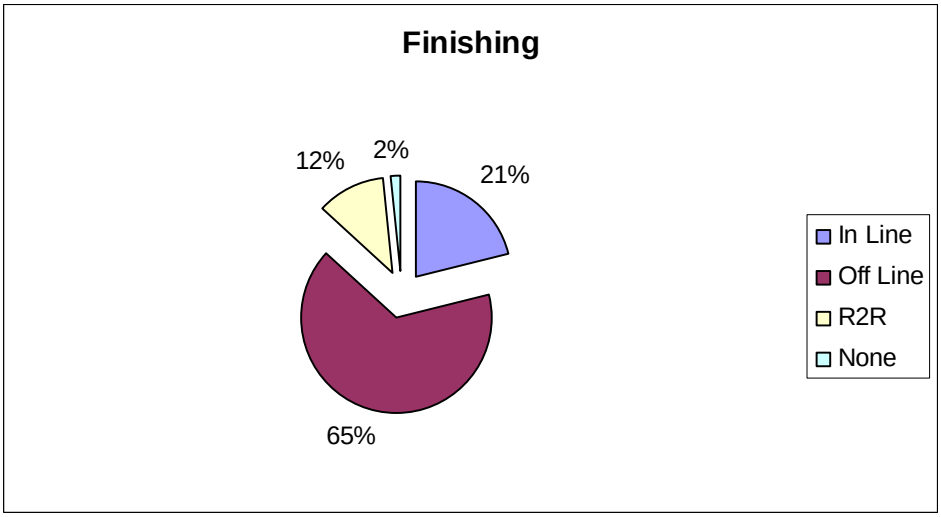


Figure 4. *Almost all companies have post--press equipment. The majority of finishing is off-line — roll-to-roll (R2R) could also be classed as off-line.*

Post-press equipment

The three most popular pieces of finishing equipment are guillotines, folders and saddle stitchers — 70% have a guillotine, over a third have a folder and a further third a saddle stitcher as well. This reflects the number of commercial printers in the survey that are equipped to process jobs completely in-house.

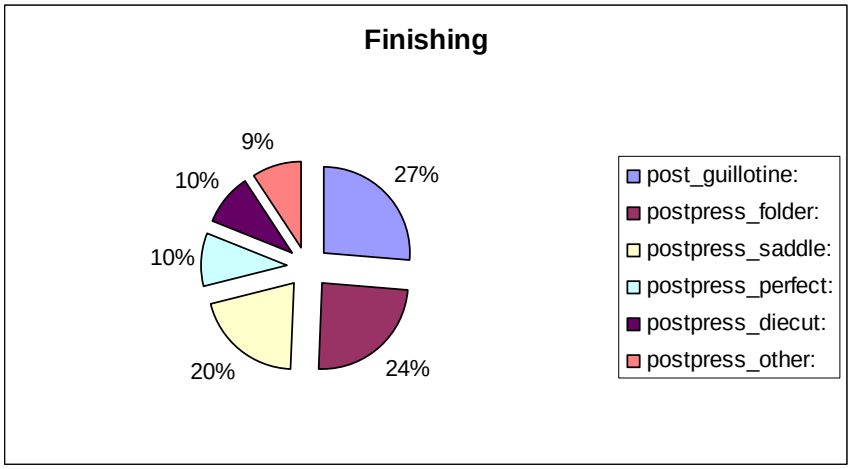


Figure 5. *Proportion of finishing equipment*

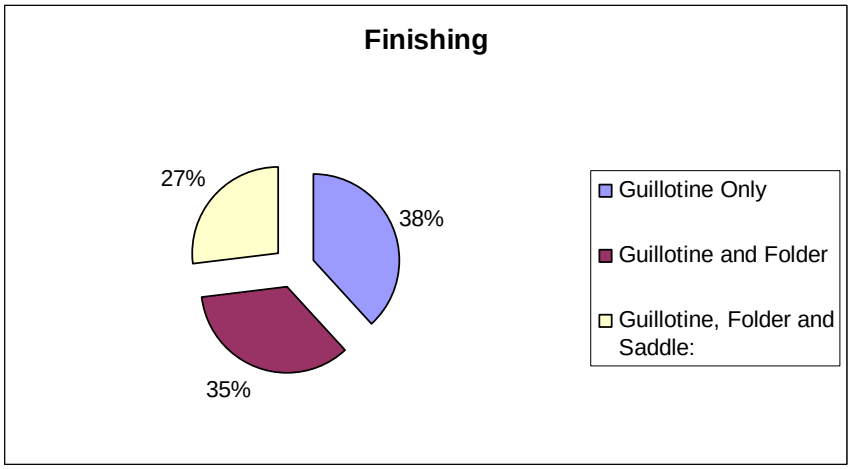


Figure 6. *Analysis of printers with a guillotine*

Interest in maintenance

The survey attracted people who have an interest in maintenance — 99% believe that effective maintenance improves production. However, this probably does not reflect the industry as a whole, as those with no interest in maintenance probably have not responded. The general attitude of the company is also typified by the high number (60%) accredited with ISO 9000. The survey therefore reflects the view of the more enlightened part of the industry. Although almost all respondents think that maintenance improves productivity, only 64% have a maintenance system. This reflects the hurdles to implementing a maintenance system in small companies, probably due to a lack of resources or understanding.

There were sufficient responses to provide meaningful results for two sub group: (a) sheet-fed printers and (b) companies with some sort of maintenance system. This allows the impact of improving maintenance procedures to be compared with all of the respondents and with the sub groups.

In terms of the printers whose main business is packaging, there is a higher proportion in sheet-fed compared with the whole of the survey. Sheet-fed was the only printing process used by 39% of the

respondents in this group, 31% have digital presses reflecting the need for commercial printers to be able to cost effectively offer short print runs to customers. The next highest proportions were coldset and heatset web offset printers with integrated high volume operations.

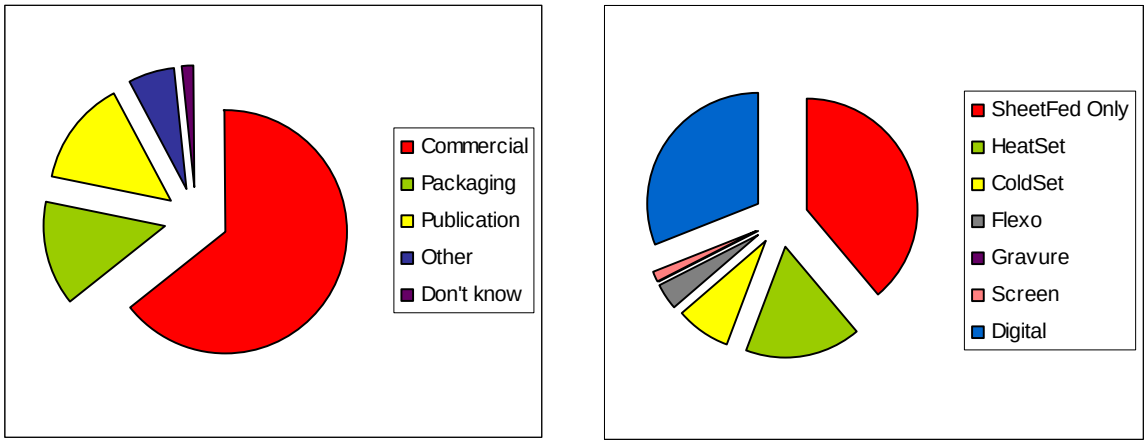


Figure 7. *Nature of business and printing processes for companies using sheet fed offset*

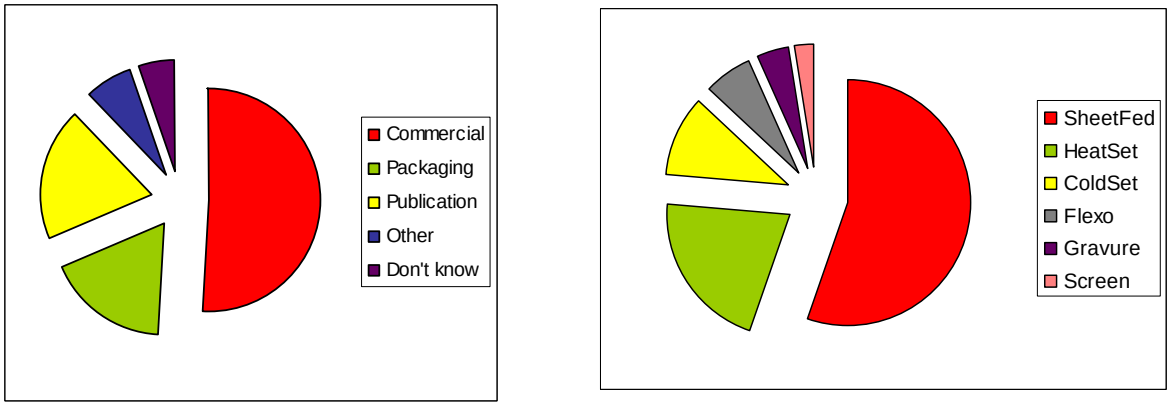


Figure 8. *Nature of business and printing processes for companies with a maintenance programme*

Companies with a maintenance system tend to be larger than the average of all respondents — more large companies (> 250 employees) and less small companies (< 50). In contrast, sheetfed tends to be smaller with a higher proportion of small and very small companies.

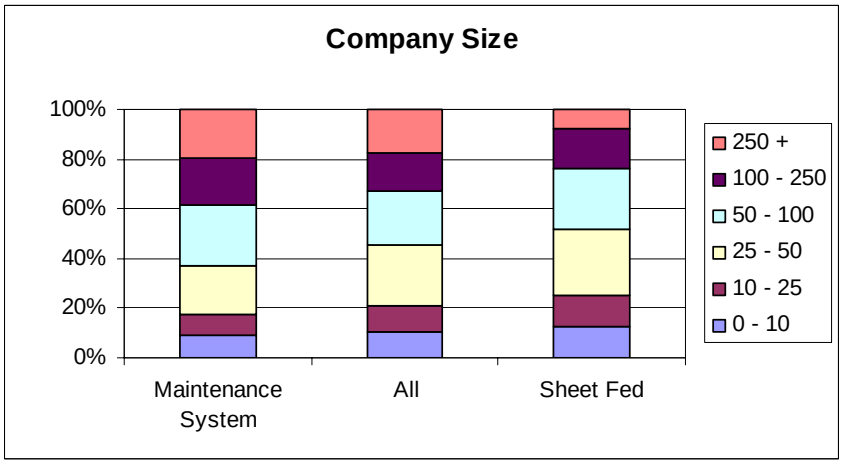


Figure 9. *Size of the companies in the survey*

Maintenance performance

Only 30% of all respondents are satisfied with their current maintenance performance (Fig. 10). Those with a maintenance system feel they were doing better. More sheet-fed printers feel satisfied (than the average) with their performance for productivity and waste. However, those with a maintenance system still felt they had scope for improvement — this reflects that those with a system have the methodologies in place to analyse all aspects of their performance and are more aware of opportunities for improvement.

Figure 10. *Satisfaction with current performance.*

Company size and maintenance staff

There was little correlation between the size of the company and whether it had any maintenance staff (Fig. 11). All companies with more than 85 staff have dedicated maintenance staff. Small companies with a dedicated maintenance staff appear to have a disproportionately high staff effort for maintenance (the survey did not quantify if the staff are part-time or if they perform other functions too). As companies become larger, the proportion of human resource dedicated to maintenance tends to average 5 to 9%. This is a wide range as few companies are totally self-reliant and bring in additional resources (suppliers or sub-contractors) when needed.

Of the 57% of companies with no maintenance staff: 73% have a maintenance system and 23% do not.

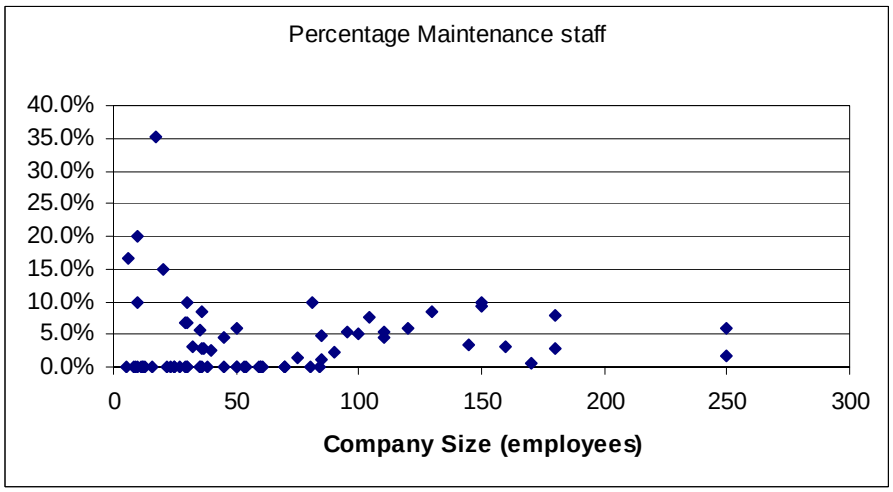


Figure 11. *The percentage of dedicated maintenance staff to total number of employees*

Over 40% of surveyed companies employ no maintenance staff (Figure 12). Nearly 75% employed 5 or less. Therefore, printers generally maintain their equipment by relying on a few internal specialists, plus the part time resource of their operators supplemented by external services.

