GG223

Preventing waste in production: industry examples

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Summary

This Good Practice Guide consists of ten Industry Examples. These demonstrate how ten companies in the UK used analysis of production data to improve control of their processes and achieve important cost savings and environmental benefits.

The specific tools and techniques used differed from company to company, depending on the problems and the types of process involved. However, each company has been able to:

- acquire a better understanding of its processes;
- analyse process performance and identify areas of avoidable waste;
- identify opportunities for process improvement;
- check that any improvements implemented have been effective;
- ensure that the level of improvement achieved has been maintained.

The Industry Examples cover a variety of industrial sectors so that as many companies as possible can draw parallels with their own processes. They also show that successful use of the various techniques is not limited by company size or by the complexity of its processes.

The Guide should be read in conjunction with Good Practice Guide (GG224) *Preventing Waste in Production: Practical Methods for Process Control*. This describes in greater detail the theory and the application of various tools and techniques that will help companies to save money.

Contents

Introduction

This Guide is one of a two Guide set which introduces a range of tools and techniques that use process data to identify and prevent waste in production processes. Companies that have tackled production waste in this way have achieved cost savings of up to 1% of turnover.

These savings result from minimising:

- the excessive consumption of energy or raw materials;
- losses in the process itself (lost yield and sales);
- any problems arising when the product is used in a subsequent manufacturing step (reduced yield and possible 'bottleneck' difficulties);
- rejects at the inspection stage;
- in-service failures.

The tools and techniques described in the Guides are based on tried and tested statistical techniques, they are straightforward to use and do not require specialist statistical knowledge.

By applying them to your production processes, your company can achieve:

- cost savings;
- higher productivity;
- higher product quality;
- a lower environmental impact.

Through a series of Industry Examples, this Guide illustrates how ten companies (Table 1) in the UK have achieved greater control over their production processes using these techniques. The

Table 1 Industry Examples: types of business and aims in relation to waste minimisation and process control

No	Name	Business	Aim
1	Perstorp Ltd	Furniture worktop manufacturer	To investigate causes of delayed product failures in service
2	C Shippam Ltd	Food spread/paste manufacturer	To minimise the overfilling or underfilling of containers
3	Transprints Ltd	Printers of textile transfer paper	To identify the causes of set-up waste and minimise the problem
4	Edinburgh Crystal	Glassware manufacturer	To map the process, identify the causes of waste and rioritise the required changes
5	Novem	Car interior manufacturer	To investigate the causes of damage and waste during the manufacturing process
6	Illbruck Koike	Rubber component manufacturer	To minimise variation during product manufacturing
7	Mitex GlassFibre Ltd	Woven glassfibre manufacturer	To minimise the waste associated with bought-in materials
8	BFF Nonwovens	Non-woven specialist fabric manufacturer	To train operators to apply formal control techniques
9	Fenner Conveyor Belting	Composite conveyor belt manufacturer	To minimise waste from processes that require an allowance to be made for size changes (eg shrinkage) during processing
10	Corus Foundry	Iron casting	To minimise product reject rates and raw material use

specific tools and techniques used have differed from company to company, depending on the problems and the type of process involved. Table 2 shows which techniques have been used by each company. Each company has been able to:

- acquire a better understanding of its processes;
- analyse process performance and identify areas of avoidable waste;
- identify opportunities for process improvement;
- check that any improvements implemented have been effective;
- ensure that the level of improvement achieved has been maintained.

Table 2 Techniques employed by the Industry Example companies to achieve their aims

	Perstorp Ltd Furniture manufacture	*C Shippam Ltd Food pastes/filling*	*Transprints Ltd Printing textiles transfer paper*	*Edinburgh Crystal Glassware manufacture*	*Novem Car interior (wooden veneers)*	*Illbruck Koike General rubber goods*	*Mitex GlassFibre Ltd Woven glassfibre*	*BFF Nonwovens Non-woven specialist fabrics*	*Fenner Conveyor Belting Composite conveyor belts*	*Corus Foundry Iron casting*
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
What is waste costing you?										
Basic production data collection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Where is waste arising?										
Process mapping/flow chart				✓						
Where should you focus first?										
Histograms	✓		✓			✓	✓			
Pareto diagrams	✓			✓	✓					
What are the possible causes?										
'Fishbone' diagrams			✓							
Experiments/investigations	✓		✓		✓				✓	✓
How consistent is your process?										
Normal variability		✓								
Special variability						✓				
Capability assessment		✓								
How can your process be improved?										
Rechecking capability		✓								
How can you maintain control?										
Control charts					✓			✓		
Other										
Operator training			✓	✓				✓		
Automatic mixer control										✓

Readers are encouraged to study those Industry Examples where the processes or problems involved are similar in type to their own. Greater detail on the theory and application of the various tools and techniques is given in Good Practice Guide (GG224) *Preventing Waste in Production: Practical Methods for Process Control*.

Perstorp Ltd

Furniture manufacturing company reduces delayed product failure and achieves substantial cost savings

A company that manufactures laminates and worktops has used a combination of numerical techniques, brainstorming and production trials to tackle the problem of delayed product failure, achieving savings equivalent to £15 000/year.

The Company

Perstorp Ltd is a Swedish-owned company that manufactures laminates and worktops for kitchen and office furniture at its Newton Aycliffe site. The plant employs 340 people and has a turnover of about £35 million/year.

The Production Process

The process creates durable and decorative surface finishes by laminating and bonding paper, resin and other materials onto a chipboard base.

Fig 1 Pareto table and diagram

AYCLIFFE LAMINATE DEPT. DRY PROCESS-WASTES
(EXCLUDING "UNKNOWN" WASTES)

MANUFACTURING AND LOGISTICS
QLEM

BY VALUE x £1000

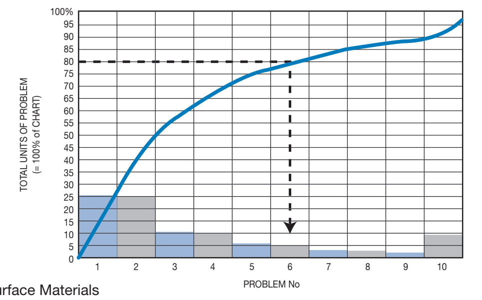
PARETO ANALYSIS FOR: JANUARY 01/98

DEPARTMENT		TEAM			TEAM LEADER	SUPERVISOR

No.	PROBLEM	UNITS k£	CUM	% OF TOTAL	CUM %	COMMENTS
1	TEXTURE PAPERS	74.6	74.6	26.0	26.0	
2	PRESS 1&2 REJECTS	72.6	147.2	25.3	51.2	(G) £37506 (P1) £35102
3	TRIMMING	30.8	178.0	10.7	61.9	(G) £18031 (P1) £12750
4	ALUMINIUM FOIL	30.0	208.0	10.4	72.4	
5	CYCLE COUNT LOSSES	15.3	223.3	5.3	77.6	
6	SANDING	12.3	235.6	4.3	82.0	(0) £8047 (P1) £4238
7	GRECON BELT CLEANING	10.6	246.2	3.7	85.7	
8	OTHER SECTION REJECTS	9.5	255.7	3.3	89.0	
9	MELAMINE IMP. REJECTS	5.4	261.1	1.9	90.8	
10	GRECON SCRAPPED WASTES	5.3	266.4	1.8	92.7	
11	FACE ASSEMBLY SCRAPPED WASTES	4.5	270.9	1.6	94.3	
12	MELAMINE INT. SCRAPPED WASTES	3.6	274.5	1.3	95.5	
13	RELEASE PAPER	3.0	277.5	1.0	96.6	
14	OTHER ITEMS	9.9	287.4	3.4	100	
		287.4				
						509.3T 164.5T

PRESS 1 PROCESSED 165941 m², 231746 kg
GRECON PROCESSED 287396 m², 277510 kg

Percentage of Accumulated Defects for: JANUARY



Perstorp Surface Materials

The Process Control Problem: Product Failure Within the First Year

The Newton Aycliffe site already operates a QLEM (Quality, Leadtime, Efficiency and Motivation) programme. As part of this programme, the company has formed a partnership with its waste contractor, to reduce the quantity of waste produced, improve waste segregation and increase recycling.