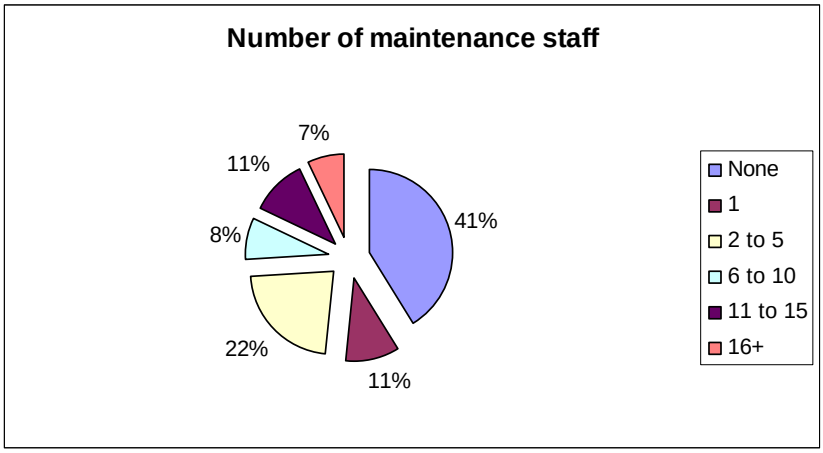


Figure 12. *Total number of maintenance staff employed per company*

Maintenance skills

The skills of maintenance staff appear to be evenly distributed (Fig. 13) with a slightly higher proportion of multi-skilled technicians, but this result will have been biased by the larger companies who employ multiple staff with dedicated skills.

When the skills range of staff employed at individual companies is analysed (Fig. 14), then the majority of companies have either only a multi-skilled maintenance staff or a combination of multi-skilled and mechanical. This reflects the findings throughout this survey that printers are reluctant to tackle electronic and hardware related problems, but are happy to address issues related to the mechanics of the press and postpress.

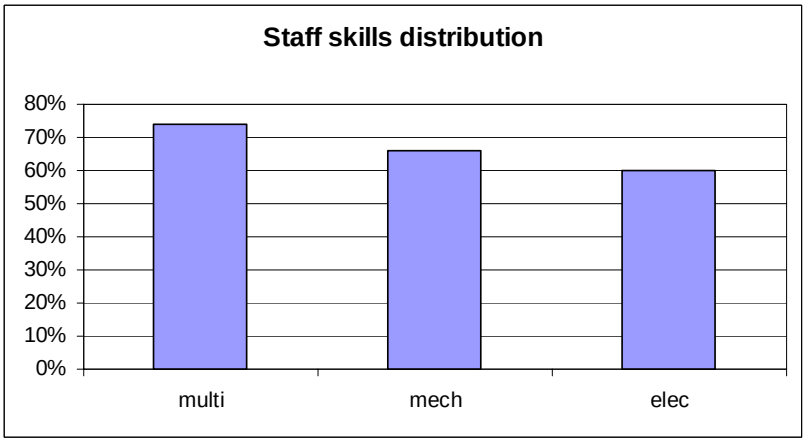


Figure 13. *Maintenance staff skills distribution*

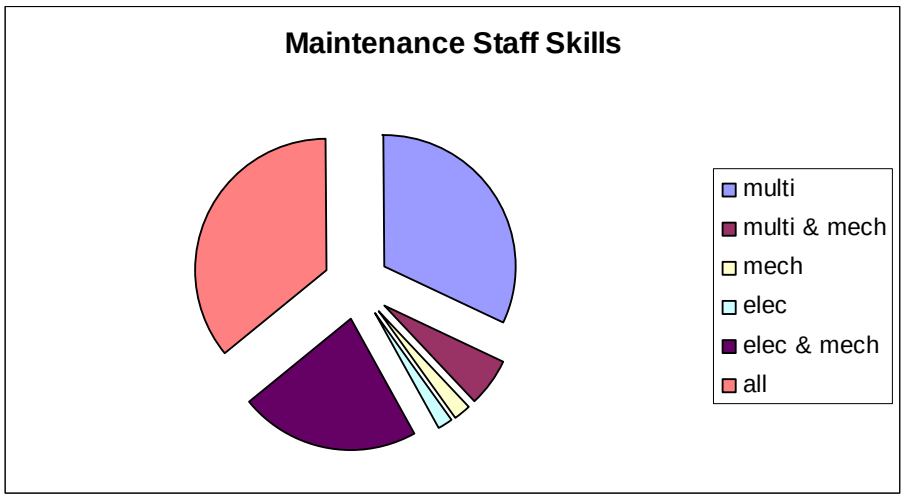


Figure 14. *Distribution of maintenance staff skills by company*

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 industry's structure.

Maintenance Practices

To give immediate feedback to companies completing the questionnaire, their responses in sections 2, 3 and 4 were scored. The first provides a profile of their performance in terms of the maintenance staircase — responses were scored in sections for "fix it when broken" (as and when), restorative, planned preventative and condition monitoring. As the company progresses from no maintenance plan through to productivity based maintenance, then there will be a shift from the scores being solely in the "fix when broken" (i.e. no strategy) to a set of results that spread across all three categories. This indicates which maintenance approaches are used in their plant. Companies with a distribution across the four categories have the more enlightened maintenance approach. It is important to note that it is not necessarily wrong to use the "fix it when broken" approach for some processes (see examples from other industries).

The maintenance scores of the respondents (figure 15) is representative of companies with an interest in productivity who 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 is probably biased by the attitude to maintenance expressed by the respondents in the opening section of the survey).

The group of companies that state they have a maintenance programme have a strong emphasis on preventative maintenance, with almost no "fix when it breaks", but a surprisingly low score in the predictive area. The development of a strategy would appear to be at the predictive point on the productivity maintenance stairway.

There is an apparent dichotomy of scores with the sheet-fed group who are highest on the "fix it when it breaks" and predictive. This reflects that smaller size companies are often forced to use an "as and when" approach to the majority of repairs. However, their operators tend to more readily detect the changes that herald the onset of failure, possibly this is because in smaller companies there is more operator "ownership" of equipment.

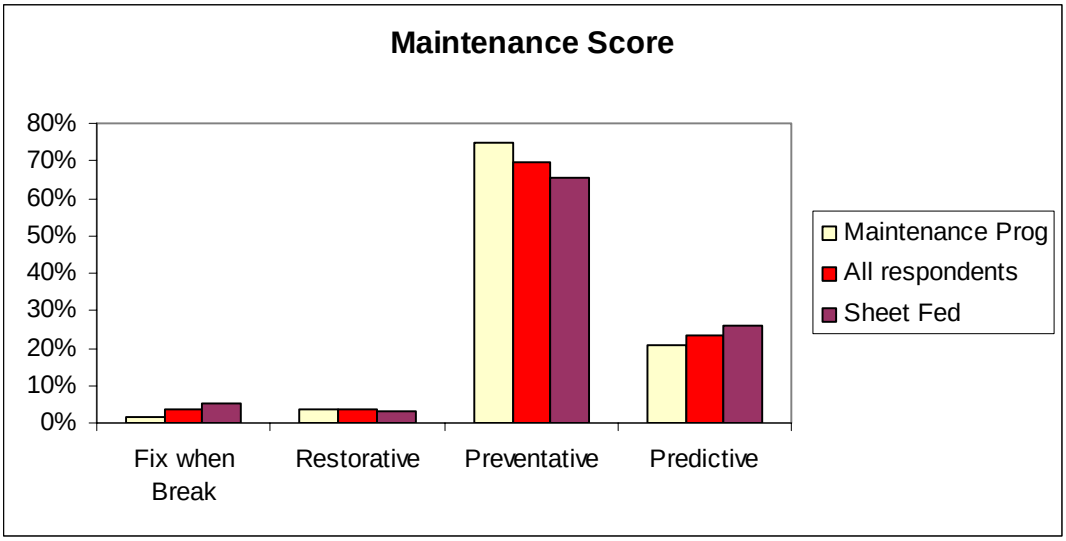


Figure 15. *Average maintenance scores. Companies with a distribution across the four categories have the most enlightened maintenance approach.*

Introduction of maintenance programmes

There is a steady trend of companies introducing maintenance programmes since 1997. There has been no step change or indication of the impact of any awareness campaign. This would suggest that the adoption of a maintenance strategy is just another tool in the pursuit of improved productivity and competitiveness.

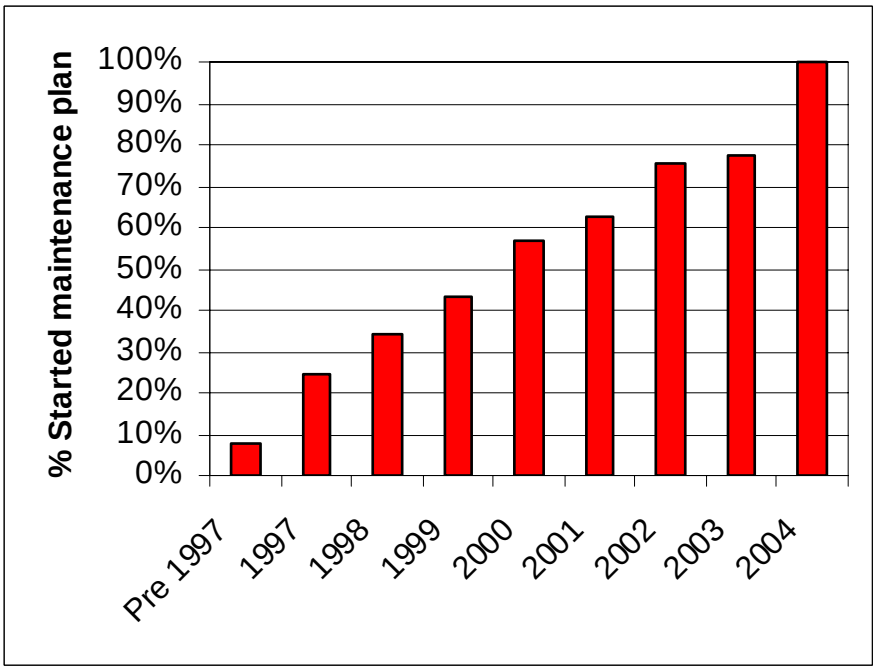
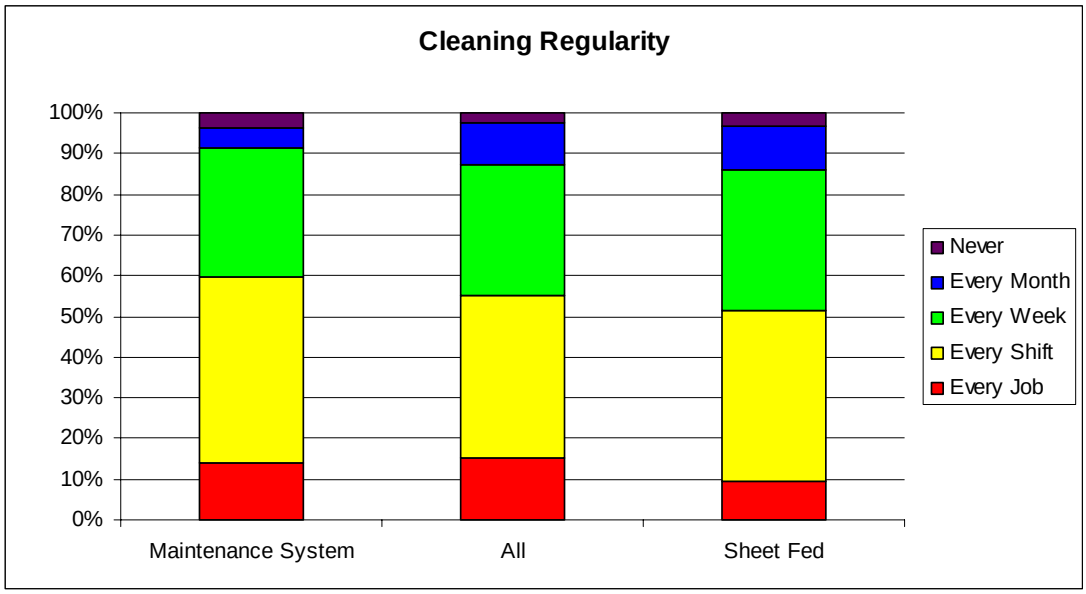


Figure 16. *Date of introducing maintenance programme*

Cleaning, inspection and lubrication

Cleaning is fundamental to productivity maintenance because it also facilitates equipment inspection. Therefore it is no surprise that 89% consider their plant to be moderately clean and the balance very clean. Lubrication is the other main stay of productivity maintenance. Both these tasks are routinely performed by operators. Cleaning is made more regularly — in over 75% of plants at least once a week, usually every shift and in some cases, for every job. Lubrication is normally weekly and in some cases monthly. Companies with a maintenance programme tend to have their operators clean and lubricate their machines more frequently. The sheet-fed group tends to pay less attention to these activities than the average.