Departmental teams monitor key performance indicators such as waste, yield and 'housekeeping', and display the findings on boards in their work areas. Numerical techniques such as Pareto analysis[1] are used to show the nature and extent of the problems identified, and the associated financial implications. Plotting the findings on a Pareto diagram (Fig 1) provides a visual

[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

representation of the problem, highlights where action might be taken to improve the situation, and can be used to track the results of these actions during subsequent months.

Using Pareto analysis highlighted a costly problem that originated in the Bonded Components Department: some of the laminated tops were coming apart over a period of several months after installation and were being replaced under Perstorp's long-term performance guarantee policy. The Pareto diagram histograms showed that these failures started immediately after installation, built up after six months and continued to occur for more than a year.

The Solution

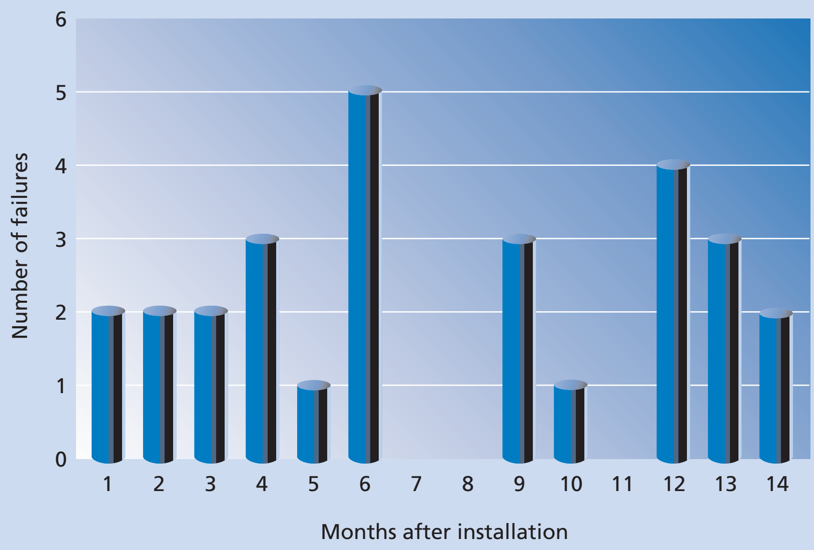
A number of brainstorming sessions combined with various production trials highlighted the cause of the problem - imperfect sealing between the laminate and the substrate, which allowed moisture to enter the chipboard and, over a period of time, cause delamination.

Some simple modifications were made to the laminating process, notably redesigning the sealing system to improve its resistance to water vapour during service. Initial observations in the factory indicated that this had probably solved the problem. However, it was recognised that the true test would be an improvement in product reliability after 6 - 12 months in service.

The Results

During the three months preceding the production modifications, the number of reported failures was 28 (Fig 2), which was equivalent to 112 per year. Following the modifications, the reported failures have dropped to less than 50 per year, a reduction of more than half. Confirmed levels of improvement to date are equivalent to an annual saving to the company of around £15 000/year.

Fig 2 Laminated top failures reported during the three months prior to production modifications



C Shippam Ltd

Food manufacturing company resolves the problem of overfilling containers

A company manufacturing spreadable products and canned ready meals has used statistical techniques based on existing data to reduce overfill from 3% to 0.3%.

The Company

The Chichester site of C Shippam Ltd produces spreadable products such as salmon spread and other sandwich fillings, plus own-brand and supermarket-brand canned ready meals. The site employs 180 people and has a turnover of £26 million/year.

The Production Process

Production involves processing boneless meat or fish plus spices and vegetables to produce a paste, which is then packed in jars. Sterilisation takes place in the jars once they have been filled and sealed.

The Process Control Problem: Overfilled Containers

European 'Average Fill' regulations require the producers of consumer goods to carry out approved fill control checks and maintain records of the results over an extended period. The regulations specify that, for a sample of a large number of items:

- average net weight should be no less than the stated label weight;
- no more than 2.5% of items should be <94% of the label weight;
- 'no' items (or a statistically insignificant number of items) should be <88% of the label weight.

Filling processes with a high capability[1] (ie the fill weight will not vary greatly) usually satisfy these conditions with an average net weight very close to the target label value. By contrast, filling processes where the variability in fill weight is high must set a target fill weight that is significantly higher than the label value to ensure compliance. This was the situation at Shippams. Average fill weight was significantly above the label value, increasing production costs. Some individual jars were even overfilled to the extent that they were rejected on the grounds of poor closure or overflowing product.

The Solution

Shippams recognised that variability of fill can be affected by factors other than the performance and capability of the filling line. Product density, for instance, can be a contributory factor, and this depends on processes upstream of the filling line.

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[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

The company has made innovative use of its filling control records to reduce its levels of waste. It constructed a history of mean fill values and standard deviations, and used this to relate filling line **effects** to upstream process **causes**. As a result, improvements have been made in:

- the quality and density of the paste;
- filling temperature control.

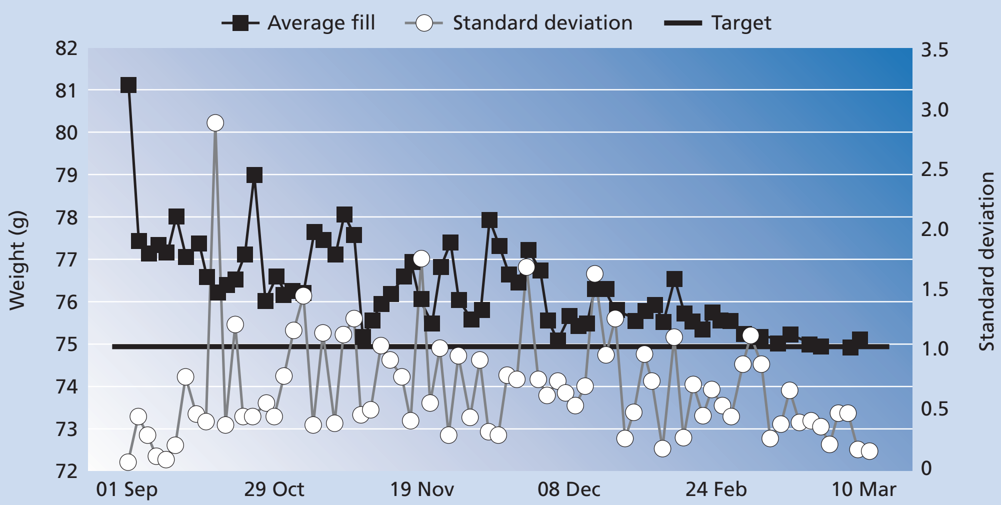
In addition, control procedures have been related to product run lengths.

The company accountants have also made use of average fill level data when calculating factory operating costs and have encouraged the reduction of these levels to as near target level as possible.

The Results

Over a six-month period, the standard deviation of the fill was reduced from more than 1 g to less than 0.3 g (Fig 1). The capability index of the process improved over the same period to a Cp value of 2.15, which is similar to that achieved in many engineering processes. As a result, Shippams safely reduced the target fill weight and reduced overfill from 3% to less than 0.3%. There was also a reduction in jar reject level.

Fig 1 Average jar fill weights and level of variation (shown by standard deviation)



Transprints Ltd

Pattern printing firm uses data-based approach to reduce its levels of waste

A firm that prints patterns onto transfer paper has used production data and appropriate presentation and brainstorming techniques to identify problems, encourage production changes, reduce waste and generate savings worth an estimated £80 000/year.

The Company

Transprints Ltd (part of the Imperial Home Décor Group) prints patterns onto transfer paper for use in the clothing industry. The site at Morecambe employs 140 people, and the annual turnover in 1998 was approximately £13 million.

The Production Process

The company's printing process involves both gravure printing machines and a flexographic machine. Inks are prepared off-line; the product is colour-matched on the machine to make sure it meets customer/design requirements; and the production run is then completed.

The Process Control Problem: High Levels of Set-up Waste

Transprints Ltd undertakes finite production runs to meet individual customer demand. Average run length is 2 000 metres, but ranges from 1 500 metres to 10 000 metres. There are several design and/or colour changes on each machine every day, resulting in a high level of set-up waste - typically 12% or 200 metres per change. This represents a significant cost in terms of paper, ink, labour, energy and lost machine time, a cost that has been estimated at about £1.8 million/year.

The Solution

The company's first step was to set up waste improvement teams for each of the three production shifts (green, red and yellow). The aim was to:

- identify the key causes of set-up waste;
- collect process data on levels of waste and variations by shift;
- introduce changes in operator procedure, thereby reducing waste levels on a sustainable basis.

Brainstorming and cause and effect diagrams

Each shift team held brainstorming sessions and used a simple cause and effect 'fishbone' diagram[1] to focus the discussions. This approach identified a number of areas of concern (Figs 1 - 3), and the results were then pooled so that each shift had access to all of the ideas resulting from the brainstorming sessions.

Fig 1 Cause and effect diagram summarising the conclusions of the Green Shift brainstorming session

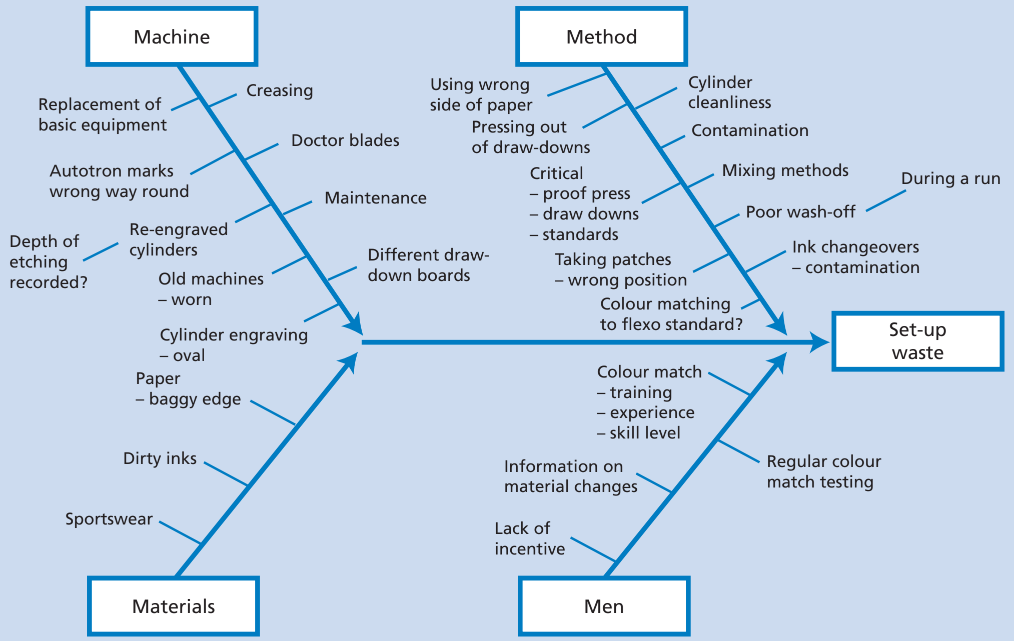
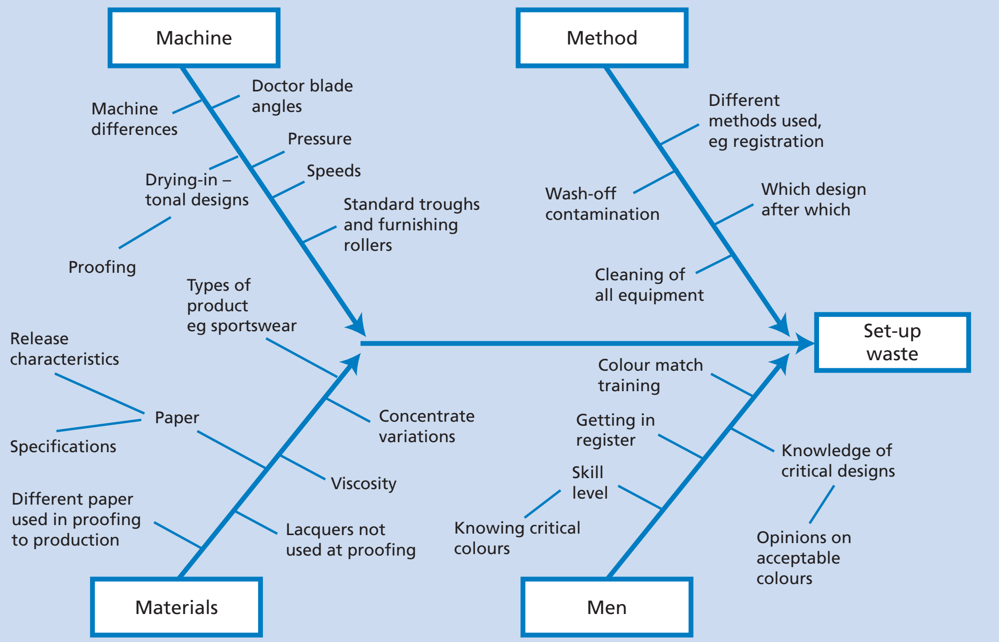


Fig 2 Cause and effect diagram summarising the conclusions of the Red Shift brainstorming session



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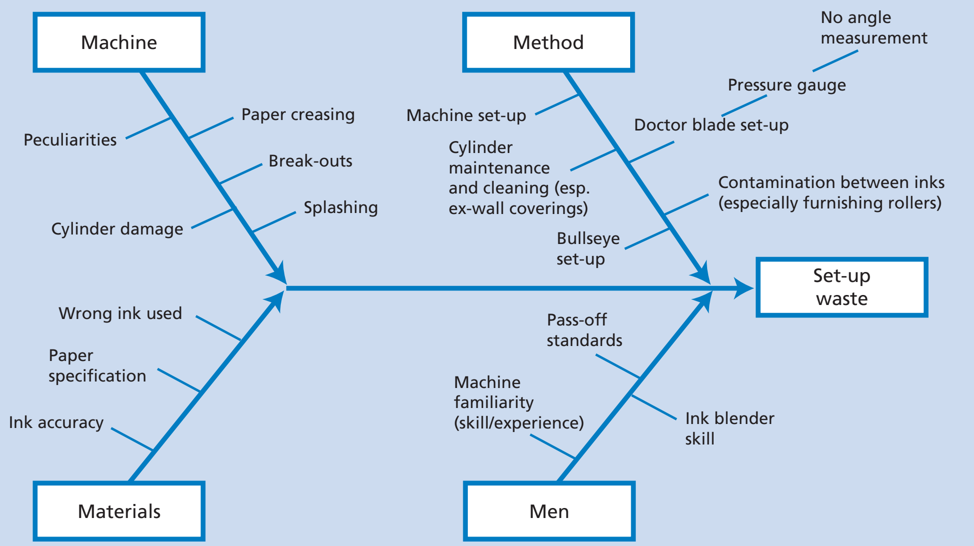
[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

Fig 3 Cause and effect diagram summarising the conclusions of the Yellow Shift brainstorming session



The results of these three brainstorming sessions were pooled and discussed. Three main problems were identified. Each shift agreed to address one problem.