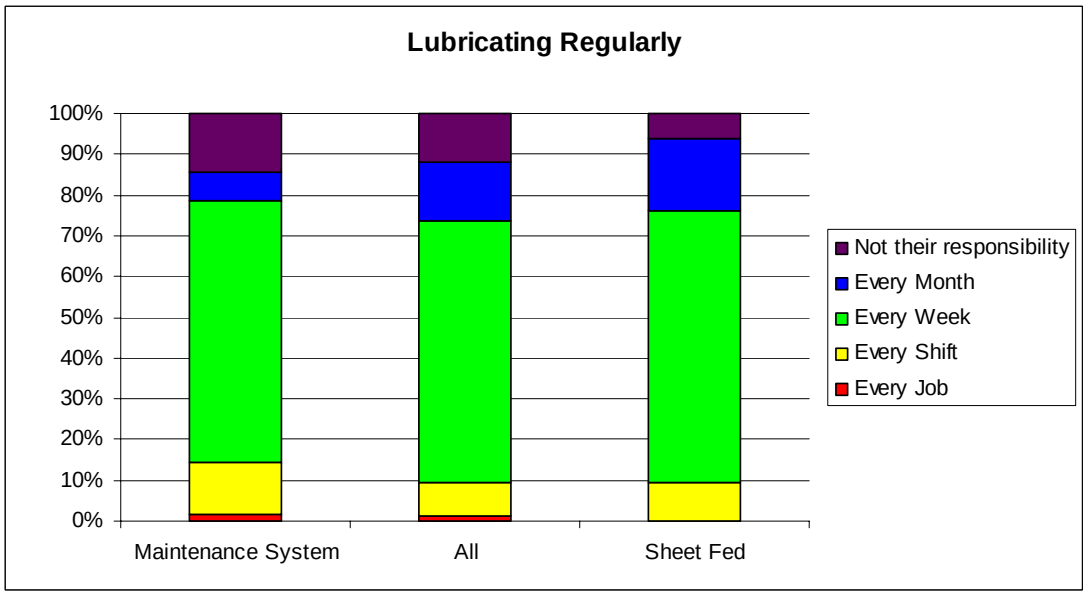


Figure 17 *Task normally undertaken by operators.*

Planned Maintenance & Standard Operating Procedures

The majority of the companies have a planned maintenance programme for their major capital items. Figure 18 shows 31% have a planned programme for all of their equipment and 39% for three-quarters of their equipment. The average of all respondents, and the sheetfed-only group, is almost identical. This suggests the difference is across the board; therefore the group with a maintenance programme are distinctly better in planned interventions.

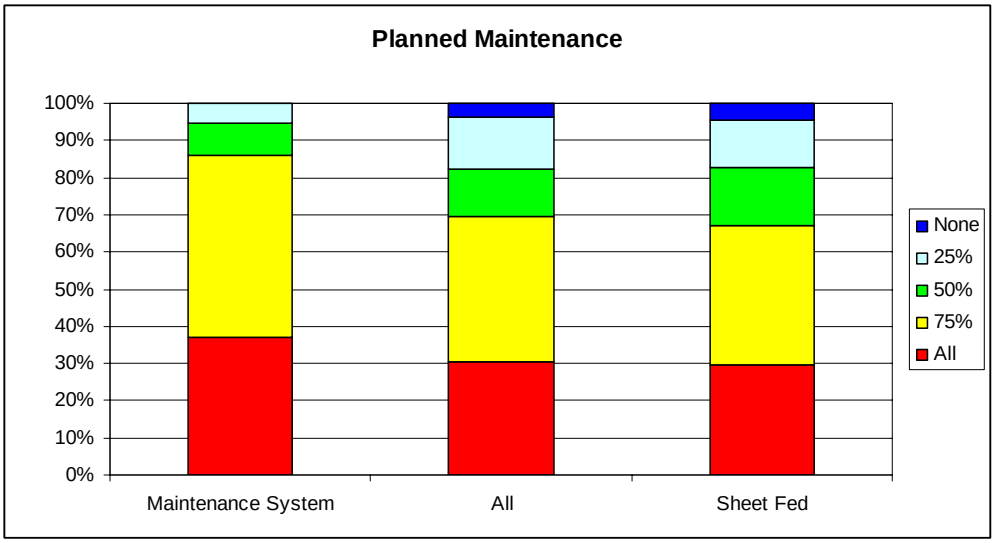


Figure 18. *Proportion of equipment for which there is planned maintenance.*

It is not surprising that the group with maintenance systems rely heavily on standard procedures for maintenance (Fig. 19).

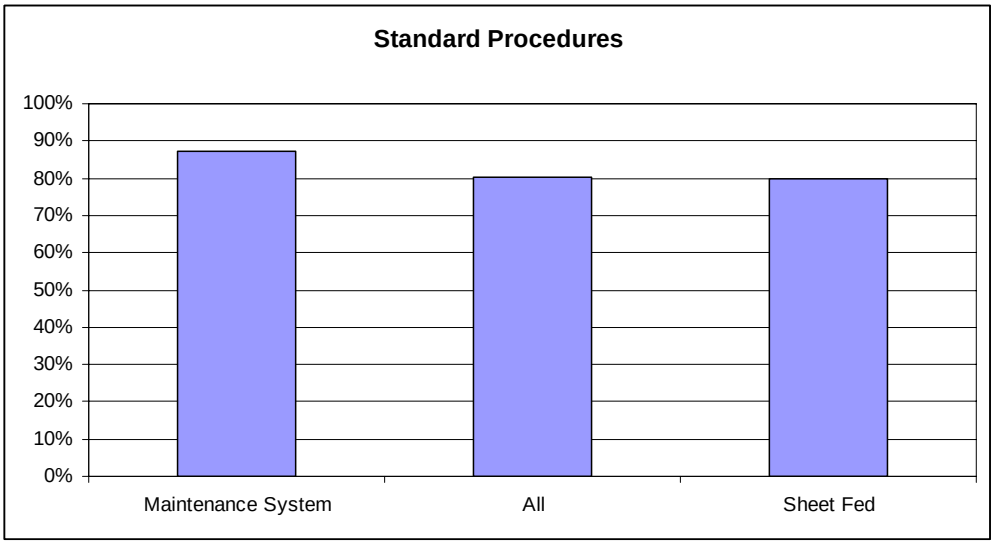


Figure 19. *Use of standard maintenance procedures*

Spare parts

Very few companies (10% or less) replace components at the interval recommended by the manufacturer. This suggests (a) the frugal attitude of printers and (b) implies that the intervals recommended by manufacturers are different to those in practice. This is not surprising, as this and other studies find that the same equipment often works very different duty cycles of run length and speed that effect the expected life of components. The group with a maintenance programme placed a greater emphasis on inspection and monitoring output to decide when to replace components. Production is occasionally stopped due to a lack of spare parts (82%) and only 6% frequently experienced losses of production.

Only 15% never use third party consumables, while 26% frequently use them — 97% ensure their compatibility before use most of the time, 77% all of the time.

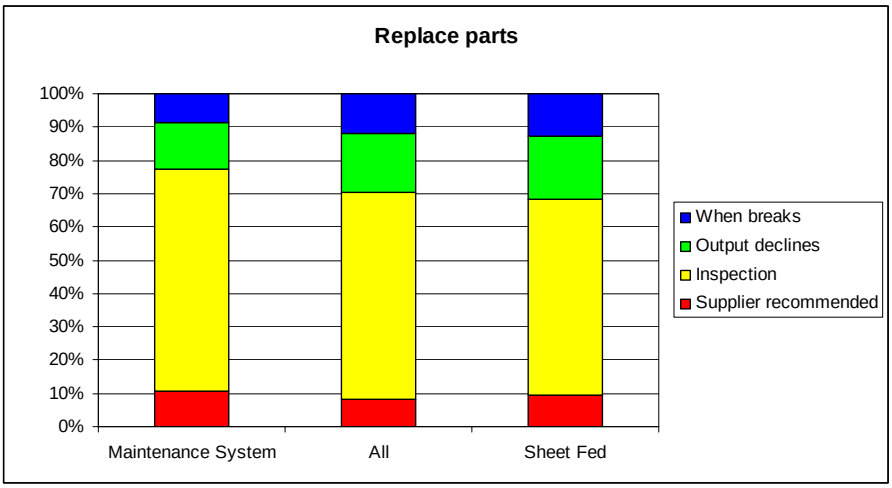


Figure 20. *Frequency of replacing critical parts*

Maintenance recommendations

Most printers follow the OEM's recommendations and there are a number who do more than is suggested in the manual for some pieces of equipment (Fig. 21). It is quite likely that feedback from end users could assist the suppliers to develop more effective maintenance procedures for all customers. Both the sheet-fed group and the maintenance programme group all did more than was recommended. 80% of companies have standard operating procedures for maintenance and 68% keep a log-book for most of their equipment.

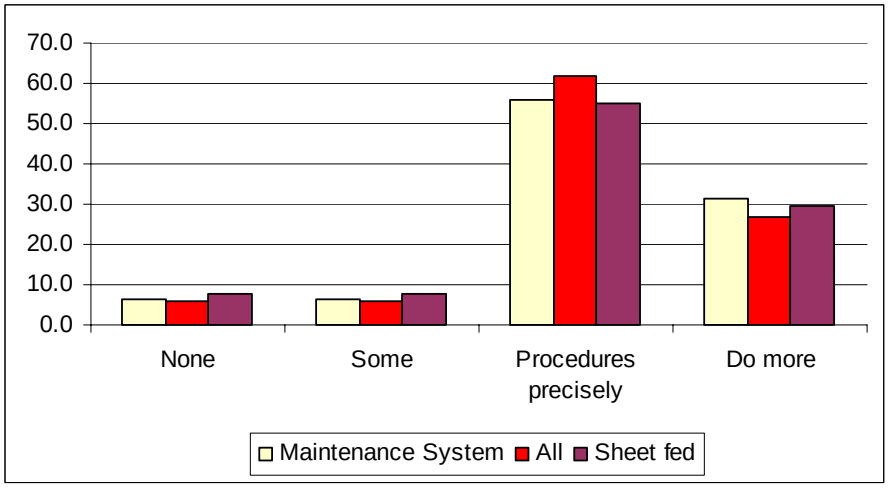


Figure 21.

Extent to which the manufacturers' maintenance procedures are followed.

Third party parts

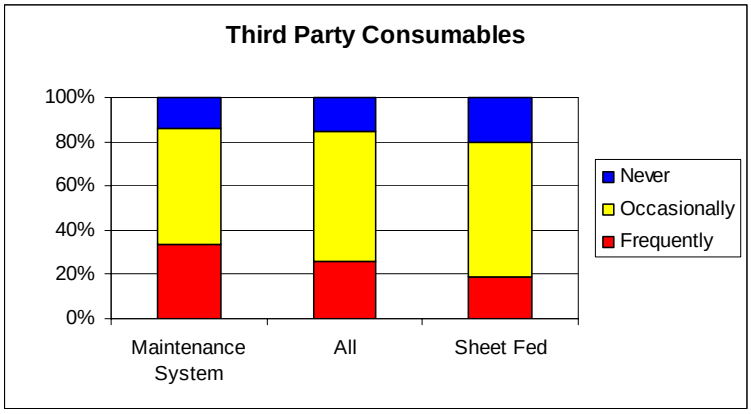


Figure 22

Use of third party consumables parts.

All respondents occasionally used third party consumable parts. The group with a maintenance programme are more confident users of third party products reflecting a side benefit of the programme.

Parts availability and down-time

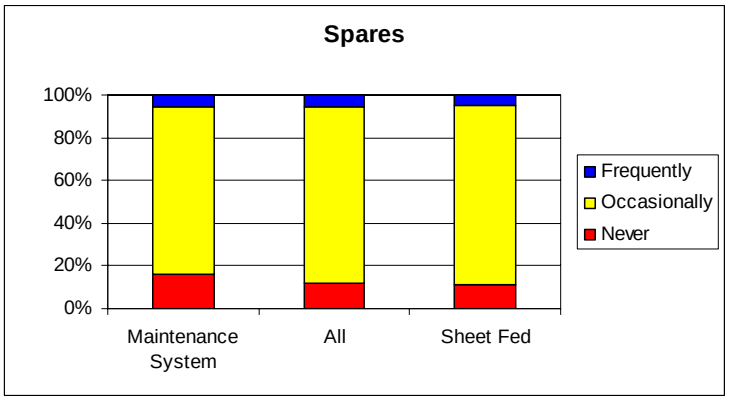


Figure 23

Losses in production due to equipment breakdown and lack of spares

Shutdowns

Few respondents shut down plant for restorative maintenance, those that do undertake them annually. 50% of the group with a maintenance programme have routine shutdowns for restorative maintenance.

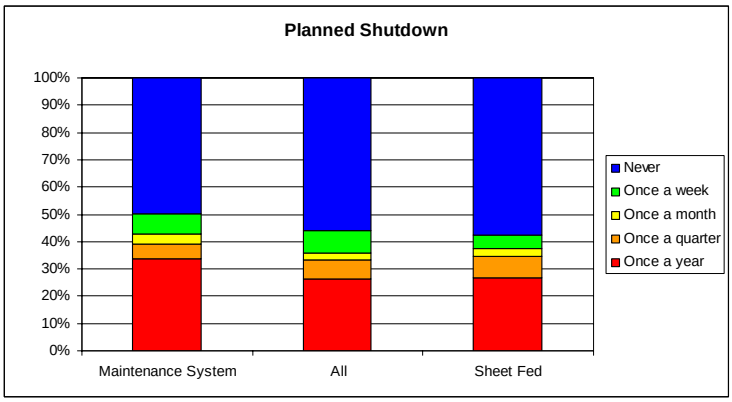


Figure 24

Frequency of restorative maintenance.

Condition monitoring

Over half of the respondents expressed that their operators use their senses for condition monitoring, i.e. operators look and listen for changes that indicate deteriorating machine condition. Even some of the most advanced systems used by the military accept that operators can frequently provide the best early warning of failure due to their ability to simultaneously compare multiple inputs — something that neural network technology is only barely able to mimic.