Shift	Problem addressed
Green	Number of print samples required
Red	Number of metres per sample
Yellow	Obtaining print register[2]

Improved data collection and presentation

For each problem, the main production sheet was modified so that data could be collected not only for the length of waste per set-up, but for each project area identified.

Each shift was made responsible for collating and analysing data for its particular project by machine, product type[3], run length and shift.

Presentation of the data in diagrammatic form made the findings more meaningful. Two types of chart were used:

- Bar charts showing set-up waste for different components of the set-up process and for each shift - for all machines (Fig 4 overleaf) and for the P8 machine (Fig 5 overleaf).
- Histograms for two components of the set-up process (Figs 6 and 7 overleaf), establishing the relationship between amounts of waste produced and the number of products (or jobs) producing that waste. For example, during colour matching (Fig 6 overleaf), the range of waste 51 - 100 m accounted for 14 000 m of waste from 190 products.

[2] Setting up the machine for colour printing so that each colour component image is correctly superimposed on the previous one.

[3] Expressed in terms of numbers of colours used, complexity of printing operation etc.

Fig 4 Set-up waste for all machines by shift and by set-up component

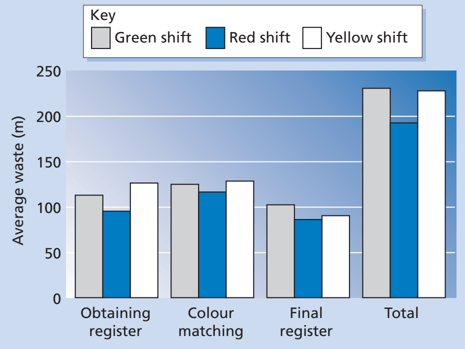


Fig 5 Set-up waste for P8 machine by shift and by set-up component

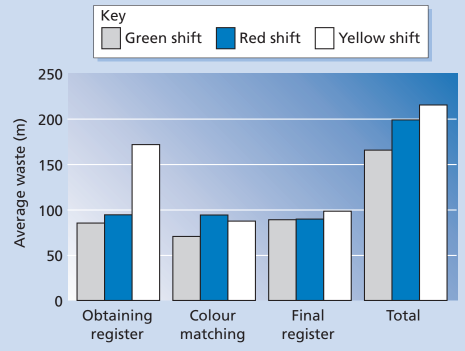


Fig 6 Histogram showing waste associated with colour matching

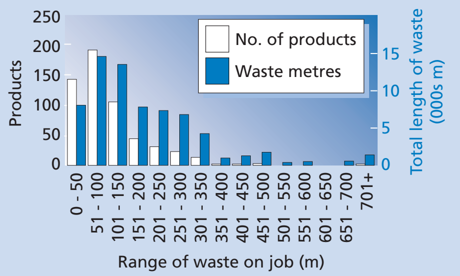
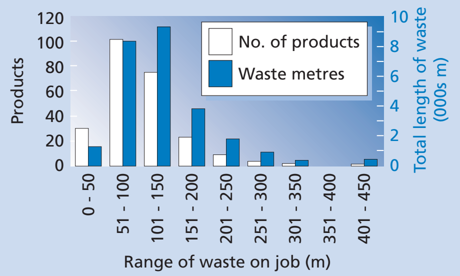


Fig 7 Histogram showing waste associated with obtaining register



Examination of the diagrams raised a number of questions:

- Why do some jobs generate more than 100 m of set-up waste while obtaining print register?
- Why has Green Shift the best performance on P8 but the worst performance overall?
- Why was Yellow Shift's register waste on P8 almost double that of the Red and Green Shifts?

The diagrams were used as benchmarks, highlighting the areas that needed to be looked at more carefully and providing a focus for follow-up brainstorming and production trials.

Trials and production changes

The subsequent brainstorming sessions resulted in a series of trials being set up on the various machines. Changes were made to the methodology and the equipment used, both on the printing machines themselves and in ink preparation. Items such as blade angles and pressures were optimised and standardised across machines, and some operator training was carried out as part of the improvement process.

The Results

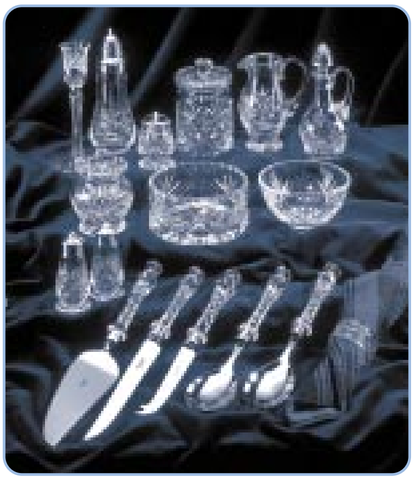
Despite a change in the market to shorter run-lengths, which would tend to increase waste levels, overall waste as a result of the production changes described above was reduced from 12% to 10%, saving the company an estimated £80 000/year.

Continued use of various types of chart draws attention to changes as they happen and ensures that the improvement is maintained.

Edinburgh Crystal

Glassware manufacturer achieves substantial savings by identifying and addressing the causes of breakage

A manufacturer of crystal tableware has used flow diagrams and Pareto analysis to identify the causes of product breakage. Subsequent improvements in maintenance and training have achieved reductions in waste levels worth £60 000/year.



The Company

Edinburgh Crystal has made crystal tableware at Penicuik for more than 100 years. The site employs 305 people, and turnover in 1998 was £22 million.

The Production Process

Edinburgh Crystal's products are made from shaped blanks, which are either blown from liquid crystal produced in its own furnaces or bought in from other crystal suppliers. These blanks are cut to the desired design using abrasive wheels. This process can be entirely manual; alternatively, it can be carried out on an autocutter machine. After cutting, the product is polished to produce the typical sparkling crystal appearance required.

The Process Control Problem: Breakage

The possibility of delicate objects being broken arises at each stage of the production process, and breakage is a significant source of waste.

The Solution

The company has set up a broad waste minimisation programme to reduce the costs of waste, which is currently costing about £1 million/year.

Identifying the causes of breakage

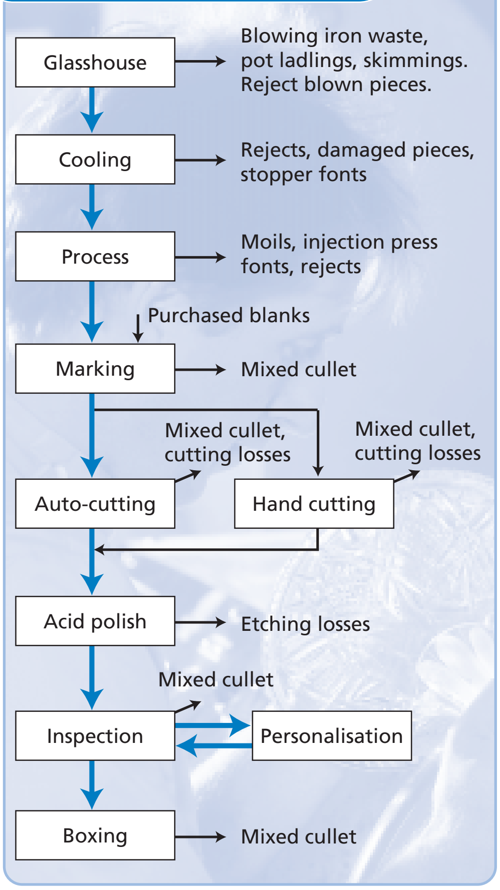
Initially, there were many opinions within the company as to the main causes of breakage. A flow diagram was prepared and refined to show all the significant breakage points (Fig 1 overleaf). This was then used as a basis for discussions as to where the greatest losses occurred.

It quickly became clear that more accurate, quantified information was needed about the number of breakages at individual points in the production process, although there was general agreement that significant potential for improvement existed in the Autocut and Process Departments.

Data collection and presentation

Shop-floor teams were set up to collect the necessary data for both departments. Their first task was to design data sheets recording the origin and cause of breakage and to ensure their use. The aim was to ascertain where the breakage occurred, on which part of the product and, if possible, why. Because existing information highlighted the type of breakage/damage occurring, the emphasis was placed on identifying the cause.

Fig 1 Flow diagram of crystal production process



Pareto diagrams[1] were prepared from the data collected using the new data sheets. These showed clearly that, in the Autocut Department, just one problem accounted for about half the losses in certain parts of the process:

- wall cutting - set-up difficulties accounted for nearly 40% of losses (Fig 2);
- star base cutting - stem/base breakage accounted for nearly 50% of losses (Fig 3);
- variable-depth cutting machine - vacuum system problems accounted for nearly 60% of losses (Fig 4).

Using Pareto diagrams allowed operators and supervisors to agree on the real causes of the problems experienced and to abandon existing 'gut feelings' and unsubstantiated theories. They could now concentrate on the relevant corrective actions. These included focusing machine maintenance on certain key areas such as the vacuum system, and providing additional training for critical and difficult processes.

Fig 2 Pareto diagram of problems experienced during wall cutting

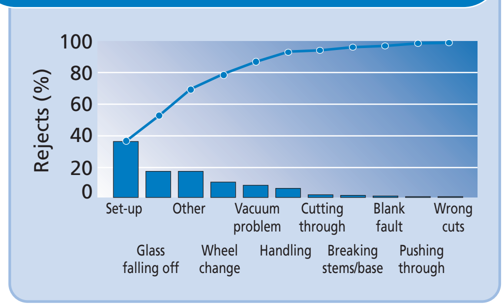


Fig 3 Pareto diagram of problems experienced during star base cutting

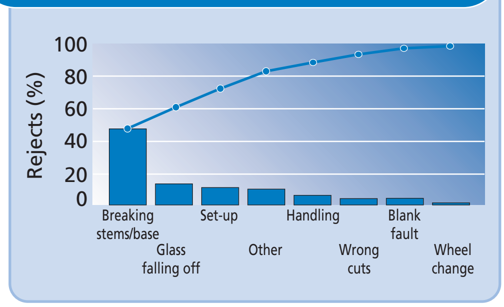
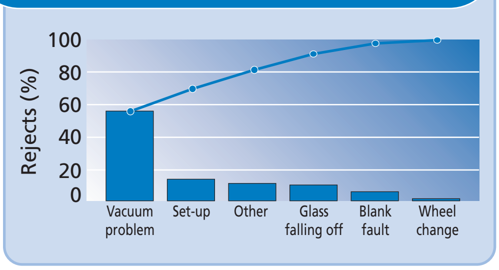


Fig 4 Pareto diagram of problems experienced on variable-depth cutting machine



The Results

The company achieved a six-month reduction in waste levels equivalent to a saving of £60 000/year.

Rates of breakage continue to be recorded, and the results are fed back to operators using histograms - an effective visual indication of performance achievements.

[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

Novem

Manufacturer of quality car fascias reduces the rejects associated with polishing

A producer of high-quality veneered, laminated vehicle fascias has used a statistical approach to reduce the number of rejects associated with 'rub-through' during polishing and achieved savings equivalent to about £70 000/year.

The Company

Novem produces very high-quality veneered, laminated fascias for vehicle manufacturers at its Coventry site. The site employs 250 people and has a turnover of about £13 million/year.

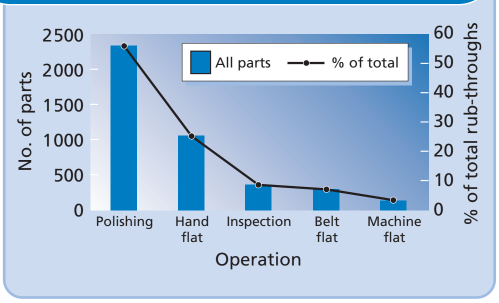
The Production Process

Walnut veneer is purchased in sheets. It is treated to adjust the moisture content and is then laminated onto the metal panel that will be fitted to the vehicle. After various colouring and coating operations (including polyester lacquering), the apertures for instruments are milled and the fascias are polished.

The Process Control Problem: 'Rub-through'

'Rub-through' is a problem that occurs during polishing when too much of the surface lacquer is removed, exposing the walnut veneer and causing the component to be rejected. It is a major cause of defects.

Fig 1 Pareto analysis of where rub-throughs are found



The Solution

Pareto analysis

The company began its search for a solution by examining the components at various stages in the production process and constructing a Pareto analysis[1] of where the rub-throughs could be detected. The analysis showed clearly that the two final polishing operations - hand flatting[2] and hand polishing - were mainly responsible for the problem (Fig 1).

Measurement

Although the polyester lacquer is intended to be 1 mm thick, there were no thickness measurements and no target for lacquer removal during polishing operations. Twenty measurements were, therefore, made in each of seven positions on a typical component at three stages in the process:

- before flatting;
- after flatting;
- after final polish.

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[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

[2] Removal of surplus or uneven lacquer to create the desired even surface finish.

Tables 1 - 3 show, for each stage of the process, the maximum and minimum value recorded at each position plus the average and standard deviation for the measurements taken. The average thicknesses of lacquer removed during flatting were significantly higher and more variable than those removed during polishing. This suggests that the source of the problem was the flatting process.