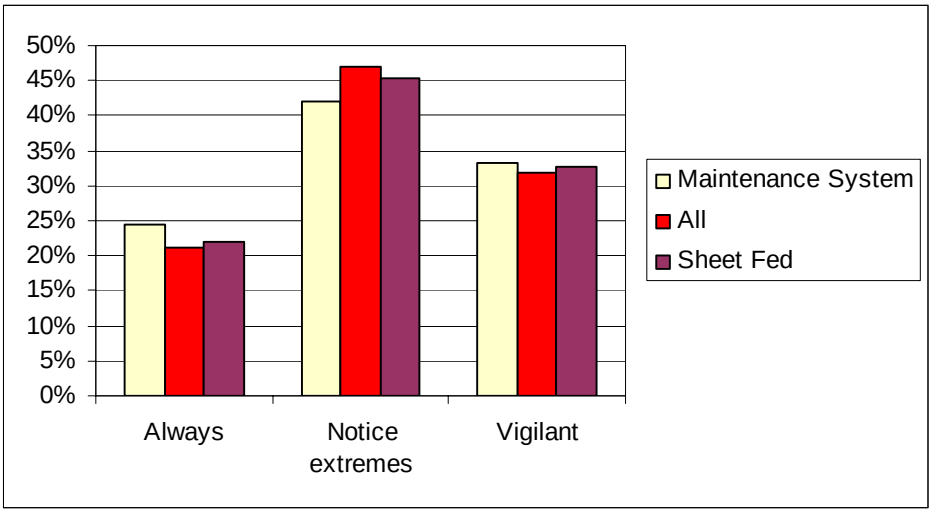


Figure 25 *Operator based condition monitoring*

All companies believe their operators notice extremes, but both the maintenance programme and sheet-fed groups feel that their operators detect more changes (Fig. 25). The group with maintenance programmes has the highest score in noticing extremes and being more vigilant —this reflects the effectiveness of their training and general staff involvement.

A number of the companies condition monitor power, temperature and quality. Little use is made of vibration monitoring that is widely used in other industries where plant is rotating continuously such as pumps or fans — this is inappropriate for sheet-fed because the shock loads from the passage of sheets would swamp the subtle changes detected by the system.

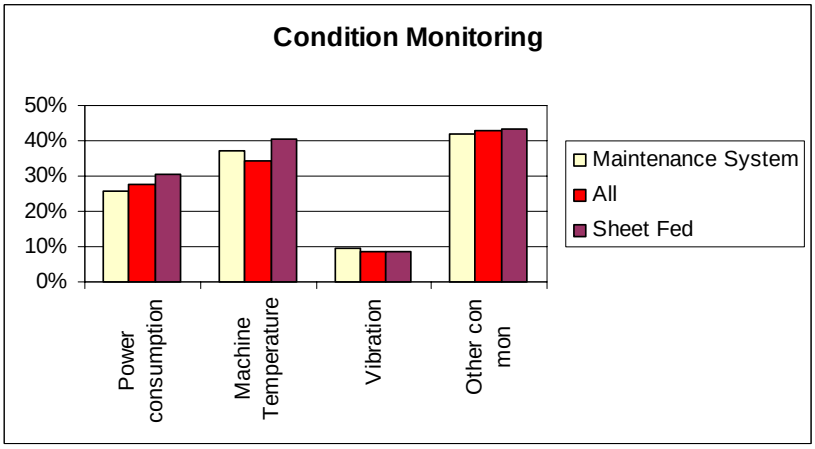


Figure 26 *Use of Condition Monitoring*

While there is different emphasis between the groups of respondents, all have some form of condition monitoring, some of which are monitored continuously. The primary use of data from sensors (nearly 50% of the sheet fed and the overall group) is to identify the cause of failure — not to predict failure (Fig.27). The maintenance programme group monitor condition most frequently and only 30% use data to identify failure cause.

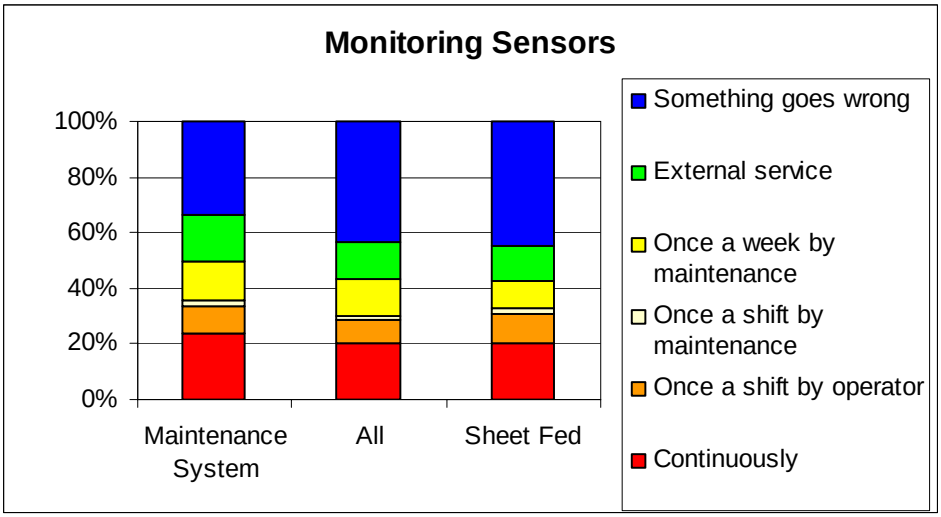


Figure 27 *The frequency of checking sensors.*

Benefits from maintenance

Companies with maintenance programme see the perceived payback mostly in terms of fewer press stops, followed by benefits of higher throughput, more consistency and less waste.

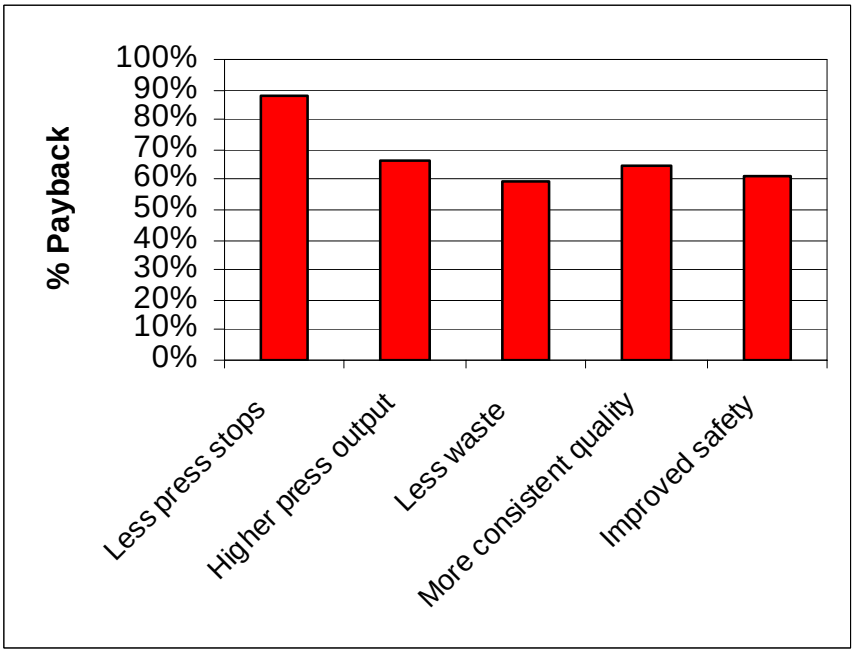


Figure 28. *Pay back of maintenance programme*

The remaining results are divided into the response for all the respondents and for the sub groups. This highlights the advantages gained by those with a maintenance programme.

In spite of respondents belief that maintenance is critical to improving performance they were still experiencing some loss of production due to breakdowns. This was broken down into chronic short stops (10 minutes to 3 hours) representing inconveniences (but still a significant loss of productivity) and more major sporadic failures. Although the group with the maintenance programme appear to be less effective at preventing short stoppages this is probably because they have more accurate record keeping.

It is important to bear in mind that the answers to these questions are based on the respondents' perception of their performance and is not based on actual production data. Another issue is the definition of what is a maintenance-related stop. For example, if a press is stopped to re-set the inking rollers or repack a blanket — normally routine operator maintenance — then this is an unscheduled stop due to lack of preventive maintenance.

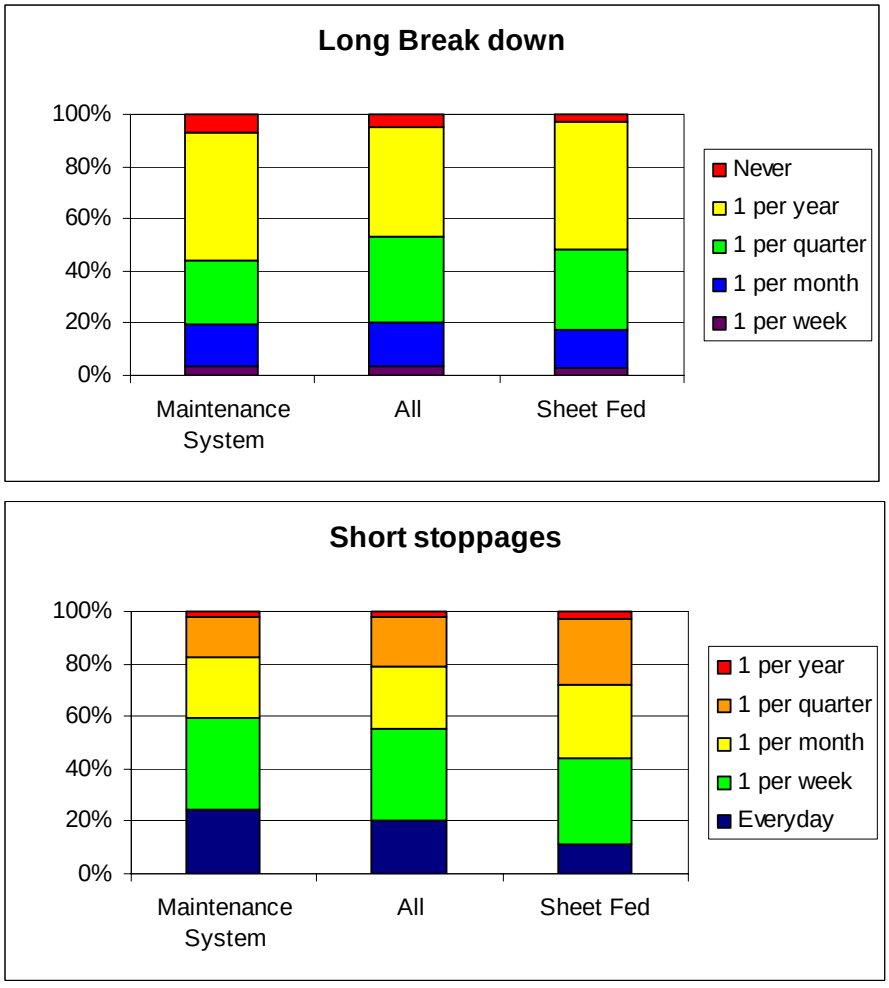


Figure 29 *Losses in production due to equipment breakdown. The cumulative effect of multiple chronic short stoppages is extremely high.*

Output speed

In terms of productivity, the majority of presses and post-press equipment was operated at between 40 and 80% of design speed. There is considerable scope for improving productivity by increasing the operating speed. In this aspect the group with a maintenance programme tend to operate at higher speeds.

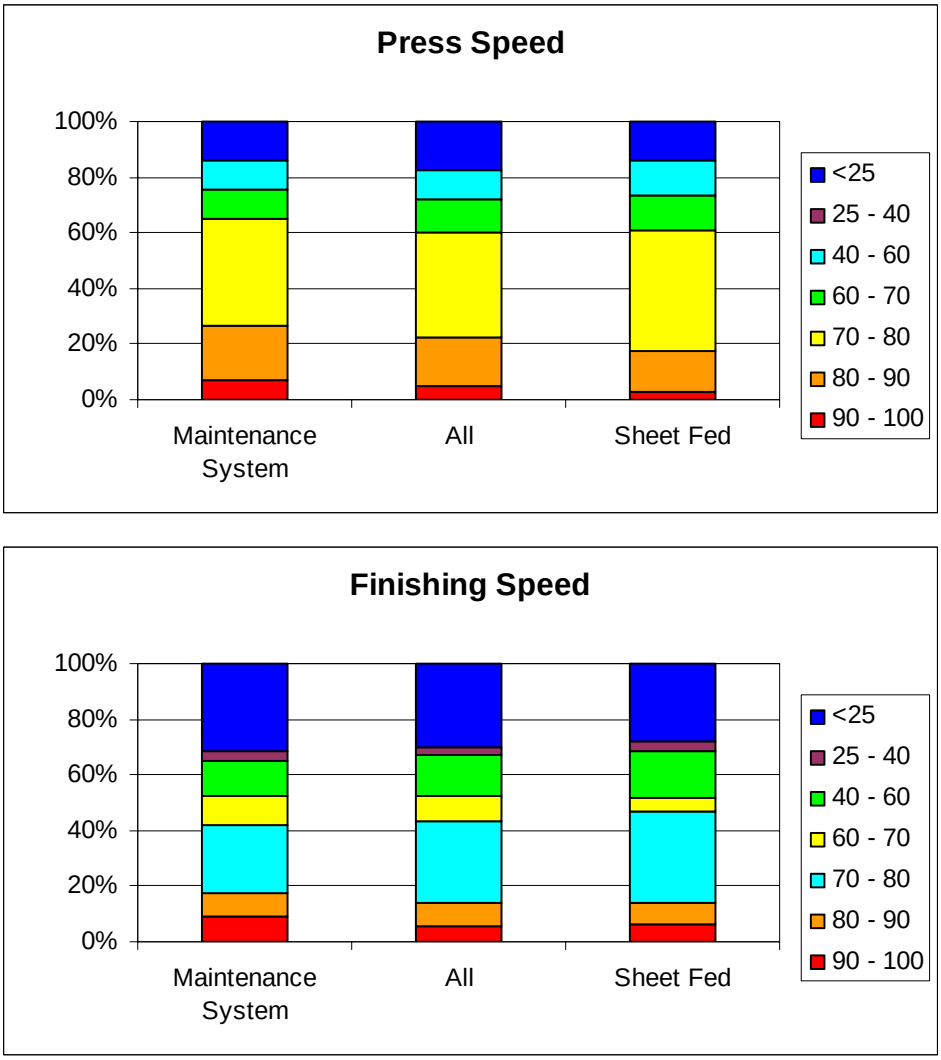


Figure 30 *Operating speed for presses and finishing equipment*

Management of Maintenance

The other information fed directly back to the respondents related to their management of maintenance. The people power was scored on key questions to judge the extent to which the whole work force is involved in the process and is shown by columns 1. Similarly, the questions on availability, speed and failures were used to produce an indication of understanding of economic impact of breakdowns shown by columns 2. Columns 3 shows the KPI (Key Performance Indicators) score and relates to the number of indicators that the company routinely records, the frequency at which they are recorded and management involvement. (An arithmetic total based on one point per box ticked and a weighted scale for the frequency.) Those with a maintenance programme did better in all of these analyses. The implementation of a maintenance programme requires significant operator participation and this implies a culture of employee involvement.

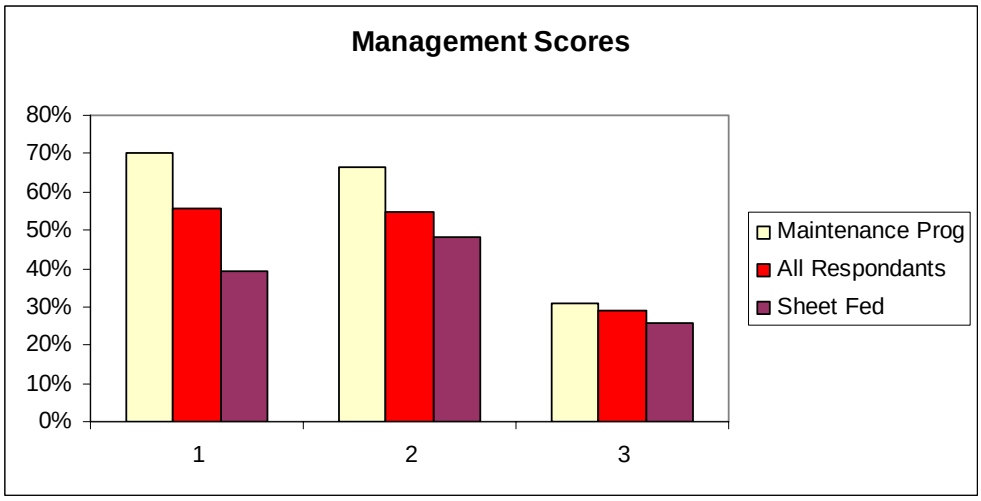


Figure 31 *Average management scores fed back to the respondents.*

Responsibilities

Although 59% of companies involve operators in maintenance, only 43% give them any specific training. Operators play a major role in routine maintenance and cleaning whilst more major tasks are made by internal maintenance staff or external suppliers.

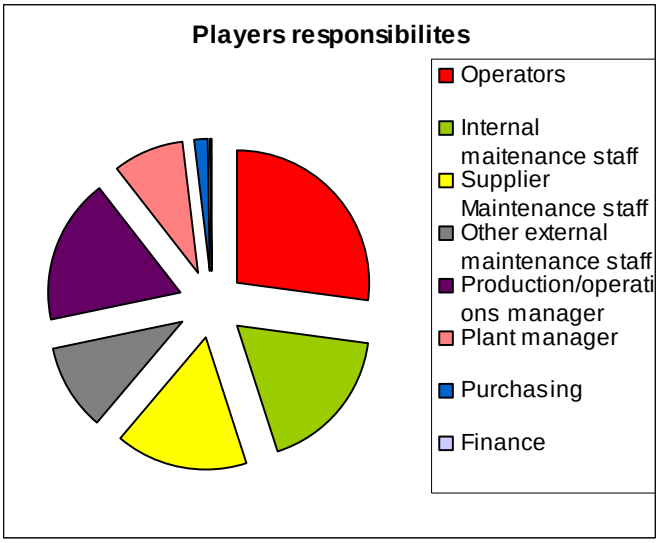


Figure 32 *Responsibilities for maintenance*

Team meetings

Team meetings reflect the integration of production staff into the management process — they are mostly held at monthly intervals. However, a significant number of companies have no team meetings that indicates a more autocratic style of management.

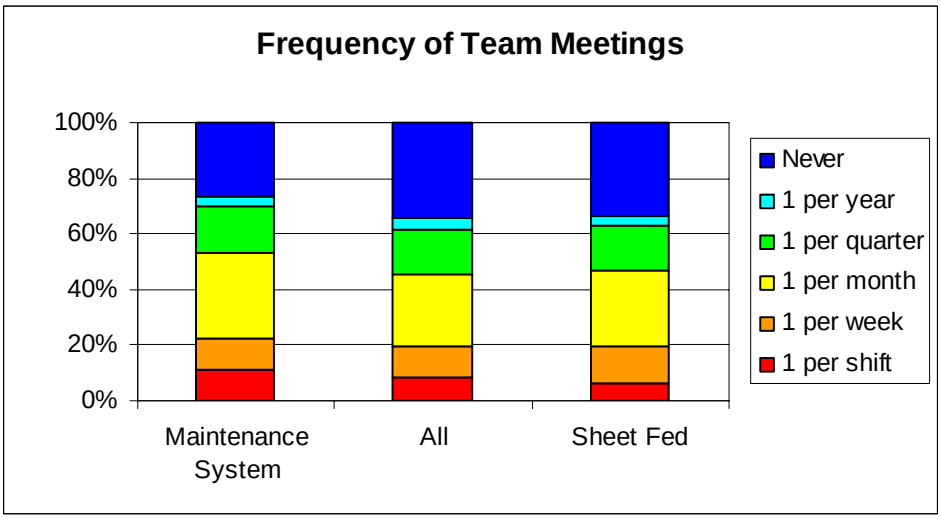


Figure 33 *Frequency of team meetings*

Successful implementation

Respondents were asked to assess the importance of different aspects of the management system that impact on the successful implementation of a maintenance programme (using a graded score Very high to Very low).

- The most important 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, as well as the need for standard operating procedures highlighted in the survey.
- The need to match tasks to skill levels (sum of scores for high or very high importance) is also high.
- Matching skill levels is perceived to be quite critical as most respondents stated in a previous question that they provided little maintenance training to operators.
- Holding stocks of spares is seen to be the least critical. Only a small amount of time is lost through the non-availability of spares — this suggests that most of the printers in the survey have identified critical spares to stock.
- A surprisingly low score is attributed to monitoring of KPI's, because these help identify opportunities for improvement and provide documentary evidence of maintenance benefits. KPI's are regularly monitored monthly or weekly but in some cases only quarterly. The production manager normally reviews the data and the head printer is also involved in some companies. Only 23% benchmark KPI's.

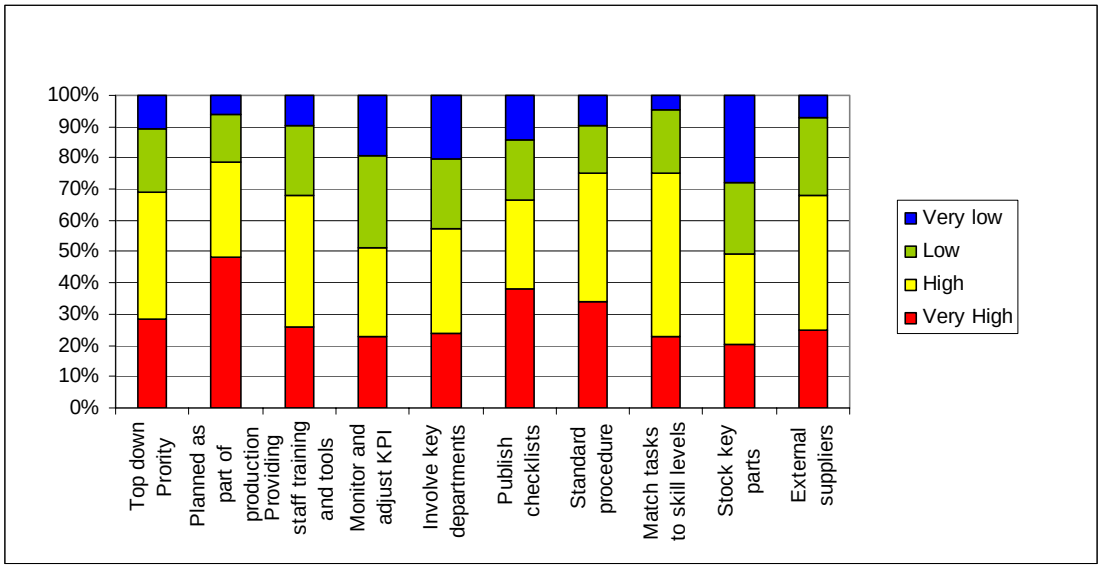


Figure 34 *Relative importance of different aspects of maintenance management.*

Companies with a maintenance programme rate most highly the key aspects of maintenance (planned as part of production, training, standard procedures and check lists) in comparison to the group as a whole and sheet-fed in particular (Figure 36).

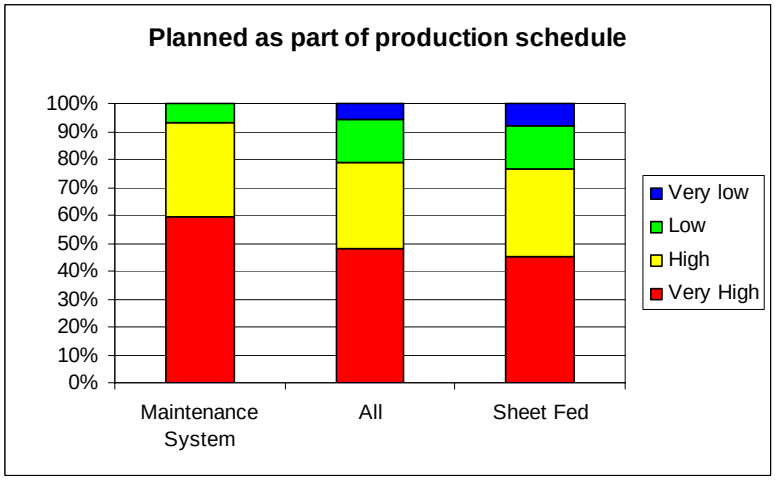
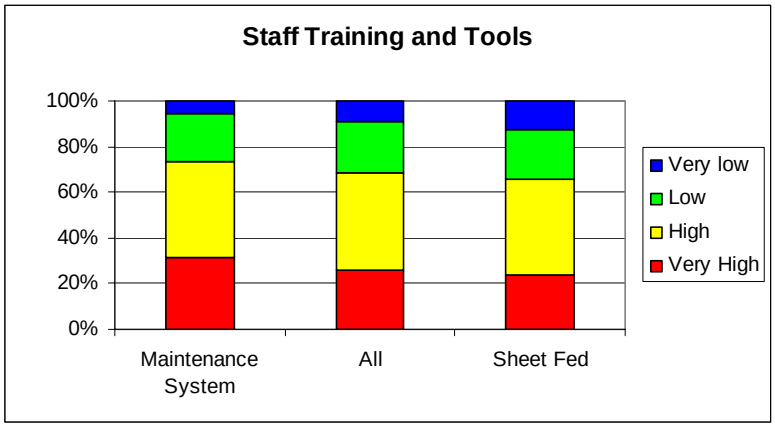
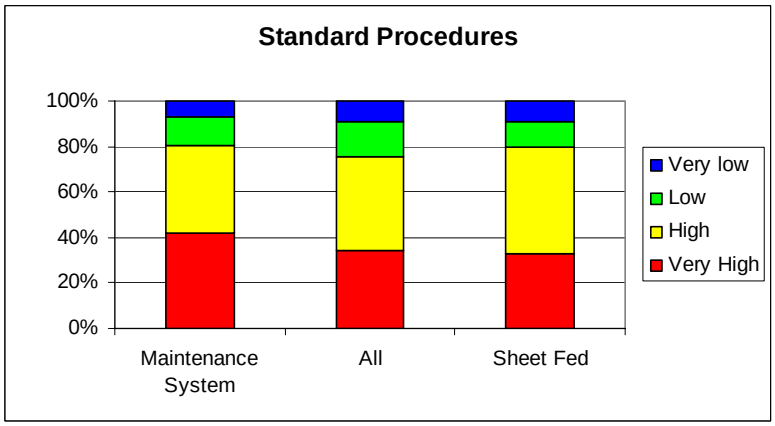


Figure 35 Companies with a maintenance programme plan their maintenance better.