Table 1 Thickness of polyester lacquer at each position before flatting (mm)

Position	Maximum recorded	Minimum recorded	Average	Standard deviation
1	1.15	0.98	1.05	0.04
2	1.07	1.01	1.05	0.02
3	1.10	1.02	1.06	0.02
4	0.91	0.79	0.86	0.04
5	0.92	0.82	0.87	0.03
6	0.98	0.85	0.93	0.03
7	0.84	0.73	0.78	0.03

Table 2 Thickness of polyester lacquer removed during flatting (mm)

Position	Maximum recorded	Minimum recorded	Average	Standard deviation
1	0.65	0.39	0.47	0.08
2	0.17	0.01	0.08	0.04
3	0.60	0.35	0.43	0.06
4	0.22	0.01	0.11	0.06
5	0.39	0.05	0.23	0.09
6	0.44	0.12	0.34	0.07
7	0.31	-0.01	0.10	0.09

Table 3 Thickness of polyester lacquer removed during final polish (mm)

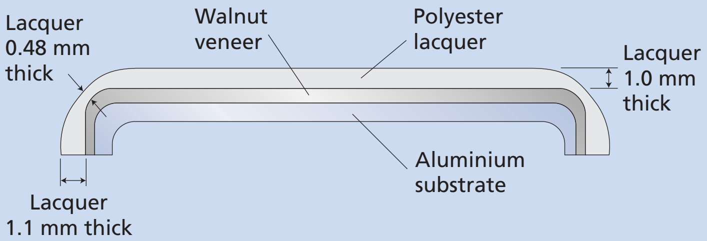
Position	Maximum recorded	Minimum recorded	Average	Standard deviation
1	0.07	-0.09	0.00	0.04
2	0.28	0.01	0.06	0.08
3	0.10	-0.02	0.01	0.03
4	0.14	-0.13	0.02	0.06
5	0.15	0.00	0.02	0.04
6	0.20	-0.06	0.02	0.05
7	0.07	0.00	0.02	0.02

Testing and trials

Subsequent investigation included some testing to destruction. This showed that the corners of the components had a much thinner layer of lacquer than the flat top of the body (Fig 2).

The company calculated that the probability of rubbing through on the corners was at least 12%, ie that one in every 8.3 components would suffer from 'rub-through'. They also found that lacquer removal was highly variable during flatting, even without this 'corner effect'. One possible cause identified was the range of different ways of using the machine flatting equipment - no standard process method had been defined.

Fig 2 Distribution of lacquer over components



A series of trials was carried out to establish the best flatting technique for minimum lacquer removal, and this was established as the standard method. Trials were also carried out using various coating conditions and different numbers of coats to reduce the corner thickness problems.

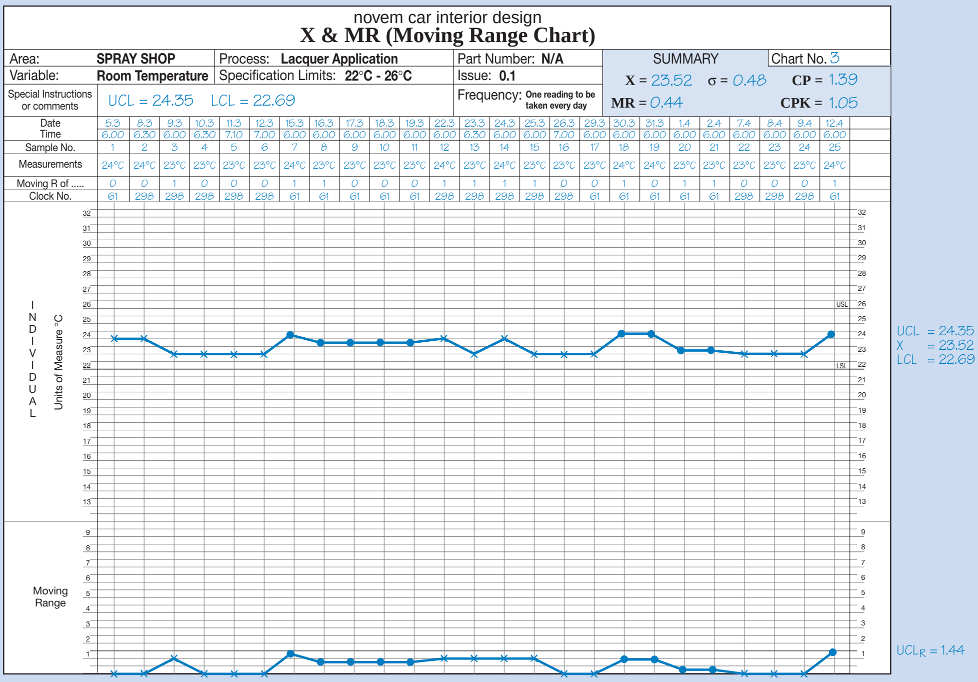
Control charts

Shortly after the new procedures had reduced rub-through levels, the problem appeared to return - but in a more severe form. Investigation showed that, in this instance, the lacquer was cloudy and spotted, and operators were overpolishing to compensate. After several trials, the cause of the problem was traced to temperature variations in the lacquer shop - a temperature above 26°C caused low viscosity and a cloudy coating, while a temperature below 22°C created problems of aeration and spotting. A statistical process control chart (see GG224) was introduced to help operators control lacquer room temperatures at the appropriate level (Fig 3), and this approach resolved the problem.

The Results

The level of rejects declined from more than 10% to less than 7%. Cumulative savings over the first nine months amounted to £53 000 - equivalent to an annual saving of £70 000.

Fig 3 Statistical process control chart



Date	5.3	8.3	9.3	10.3	11.3	12.3	15.3	16.3	17.3	18.3	19.3	22.3	23.3	24.3	25.3	26.3	29.3	30.3	31.3	1.4	2.4	7.4	8.4	9.4	12.4
Time	6.00	6.30	6.00	6.30	7.10	7.00	6.00	6.00	6.00	6.00	6.00	6.00	6.30	6.00	6.00	7.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Measurements	24°C	24°C	23°C	23°C	23°C	23°C	24°C	23°C	23°C	23°C	23°C	24°C	23°C	24°C	23°C	23°C	23°C	24°C	24°C	23°C	23°C	23°C	23°C	23°C	24°C
Moving R of	0	0	1	0	0	0	1	1	0	0	0	1	1	1	1	0	0	1	0	1	1	0	0	0	1
Clock No.	61	298	298	298	298	298	61	61	61	61	61	298	298	298	298	298	61	61	61	61	61	298	298	298	61

Illbruck Koike

Components manufacturer uses statistical techniques to resolve a distortion problem

A company producing components for manufacturers of office equipment has used statistical techniques to confirm the existence of mould distortion. A subsequent change of press virtually eliminated scrap and achieved savings of more than £10 000/year.

The Company

Illbruck Koike produces a range of precision-moulded rubber components for manufacturers of office equipment such as photocopiers. The company's site in Wrexham, Clwyd, employs around 100 people and has a turnover in excess of £5 million/year.

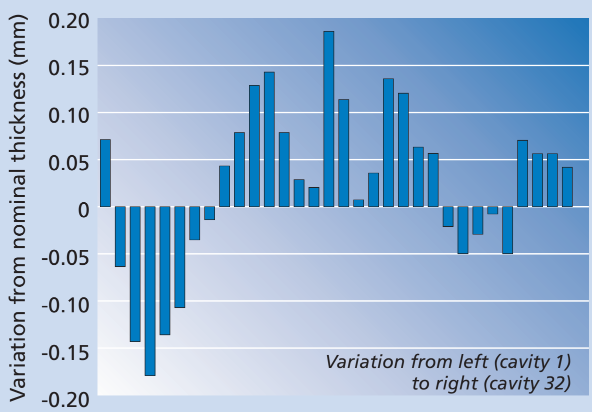
The Process Control Problem: Variation Across the Mould

Office equipment demands tight tolerances, so it is critical for the company to minimise variability to reduce its reject levels and costs. However, the operator responsible for the production of one moulded rubber component noticed that the thickness of the finished components appeared to vary with the mould cavity in which the component had been formed. This suggested that there was a 'special' (and, therefore, controllable) cause of variation, which could be tackled to reduce reject levels.