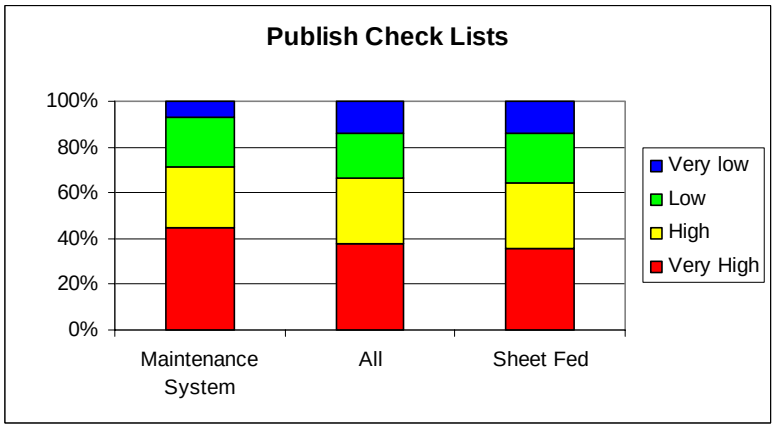


Figure 36 *Most significant aspects of the management system compared by group*

Key Performance Indicators (KPIs)

The majority of the companies evaluate some KPIs related to production availability and output. However, there appears to be a massive under measurement of what would normally be regarded as key data. eg. waste is not a popular measure even though it directly effects productivity and is generally the highest material cost. Maintenance specific KPIs tend to be related directly to chargeable costs: machine downtime, unplanned stops and costs of consumables. This may reflect the desire to make cost claims to suppliers.

Data more critical to improving reliability and availability while reducing maintenance costs are infrequently monitored (e.g. Mean Time Between Failures and the repeating of previous maintenance)

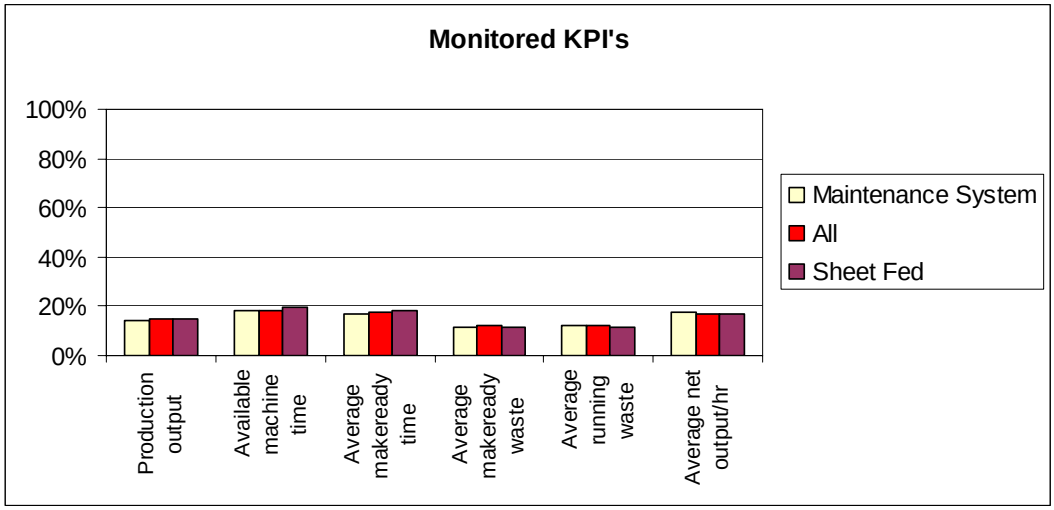


Figure 37 *Production KPIs*

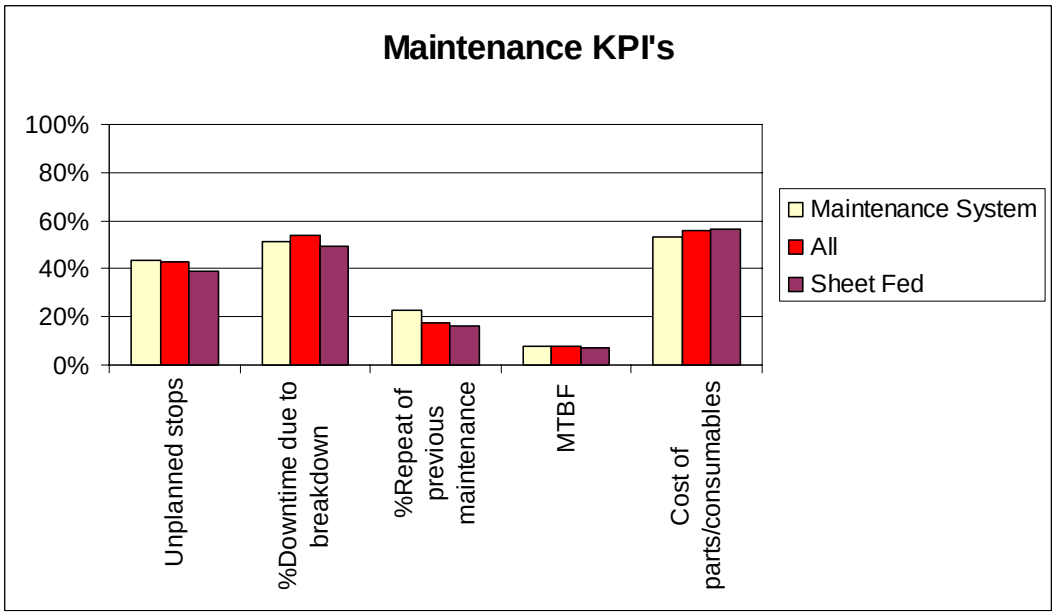


Figure 38 *Maintenance KPIs*

Productivity Maintenance report

Section 3

Mini case studies — what printers say

The following pages are summaries of the reports from non-structured interviews with staff connected with maintenance at 18 companies. The results of each interview have been structured to allow rapid access to key information.

N° 1: Sheet-fed Offset — Commercial printer

Size & intensity: 12 staff — 8 h/5days.

Operating snapshot: The company is located in a purpose-built factory constructed by the Welsh Development Agency. The printer invested in CTP and a new 4-colour press (with CIP and fully integrated set-up) but the original company went into receivership in January 2004 and was bought by another Welsh printer. The new company will invest in additional finishing equipment to satisfy the requirements of both sites (it has available space and can call on regional investment aid).

Maintenance approach: The company relies on its suppliers to service and maintain the equipment. It carries a few spares for consumable items. The operators are encouraged to monitor the machine, listening for any untoward noises such as from bearings as an early indication of impending failure. All defects are recorded in a logbook. As the location is remote from the main service centres, the supplier is called out to fix a number of problems at the same time.

Documentation: All defects are recorded in a logbook.

Maintenance staff: None

Production staff: Limited to simple routines and cleaning.

External maintenance: Company has a good working relationship with its suppliers.

Condition monitoring: Operators are encouraged to use their senses to detect changes in the performance of the machine.

Housekeeping: Good. New building purpose designed. Expanding finishing business means the print hall can tend to be cluttered and will be rectified when the company has extra space.

Spares: Consumables only. Spares order on JIT basis (see note above).

Maintenance results:

Operators monitoring the machines allows for scheduling repairs before breakdowns occur to avoid consequent loss of production. For example: Operators reported that a bearing was making strange noises that indicating deterioration to a possible failure. New bearings were ordered and a convenient service time was scheduled with the supplier to change bearings without interfering with production. Pairs of bearings were replaced because the stress on the partner bearing would have been increased and have a higher risk of failure in the near future.

Keys for success

- Experienced operators that can monitor equipment condition.

N° 2: Sheet-fed offset — Commercial printing

Size & intensity: 17 staff — 24 h/ 7 days.

Operating snapshot: Small financially independent group that provides a complete service from design through to finishing. The company has a digital press located in a different unit on the same industrial site serviced by the design department.

Maintenance approach: Scheduled and breakdown.

Documentation: Maintain log book on each press as a record of breakdowns.

Maintenance staff: None.

External maintenance: Breakdown and repairs by sub contractors, mostly former supplier employees.

Scheduled maintenance: General maintenance is by the printers.

Condition monitoring: None

Housekeeping: The cramped press room is currently being re-organised with ViP engineers to transform its workflow into a more logical pattern and to make the best use of available space.

Spares: Keep minimal spares. Most replacement parts are resourced directly from suppliers.

Keys for success

- Keep a log on each press as a record of breakdowns.
- Keep OEM technicians mind on the job they are being paid for —ban mobile phones to answer other queries

N° 3: Sheet-fed offset — Commercial printing

Size & intensity: 20 staff — 24 h/5days.

Operating snapshot: A family-owned commercial printer working in an industrial unit. The company is working with the ViP engineers to improve manufacturing performance.

Maintenance approach: The plate setter and pre-press equipment are maintained under a contract with supplier. This is seen as a benefit because the equipment has proved to be the most unreliable. All other equipment routinely maintained by staff and repairs use external services as and when required.

Quality & Documentation: The company keeps detailed records of performance, so that they can accurately estimate maintenance and other costs. This data provides a basis to evaluate the cost benefit of comprehensive maintenance products offered by the press supplier. Notice boards used for communication.

Maintenance staff: None

Production staff: Printers clean and lubricate. They could also reset grippers if they were shown how to by the supplier.

External maintenance: One supplier of capital equipment calls regularly, however, no representative from the other supplier has been since they sold the equipment. The company has access to a local engineering company who can provide maintenance and manufacture of parts. They have also suggested improvements on detailed design.

Scheduled maintenance: Regular maintenance of 2-3 hours scheduled into production.

Condition monitoring: Identify what needs doing and order spares in advance.

Housekeeping: Excellent

Spares: Press consumables only.

Maintenance results

- Identify good local engineering company to provide maintenance as required and suggest design improvements.
- Identifying OEM standard industrial components that are manufactured or stocked locally and can be delivered more rapidly than from the equipment supplier.

Keys for success

- Booking maintenance into the schedule using job cards.
- Accurate knowledge of the costs, including the hidden costs of reduced speed while awaiting for repairs.

N° 4: Sheet-fed offset — Commercial printing

Size & intensity: 29 staff — 24 h/7 days.

Operating snapshot: Located in the former premises of the local newspaper, along with its graphic design arm, who perform contract work that is not always printed in-house. The company specialises in quick turn around of jobs in a minimum of 12 hours. Equipment includes a 5-colour press that is 4-years-old and used for most job, a 2-colour press, finishing equipment and CTP. The company's limited finishing facilities means that much of this work is sub contracted to local suppliers, who then deliver it back to the company for quality assurance before delivery to customers.

The family run business is in a period of phased investment with the aid of the European Regional Development Fund. As part of this programme the company had to employ three new staff. One of them, appointed in 2002, is the works manager who bought with him significant international printing industry experience having previously worked for three leading printing and finishing equipment manufacturers. He joined the company because it offered him a better quality of life.

Maintenance approach: With only one principal press, the company could not rely on a breakdown service because this could lead to the risk of failing to meet customer delivery dates. For this reason, they have maintenance contract with the suppliers of all the major equipment — a fixed annual fee with direct debit. The press supplier provides a major annual service plus interim service along with a 24-hour call-out to which the supplier must respond within 8 hours. The CTP system has a similar maintenance contract and the guillotine is inspected and checked every 6 months because of HSE requirements.

Maintenance staff: 1 person.

Production staff: Printers undertake routine maintenance: cleaning, lubrication, replacement of coolant, and changing oil and filters.

External maintenance: OEM maintenance contracts.

Production staff: Routine maintenance — cleaning, lubrication etc. — to an established plan for each machine.

Scheduled maintenance: By OEM maintenance contracts.

Condition monitoring: Operators are starting to become aware of abnormal events using their senses as "human condition monitors".

Housekeeping: Excellent

Spares: Only consumables, stock maintained using a kan ban system.

Maintenance results

- Reliability, the company has not missed a delivery date in 30 months.

Keys for success

- Changing staff attitudes, being clean and tidy does not require extra effort just care. This has been achieved without anybody working any harder. "After operators have finished the run they pick up a broom and tidy around the press."
- If a large smash occurs digital photographs are used to record details of what happened.
- Attention to detail extends to all aspects of the business, e.g. correct shipping preparation even when a job is being shipped to a sub contractor to ensure no preventable lost time or damage occurs.

N° 5: Sheet-fed offset — Commercial printing

Size & intensity: 30 staff — 24 h/ 6 days.

Process & Business: Sheetfed Offset — Commercial printing.

Operating snapshot: The company operates CtPlate, two sheetfed presses and finishing in a modern factory unit. Presses are operated at varying speeds related to types of substrate being printed.

Maintenance approach: Maintenance is seen as a part of the company culture to identify and rectify reasons for quality failure or productivity underperformance.

Quality & Documentation: Reviewed list of recommended standard maintenance procedures from suppliers' manuals and then developed their own programme.

External maintenance: An independent maintenance company is used for most major repairs and occasionally the suppliers service staff are used.

Maintenance staff: None.

Production staff: Operators are switched between the presses on a shift basis. There is a chief printer who supervises both presses.

Scheduled maintenance: Operator-based using company-developed procedure list. Cleaning and lubrication is made at a fixed time every week and the chief printer is responsible to make sure that all tasks are completed. The operators skills are graded to different maintenance tasks.

Condition monitoring: None.

Housekeeping: Excellent

Spares: Uses local suppliers where possible.

Keys for success

- Problem lists on side of the press (snagging list) signed off by senior staff when completed.

N° 6: Sheet-fed offset — Label printing

Size & intensity: 32 staff, 24 h/5 days.

Operating snapshot: Family-owned and managed company for 125 years. Prints and converts paper and plastic substrates using conventional and UV processes, hot foiling (operating UV for 6 years and judges this an extremely satisfactory investment). Current strategy is to improve productivity from having the right plant and operating conditions and to diversify clients and products. Previous production and maintenance managers were retired early to recruit new staff with desired skills and working attitudes. Used some ViP resources to improve manufacturing flow. The goal is to re-shape the company to make it more adaptable, even if change leads to casualties inside and outside the company, e.g. refusal to participate in reverse auctions to sell printing to existing customers.

Maintenance approach: Maintenance is fully integrated into an overall manufacturing strategy — result is improved control of effective time.

Quality & Documentation: Beginning to build a database on time and productivity using KPIs suggested by ViP.

Maintenance staff: Recent appointment of engineering manager who previously worked as a contractor (electrical engineer with good mechanical skills but no print industry training — preferred by the company). Other staff are a general assistant and a production worker part-time (brothers who compete to find solutions).

Production staff: All operators now have tasked roles that are proactively supported by maintenance staff. Good operator response because “they feel they matter” as previously they were largely ignored and became frustrated from repetitive non-responses.

External maintenance: Occasional use of OEM service staff but experience is that they are very expensive and not very good. Prefers small specialist companies from local area.

Scheduled maintenance: Weekly by equipment operators.

Condition monitoring: None.

Spares: Purchase as needed. Prefers to find alternative sources than purchase from OEM suppliers. Will organise repair of components that OEMs only replace, eg. identified a service to rebuild circuit boards for around £50 instead of purchasing new for £500.

Maintenance results

- Improved control of effective time.
- Improved motivation of production staff in maintenance
- Better control over maintenance costs and results

Keys for success

- Hire staff with the right skills and attitudes.
- Integrated maintenance into an overall manufacturing strategy.
- Appropriately involve relevant production staff in maintenance and listen to them.
- Identify small, local suppliers with specialist skills to provide time and cost efficient maintenance services.

N° 7: Sheet-fed offset — Commercial printing

Size & intensity: 40 staff — 24 h/ 7 days.

Operating snapshot: A long-established commercial printer operating from a remote location.

Maintenance approach: Planned maintenance is part of production scheduling. The company's remote location has made them extremely self-reliant (compared to other companies surveyed) because it takes suppliers at least 12 hours to reach their site.

Maintenance staff: 1 working 3 days week, but available on call-out 24 hours day. The maintenance engineer completed an apprenticeship and then worked in manufacture and service of specialist instruments. In addition, his hobby of making working models of steam locomotives in his home engineering workshop allows him to manufacture small items required in the print shop. The company's IT manager is also "is good with electronics" and broadens the skill base available.

Production staff: Cleaning and lubricating.

External maintenance: Good working relationships with OEM suppliers, who appreciate the difficulties caused by their location.

Scheduled maintenance: Monday morning reserved for maintenance. The 3-knife trimmer is maintained and adjusted by the supplier because of the safety implications.

Condition monitoring: Operators tend not to notice slow deterioration in performance and gradually adjust to compensate. The engineer regularly operates each machine (twice a month) to detect drift and changes in performance so that he can plan maintenance.

Spares: Many of the spares supplied with the capital equipment have not been used — this suggests that the suppliers' selection was deficient.

Maintenance results

- The presses are fitted with remote monitoring and a modem connection. On one occasion when the press had stopped and this was being used to identify the cause, the supplier's staff told the company to "turn off the press, it's on fire". When they opened the control panel they found two circuit boards were burnt out.
- There lack of basic fitting skills is prevalent in the industry, eg. a bar and sledgehammer had previously been used in the replacement of a bearing (there were witness marks on the shaft!). When the bearing failed again, a simple "bearing puller" was used and the bearing was replaced without undue force.
- Cast aluminium pulleys supplied by an OEM wore out rapidly because it was made from inherently soft material. The company commissioned replacements from a machine shop using aircraft grade aluminium and there have been no failure since.

Keys for success

- Most of the machines use standard engineering components. Identifying these enables the company to use purchase locally with faster availability and at a reduced cost. The Internet is used to resource spares, identifying the original supplier of components.
- Dealing direct with an electric motor supplier reduces turn around and costs to the company.
- Manufacturers could benefit from the innovations of their customers, e.g. a simple wheel arrangement had ensured adhesion of covers of any thickness in a binding machine. While the next generation of machines had a different arrangement, this low cost modification could easily have been supplied as a retro fit to other customers.

N° 8: Sheet-fed offset — Commercial printing

Size & intensity: 40 staff, 24 h/5-6 days.

Operating snapshot: Highly flexible family-owned commercial printer (two 5-colour presses from different manufacturers) and finishing equipment providing rapid job turn-around. The tight margins in this business sector means that the paramount priority is to reduce operating costs.

Maintenance approach: On arrival two years ago, the head of operations began to call on assistance from the expert staff of suppliers who have become the company's best maintenance asset. One example is implementing a standard range of inks and chemicals from a single supplier (previously seven suppliers). The contract not only reduced purchase costs and introduced standardisation but was also accompanied by the ink supplier providing weekly visits from a technician to monitor and improve conductivity stability, chemistry, dampening system and help find solutions to problems like alcohol reduction, roller glazing and water treatment (water quality a big problem). The same principle is applied with CtPlate and press suppliers to calibrate and maintain process control.

Quality & Documentation: Conductivity, pH, roller temperatures are recorded weekly by ink supplier. However data is not currently exploited to its full potential. Other maintenance requests handled informally — a white board may be a good first step to be more systematic. Spoilage and output per machine were being monitored to analyse priorities for improvement, but the difficulty is limited resources to do so continuously.

Maintenance staff: No dedicated staff.

Production staff: Concentrate on introducing Standard Operating Procedures for equipment set-up. Most of the older production staff have not worked at other companies and tend to hold entrenched views because they have not experienced other ways to work. However, if there are problems they are the only ones to be able to assist the younger staff.

External maintenance: Organises round-table on specific issues with all suppliers concerned. Very mixed emergency call-out support from press suppliers — one very good, the other mediocre.

Scheduled maintenance: Weekly by equipment operators. Monday morning is devoted to maintenance but this is not documented and generally unsatisfactory — this is a problem of resources of a 'tight ship' in a small company and getting operators to understand why they need to work systematically.

Condition monitoring: Of inking and dampening systems weekly by ink supplier.

Spares: Minimum.

Maintenance results

- Better overall productivity from working with suppliers' staff.
- Single source ink supplier reduced purchase costs by 30% and includes regular maintenance service without cost (or internal resources) and available on 24-hour call-out.

Keys for success

- Work with suppliers.
- Inform and motivate production staff.

N° 9: Sheet-fed offset — Commercial printing

Size & intensity: 53 staff — 24 h/5 days.

Operating snapshot: The family-owned company has invested heavily in technology including a one-year-old 5-colour, a three-year-old 6-colour and a 5-year-old 12-colour along with finishing and prepress equipment appropriate to its scale of operations. The company uses MIS and JDF technologies and is a beta test site for the latest JDF software. All the equipment is linked in a network but production planning continues to use a tried and tested card system. All the equipment is from one supplier. In the past the company replaced its equipment every five years, but now is keeping machines longer to reach a satisfactory return on investment.

Maintenance approach: A comprehensive agreement for spares and breakdown provided by the OEM supplier. The call-out response time is good because of their relatively close locations with motorway access.

Maintenance staff: None.

Production staff: Carry out routine maintenance as laid out in the supplier's manual.

External maintenance: OEM supplier

Scheduled maintenance: OEM supplier staff check the equipment every month; and carries out a 6 monthly service. Where possible, maintenance work is done over the weekend so there is no loss of production.

Condition monitoring: None

Housekeeping: Press room is tidier and better equipped than a supplier's showroom.

Spares: On-call from supplier.

Maintenance results

- The maintenance service by the supplier has paid dividends from reduced overall maintenance costs.
- The supplier also uses locally available skills to provide a rapid response.
- Supplier co-ordinates with third party service providers to minimise downtime.

Keys for success

- Using latest technology and supplier's technicians has improved press performance and maintains them always up to date.
- Printer works with the supplier to improve the product.

N° 10: Sheet-fed offset — Specialist academic printer

Size & intensity: 75 staff — 24 h/ 5 days.

Operating snapshot: Originally a family business founded over 100 years ago. Company specialises in short runs — average run length of 900 copies — of multi-section academic journals. The combination of short runs and multiple sections means that the plate making facility is always in full production to supply two 5-colour, one 4-colour and a 2-colour press (all less than six years old). The company offers a complete finishing and despatch service. It also has a specialist digitisation and transcription service in India.

Maintenance approach: Until 2001 maintenance was an "as and when" basis. Production manager's background in managing a web offset printing plant is being used by the company to develop a structured maintenance strategy that is fully integrated with production. Started from the suppliers manual but improved in light of operating experience. The MIS system is being used to monitor breakdowns.

Quality & Documentation: Maintenance procedures originate from the suppliers manuals but are improved in light of operating experience. If every service task listed by the suppliers was performed at the recommended interval it would require a full maintenance crew and corresponding production time.

Maintenance staff: 1 person.

Production staff: Printers undertake routine maintenance: cleaning, lubrication, replacement of coolant, and changing oil and filters.

External maintenance: Good working relationships with OEM suppliers, who appreciate the difficulties caused by their location. OEM suppliers repair principal equipment breakdowns. There are concerns about demarcation issues between the electrical and mechanical technicians of the press supplier — further complicated if technicians from ancillary equipment suppliers are also involved. Service would be improved if supplier's technicians were more multi skilled.

Scheduled maintenance: Undertaken by printers on a scheduled basis. In addition, some weekly maintenance tasks requires specialist staff.

Condition monitoring: None

Housekeeping: Good

Spares: The company has created a central area for spares (e.g. filters, feeder belts, heaters) that is replenished using the kan-ban principle. The spares stocked are identified from identifying and monitoring items that fail frequently and what is required to repair common breakdowns.

Keys for success

- Identifying what needs to be done and its frequency.
- The maintenance has been broken down into there schedules, A is weekly, while B and C are monthly — such as dampening and oil changes — that are scheduled into alternate periods.
- Creating a centralised spares store.

N° 11: Sheet-fed offset — Metal decorating & can conversion

Size & intensity: 80 staff, 24 h/5 days (press).

Operating snapshot: Company created in 2000 as the first UK production site for a European group. An experienced engineer is manufacturing and maintenance manager and helped set-up the site and recruit staff. The VOC-based Crabtree coating and drying line is new; three used presses (Fuji and Crabtree) are 10 and 30 years old and converted to UV operation when installed; the can conversion lines were new. Prepress is film-based and one printing down frame is set-up for FM screening.

Lots of repeat jobs that re-use the same plates (3-4 times) that usually split on the fore-edge before wearing out. Blanket life is extended by changing them for different formats (only four sizes) and replaced only when damaged. FM printing tends to slow printing speed and these jobs are strictly controlled by density and dot gain. Presses are fingerprinted and typical dot gain is 3-6% — problem is metal proofing TVI is 10-12%.

Maintenance approach: Maintenance is planned as part of the manufacturing strategy with a high level of production staff participation.

Quality & Documentation: ISO 9000. Activities are planned and documented on check sheets. There is little documentation of production incidents and breakdowns — the system is mostly intuitive.

Maintenance staff: Qualified electrical engineer, 1 electrician-fitter.

Production staff: Operators normally work on the same machine and have been successfully encouraged to have a high level of ownership. They are responsible for most routine maintenance, effective housekeeping and cleanliness.

External maintenance: Minimum.

Scheduled maintenance: Performed by press operators on a half-shift worked on Saturday morning as overtime. Service routines from OEM manuals have been progressively adapted to specific needs and experience (tasks and frequency of intervention). Maintenance staff instructs the operators on techniques and check that tasks are correctly performed. Press settings are the complete responsibility of operators.

Condition monitoring: Uses operators' senses (sight, sound, vibration) described as "basic but reasonably effective". Occasionally operators may over-react and shut down press unnecessarily but this is acceptable if infrequent.

Housekeeping: Excellent.

Spares: Internal stock of key parts.

Maintenance results

- Despite very old presses there are very few unscheduled stops.
- Service routines help extend UV lamp-life from 2 000 hours suggested by OEM to 8-10 000 hours. Consistent level of production with minimum quality defects.
- Ability to print from FM screened plates using film processing.
- During high production peaks, output on some machines can be increased by up to 30%.

Keys for success

- Team spirit, stable staff and operator-ownership means plant almost runs by itself.
- Careful selection of staff and responsibility for maintenance starts on day one; no problems are passed unannounced on to next shift.
- If it is not running right, put it right!

N° 12: Sheet-fed & Heastset Web Offset — Magazine production

Size & intensity: 340 staff, 24 h/7 days.

Operating snapshot: Part of the multi-plant group. The site provides all of the group's sheetfed printing — particularly UV magazine covers and all web offset UV/coating.