The Solution

The Engineering and Quality Departments studied the components and collected thickness data from several batches. The data were used to plot a chart showing the variation in mean thickness for each mould cavity (Fig 1). When the findings were reviewed and discussed it was clear that a pattern did exist and that this could be the result of mould distortion. An investigation revealed that distortion could be reduced considerably by fitting the mould onto one of the larger presses.

Fig 1 Variation in mean thickness for each mould cavity



The Results

The change to a larger press reduced distortion and the variation in thickness level by 50%. This increased the capability of the process[1] to a point at which scrap was virtually eliminated, and gave the company estimated savings of more than £10 000/year.

[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

Mitex GlassFibre Ltd

Producer of woven glassfibre products identifies and seeks to eliminate inconsistencies in its raw material supplies

A producer of woven glassfibre products has employed data collection and presentation techniques to identify inconsistencies in the lengths of incoming fibre. It is now working with suppliers to halve the level of the associated waste.

The Company

Mitex GlassFibre Ltd produces woven glassfibre products for building fabrication and decorative uses. The company's site in St Helens employs about 60 people.

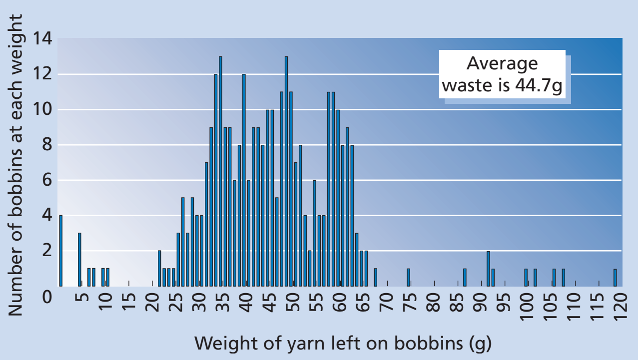
The Production Process

The production process involves loading more than 600 rolls, each containing more than 30 km of glassfibre yarn, onto a machine. The machine simultaneously winds them onto a 'beam' (large bobbin) for loading into a loom for weaving. The rolls of yarn are purchased by weight, and are specified to be a particular metered length.

The Process Control Problem: Inconsistencies in Yarn Length

The winding of a 'beam' continues until one of the rolls runs out of yarn. The remaining rolls are scrapped, and any yarn remaining on them becomes waste. The beam winding machine is then reloaded with fresh rolls of yarn and the process continues.

Fig 1 Chart showing bobbin waste by weight



The company was aware that levels of yarn waste appeared to be significant and asked shift operators to collect relevant data. The data were used to generate a histogram (Fig 1). The results showed that the typical variation in yarn length on a roll was such that, on average, 300 m (45 g) was being left on each roll, representing a scrap rate of almost 1%.

The Solution

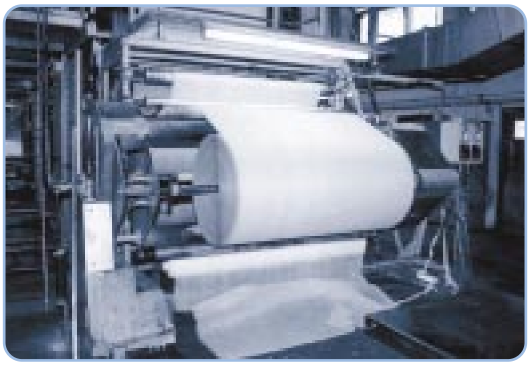
Mitex is now working with suppliers to control roll lengths. Improvements have already been made, representing annual savings greater than £5 000. Its aim is to halve the overall level of yarn waste to less than 0.5% and improve profitability through further cost savings.

BFF Nonwovens

Company manufacturing non-woven fabrics introduces control charts to improve site yields and profits

Concern at the level of operator-induced variation in the production process encouraged a non-woven fabrics manufacturer to introduce control charts. This approach has improved site yield by 2.75% and increased profits by £300 000/year.

The Company



BFF Nonwovens produces 'non-woven' textiles for specialist engineering applications. Examples include fabrics made of glass and carbon fibre. The site in Bridgwater, Somerset, employs around 250 people and has a turnover of about £26 million/year.

The Production Process

The fabrics are produced continuously on large machines using a process comparable to paper manufacture.

The Process Control Problem: Operator Intervention

The Quality Assurance Manager became concerned that operators were adjusting the bulk cloth production equipment too often and at the wrong times, and were actually causing unnecessary quality problems, scrap and downtime in misdirected efforts to improve production.

The Solution

The Quality Assurance Manager decided to address this operator-induced instability in the production process by training operators to use a data collection system in which control charts[1] could be consulted to indicate when adjustments were really needed.

All production operatives were given on-the-job training by the Quality Department. This training covered appropriate measurement techniques and the use and interpretation of control charts. The Quality Department continued to monitor closely the two sets of readings taken during each shift, and their recording and interpretation by the operators involved.

The Results

Overall site yield has improved by 2.75%. This represents an increase in annual profit of £300 000 on a raw material spend of more than £10 million/year.

[1] An explanation of the techniques and terminology used here can be found in Good Practice Guide GG224.

Fenner Conveyor Belting (FCB)

Conveyor belt manufacturer reduces waste levels by 60% using statistical process control

A firm manufacturing fire-resistant conveyor belting has introduced computerised statistical process control techniques to optimise operating conditions, control belt length and minimise waste. The savings achieved to date are worth £104 500/year[1].

The Company

Fenner Conveyor Belting (FCB) is a division of the Fenner Group, a multinational company with an overall annual turnover of £200 million. The FCB site in Hull employs about 150 people and produces fire-resistant conveyor belting, primarily for the mining and quarrying industries.

The Production Process

The complex production process involves weaving the fabric and then coating it with PVC. Natural shrinkage occurs as the product goes through various heating and cooling cycles, and this alters its length.

The Process Control Problem: Excess Length

FCB's customers order exact lengths of conveyor belt to meet their needs. Because the degree of shrinkage during the manufacturing process is variable, FCB aims to produce slightly more than the required length to ensure that the product is long enough to meet customer requirements. Any surplus is scrapped, and the average waste level resulting from this was, at one stage, about 5%.

The Solution

The company participated in a local waste minimisation project and began by investigating the factors affecting the degree of shrinkage. It then developed its own simple, computerised statistical process control (SPC) system. This system takes data on the production parameters and on the actual length of belt produced, and uses them to specify:

- operating conditions;
- the initial length of belt needed to meet the customer's final requirements after shrinkage, while ensuring a low level of waste.