Maintenance approach: Long-term, predictive, strong level of performance related control. Ownership of maintenance is encouraged with the concerned staff. Maintenance centre is also used as a resource for other companies in the group.

Quality & Documentation: Written reports do not work unless they are correctly communicated. All maintenance staff complete time-task sheets. A dedicated maintenance software system was purchased but is no longer used because it was too difficult to enter information. Company creates e-mail 'idiot sheets' on how to make certain repairs with notes on 'knacks' and illustrated by digital photos.

Maintenance staff: Maintenance manager helped establish factory as a green field site, selected all staff to create and maintain a team of 16 (6 electrical, 6 mechanical and 4 semi skilled — none with print backgrounds).

Production staff: Work on limited preventative maintenance tasks. A dedicated greaser (Tuesday-Saturday) lubricates all machines and collects relevant data. Every machine has an MIS terminal that includes a maintenance request window that sends e-mail request to maintenance.

External maintenance: Uses OEM services only when really necessary.

Scheduled maintenance: Presses have a dedicated 12-hour maintenance shift each month where printers perform PMs and maintenance staff address specific issues. There is an 'ideal' maintenance check-list for every machine but sometimes only selected items can be followed. Maintenance requests and monthly plant tour used to generate weekly repair schedule. Weekend-free of production is planned on equipment requiring major interventions. Two floating maintenance staff are available for 3 days each weekend (Friday-Monday).

Condition monitoring: Predictive maintenance is a high priority and weekends are a good time to perform it. Sensors have been installed in sensitive areas of older presses. Thermal imaging picks up many potentially expensive faults very early — recently a transformer problem identified that prevented a £10 k replacement. Monthly vibration data collected from 600 points and then analysed externally. Endescope also used.

Spares: All parts are controlled in a stock data system. They are labelled and binned in three stores in different parts of the factory. Consignment parts from suppliers are stored and when required sent to other plants. Direct purchase of standard industrial components where possible — normally not via OEM suppliers).

Maintenance results

- Major unscheduled stops are rare.
- Mechanical and electrical breakdown reduced to 2-4 % of operating hours (varies with age and type).
- Condition monitoring has reduced cost of spares and unscheduled downtime.

Keys for success

- Monthly review of KPIs
- Ultimately everything is related to people who need to work together effectively. Each team member needs to be challenged to get the best out of them.
- Two-way exchange of information with suppliers, maintenance and production staff.
- Weekend most productive for maintenance.
- Condition monitoring a high priority.

N° 13: Gravure — Publication printing

Size & intensity: 150 staff, 24 h/7 days.

Operating snapshot: Specialist gravure publication plant of a large printing group with four presses and finishing operations for high volume newspaper and consumer magazines. These products are highly time sensitive making production reliability an high priority and particularly for one press size that has no back-up. Until 2000, maintenance policy was to “fix it when it breaks”. However, with the help of external consultants (PWC) this was transformed to a Planned Preventive Maintenance strategy to help improve maintenance on “sweated” assets.

Maintenance approach: Part of an integrated manufacturing strategy. Planned Preventive Maintenance (PPM) and Operator Involved Maintenance (OIM) is now being combined using Kaizen techniques to provide a fully integrated approach. Challenge include effective communication in a 4-shift system and that different participants have different objectives. Older employees tend to be more resistant to change than younger staff. The goal is stable production that equates to less stress and less cost. Lots of minor problems disappear under stable running conditions but they reappear when things start going wrong.

Quality & Documentation: KPIs are reviewed weekly with all departments. Defect logs are maintained.

Maintenance staff: 14 staff in-house (7 electrical, 7 mechanical), most resources are focussed on presses.

Production staff: Mostly stable crews on each machine encourages ownership — “if you give them the tools to keep equipment in good condition they are likely to use them.” Kaizen techniques have improved staff understanding and co-operation to implement 5S, OIM and PPM.

The operators for publishing systems (FERAG) were selected with an electrical or mechanical background that allows them to implement most maintenance themselves (except complex knife changes).

Training is an important success issue, OEMs are not very good at training, it is better to use experienced printers as trainers combined with local technical colleges to add associated skills (using NVQ skill matrixes). Keisen also facilitates a lot of “soft” training by osmosis.

External maintenance: Different external services are used when required. There is a 24/7 call-out for press service. Generally satisfied with these services.

Scheduled maintenance: Each press has a fixed maintenance slot of four hours that backs into a makeready (usually 3-4 hours) to provide a total of seven hours. Maintenance is also scheduled for the high volume of auxiliary systems in the plant. Cross-functional maintenance planning involves relevant engineer, printer and production staff to decide on actions required and to ensure that all tasks are defined with parts and staff available for the maintenance slot.

Condition monitoring: Uses external services for thermographic and oil analysis and PC monitoring.

Spares: Stock inventory maintained and controlled.

Maintenance results

- 30% reduction in unscheduled press stops since introduction of PPM and OIM.
- 27% reduction in waste and web breaks (combination of maintenance, paper qualities and best practices).

Keys for success

- Continuous gradual change (frog in cold water that is slowly heated). Avoid taking on too much too quickly, otherwise it falls by wayside.
- Ban adhesive brown tape to “fix “equipment.

N° 14: Gravure — Packaging

Size & intensity: 24 h/5 days.

Operating snapshot: Independent company supplying plastic packaging to highly demanding brand-owner clients mostly in the food sector. All presses are from the same manufacturer (1, 10, 15 and 20 years old) but they do not print identically. The newest machine had significant start-up problems and took three months to obtain satisfactory running.

Maintenance approach: There is a preventive maintenance system but due to maintenance staff cut backs the current priority focus is on really essential areas only.

Quality & Documentation: Internal presentations are made on specific subjects to all concerned staff to explain reasons why procedures are needed and to motivate them to participate. Subjects include maintenance, recycling, health and safety.

Maintenance staff: In 2001, there were 14 maintenance staff, now reduced to four staff (two electricians, two fitters). A maintenance staff member is available on all shifts to work with printers to identify production problems and help find solutions.

Production staff: There are three crews rotated to operate four presses which means operator ownership is hard to establish. Crews perform specific scheduled items but many key tasks are being transferred to maintenance to ensure that they are always done correctly and on time.

Old operator culture was a crisis source, however, mass retirement of baby boomers is an opportunity to implement change with new staff. Operator Involved Maintenance is being implemented in all areas as part of a transition to a team culture. The result is more individual thinking that provides spontaneous suggestions for improvements — about 50% of them are worthwhile. The printing and converting departments are not currently integrated. Mini cross-department work groups are now being used to overcome differences of working cultures to work together more effectively.

External maintenance: A lot of tasks are now outsourced to contractors.

Scheduled maintenance: Tend to make selected rebuilds when work can be rotated between presses to create maintenance time. Currently only essential maintenance can be made but want to introduce preventative routines.

Keys for success

- If people are listened to and respected they will work more effectively.
- Implement Operator Involved Maintenance as part of a transition to team culture.

N° 15: Gravure and Flexo — Food packaging

Size & intensity: 230 staff — 24 h/7 days.

Operating snapshot: Site is part of an international group with 24 plants in North America. It produces food-grade packaging using two web flexo presses and two gravure presses. It also has an extruder, 2 laminators and 2 waxing machines. Engineering Manager was appointed two years ago to build on the success of his predecessor to improve performance of the factory.

Maintenance approach: Full predictive maintenance programme with a move towards condition monitoring.

Quality & Documentation: The company currently uses a paper system to control maintenance but is moving over to a fully integrated software system.

Maintenance staff: Full production staff to maintain all the equipment.

Production staff: Limited to simple routines and cleaning.

External maintenance: Work is outsourced to compliment its internal maintenance department resources.

Production staff: As well as cleaning and consumables, operators are involved in routine maintenance as this releases the maintenance staff for other tasks.

Scheduled maintenance: Planned maintenance uses a 24 hour schedule. The company has split sections from the manuals provided by the suppliers and introduced it's own frequency of maintenance based on its experience.

Condition monitoring: The company is deploying acoustic equipment to detect bearing failures.

Housekeeping: Excellent, food-grade environment

Spares: Parts are ordered in advance of scheduled shutdowns.

Maintenance results

- Improved availability
- Improved efficiency

Keys for success

- Backing from the senior management who are prepared to invest in the tools necessary for the staff to work efficiently (eg. PC's, personal organisers, software and monitoring equipment).
- Recognising and developing the inherent skills of the existing staff.
- Plot downtime against cause to identify hot spots.
- Pit stop strategy for maintenance.

N° 16: Flexo — Corrugated packaging

Size & intensity: 200 staff — 24 h/5-7 days.

Operating snapshot: Company designs and manufactures packaging from cardboard, solid board, corrugated, graphic and speciality board. Extensive product range from the smallest 'E' flute tray to very large double-wall cases in one of the most modern factories in the UK. It can also supply high quality post-print and run pre-printed liner. Company supplies corrugated packaging solutions in the South, South-West and Midlands. It is part of Europe's market leader in this packaging sector employing 17 000 people in over 100 operating companies in 17 European countries.

Maintenance approach: Each of the major capital lines has scheduled time for routine maintenance each week.

Quality & Documentation: The company is certified ISO 9002.

Maintenance staff:

Production staff: Routine cleaning and lubricating.

External maintenance:

Scheduled maintenance: The company has developed its own routines based on experience of operating the equipment.

Keys for success

Planned maintenance time slots were regularly lost under pressure from production and sales departments. This problem has been largely eliminated because of a simple new policy that requires the managing director (or his delegate) to sign-off permission to abandon a maintenance slot.

N° 17: Flexography — Labels

Size & intensity: 36 staff — 24 h/5-7 days.

Operating snapshot: A long-established independent label printer specialising in short runs for the pharmaceutical and cosmetic industries. The company moved into a purpose-built factory seven years ago where it operates two label presses with flexo heads and an additional path to two rotary screen heads on the same press. The company makes its own plates and coats its own screens.

Maintenance approach: All equipment maintained by the OEM supplier. This is described as expensive but necessary because their pharmaceutical customers require it.

Quality & Documentation: ISO 9000 and pharmaceutical accredited

External maintenance: OEM supplier.

Maintenance staff: None

Production staff: Daily checks, cleaning and lubrication.

Scheduled maintenance: Performed by OEM supplier.

Condition monitoring: None

Housekeeping: Excellent

Maintenance results

- Little unplanned downtime

Keys for success

- Regular planned maintenance by the equipment supplier

N° 18: Silkscreen and ink jet — Point-of-Sale displays

Size & intensity: 80 staff — 24 h/5-7 days.

Operating snapshot: Family-owned company for 110 years until 2003 when management buyout made. About five years ago the company was concerned about market trends and their competitive position and invested in new production equipment. They also appointed a multi-skilled technical services manager to install, train and maintain equipment and operating facilities (located in a Victorian-era factory). The company uses several silkscreen presses for multi-colour printing of runs of several hundred copies. A large format ink jet printer is used for runs up to 30 copies. Various converting equipment is often combined with intense hand-finishing using up to 50 temporary staff.

Maintenance approach: Previously there was no maintenance, if something broke but machine could still function, it was not fixed ("fix it when it stops") and few parts were held. Most equipment now has PLC control and software is rarely a problem — 99% of problems are from electronic and mechanical components. A lot of silk-screen presses are produced in small numbers and some are one-off models which complicates servicing and maintaining a parts inventory. First step was to recruit an in-house engineer and establish adequate spare parts store. The first year focus was on restoration maintenance to bring machines back to a reasonable operating condition.

Quality & Documentation: Suppliers manuals seen as generally poor with barely intelligible English. Suppliers do not readily communicate their "knacks" required for many maintenance tasks. Staff observe and record OEM technician's procedures so that they can be performed internally next time (e.g. changing the 50 gripper belts on a silk-screen press is very complex with a very specific method to achieve and takes four people 3-5 days). Maintenance is recorded to (a) provide a reference record of what has been done (b) helps meet and prove that H&S risks are managed. Effective use of simple technologies (e.g. Internet and digital photos) is highly effective to improve speed and reliability of communication with suppliers for problem diagnosis, part identification, etc.

Maintenance staff: Engineer 3 days a week — a fitter with good electronics and software skills (oil industry background); plus a general handyman.

Production staff: Limited to simple routines and cleaning.

External maintenance: Often significant start-up problems of new equipment with poor back-up after installation. Avoid relying on suppliers because their engineers only solve a specific problem at a huge cost (typical £700 for 3 hours). Remote diagnostics from two suppliers, one used intermittently, the other a failure.

Scheduled maintenance: Friday from around mid afternoon to midnight, usually dedicated to a specific series of tasks. Biggest problem is time and cost, they would like to run maintenance on Saturday but requires minimum presence of two people and overtime payment.

Housekeeping: Good, but difficult within an old building.

Spares: Adequate in-house inventory. Building spares data base to bypass equipment supplier where possible. Internet is used to correctly identify specifications (essential) and then search for availability, price and sources.

Maintenance results

- Significant increase in available production time with big impact to reduce total operating costs. Five year ago around 40% of operating hours lost to unplanned equipment stoppages this has now been reduced to about half a shift (4%).
- Permits reliable just-in-time delivery essential to meet demanding customer/competitive needs.
- Improved understanding of machine operation has improved quality e.g. registration.
- Significant cost savings on spare parts purchase from non-OEM sources.

Keys for success

- Maintenance is an integrated part of manufacturing strategy. Unless the machine is in good condition it cannot reliably produce correct quality on time.

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