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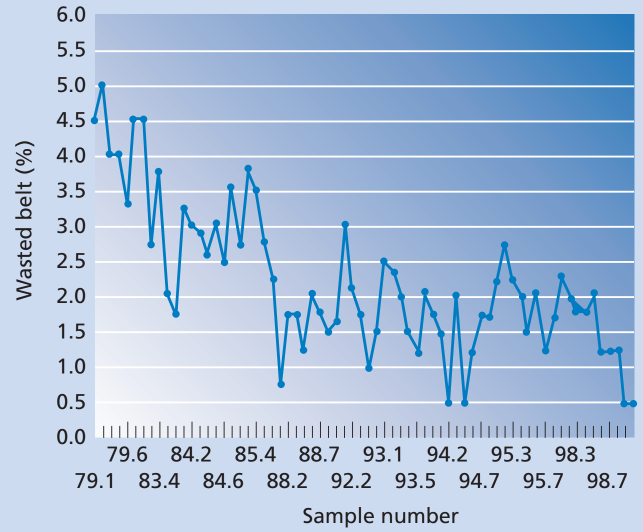
[1] Further details are available in Case History 65 (CH65), available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Fig 1 Improvements in length control on Loom M6

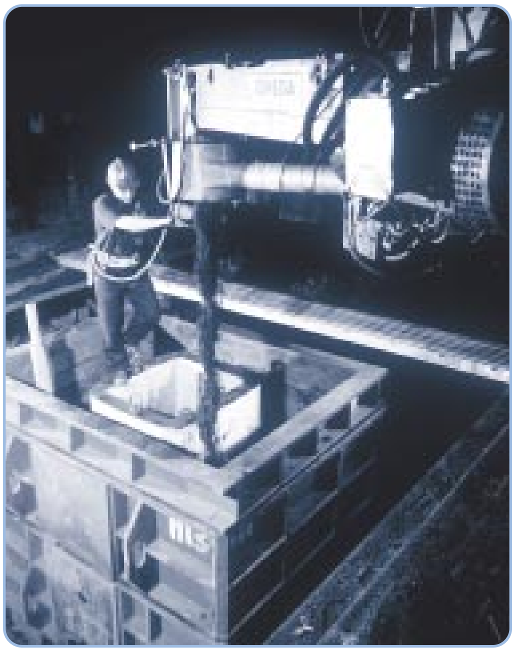


The Results

During the first year, FCB reduced its excess length production from 5% to 2%, a saving worth £104 500/year. In subsequent years, FCB has continued to benefit from this saving and has further developed its SPC systems. Fig 1 shows how length control has been improved on one loom.

Corus Foundry

Foundry uses automatic mixer control system to reduce mould losses



The introduction of an automatic mixer control system has allowed a foundry producing moulds for molten metal to reduce the quantities of binder resin and catalyst used by 10%. This generated savings worth £37 000/year together with environmental improvements[1].

The Company

Corus Foundry produces ingot moulds, bottom plates and slag pots in haematite ductile and compacted graphite (quasi-flake) iron. The site at Motherwell has the capacity and equipment to handle moulds of more than 70 tonnes and currently employs 120 people.

The Production Process

The foundry uses chemically bonded sand moulds to cast the iron components. This involves mixing cold-setting resins and appropriate catalysts with the sand and then forming the mould into the required shape.

The Process Control Problem: A High Mould-rejection Level

An operational review showed an unacceptable level of defective sand moulds. Investigation suggested that this could be reduced by improved control of the proportions of resin and catalyst added to the sand.

Traditionally, the mixing pumps were calibrated once each day, using a protocol that depended on timing the discharge of known volumes of sand, resin (a high performance furane co-polymer resin) and catalyst (an aqueous solution of *p*-toluenesulphonic acid which promotes the setting of the resin).

The procedure was designed to ensure that the weight of resin was approximately 1.22% of the weight of sand. The catalyst requirement was set to between 40% and 75% of the resin input, depending on the temperature of the sand and on the quantity of resin needed to ensure adequate mould strength. Operators also used their experience to make adjustments to the addition rates during each shift.

The Solution

The foundry installed an automatic mixer control unit, which incorporated flowmeters, sand temperature monitoring, visual alarm systems and a programmable logic controller (PLC). The unit uses data on resin flow and sand temperature to calculate and achieve the optimum catalyst addition rate.

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[1] Further details are available in Good Practice Case Study 23 (GC23), available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

The foundry has also introduced a continuous, pressurised, closed-loop resin and catalyst circulation system to avoid start-up delays, which can also result in inferior mixed sand quality.

Comparison of both the old manual system and the new automatic system with the theoretical optimum showed that catalyst addition rates with the manual system were significantly below those required - hence the high level of reject moulds (Fig 1). The automatic system, on the other hand, achieved a binder addition rate much closer to the theoretical optimum (Fig 2), resulting in a much lower reject rate.

Fig 1 Theoretical and actual binder addition rates with manual calibration

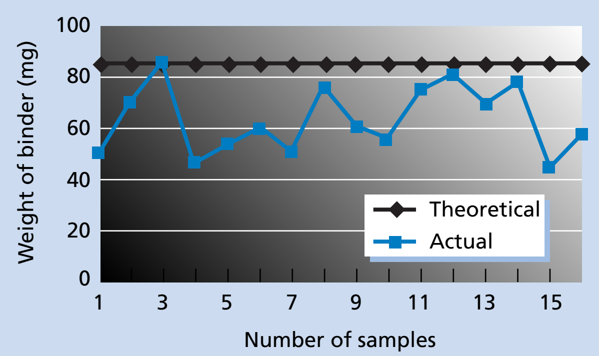


Fig 2 Theoretical and actual binder addition rates with automatic control

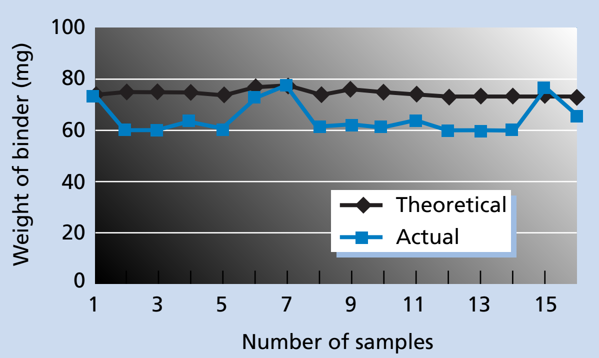
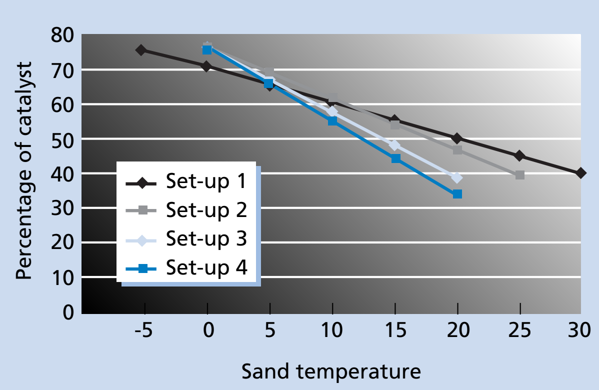


Fig 3 Changes in catalyst addition rates at higher sand temperatures



These findings encouraged the foundry to move closer to process optimisation by reducing the proportion of binder added to the sand. The resin addition rate was reduced from 10 kg/minute (1.22% of resin to sand by weight) to 8.89 kg/minute (1.09% of resin to sand by weight), still with a much reduced level of defective moulds.

The foundry also suspected that the mathematical rule used to calculate the rate of catalyst addition for different sand temperatures was too generous at higher temperatures. The foundry gradually reduced the quantity added at higher temperatures from Set-up 1 to Set-up 4 (Fig 3), again maintaining adequate mould strength and setting times.

The Results

The foundry was able to reduce the quantities of binder resin and catalyst added by 10%, and still reduce the level of defective moulds by 60%. This is equivalent to overall savings worth £37 000/year, giving a payback period on the cost of the control unit of less than one year. The 10% reduction in resin and catalyst use produced an immediate 10% reduction in the associated volatile organic compound (VOC) emissions.

Envirowise – Practical Environmental Advice for Business – is a Government programme that offers free, independent and practical advice to UK businesses to reduce waste at source and increase profits. It is managed by AEA Technology Environment and NPL Management Limited.

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- Free, on-site waste reviews from Envirowise consultants, called Fast Track Visits, that help businesses identify and realise savings.
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- Best practice seminars and practical workshops that offer an ideal way to examine waste minimisation issues and discuss opportunities and methodologies.

For further information please contact the

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