SUMMARY

The Aylesbury Vale Industrial Waste Reduction Project Ref 672880.005 was launched in May 1998 with EB Buckinghamshire Ltd providing £58,400 funding through the Landfill tax credit scheme. Oakdene Hollins Ltd managed the project.

The project was designed to challenge the accepted method of subsidising industrial waste reduction projects. Previous waste minimisation projects (Catalyst etc) demonstrated that significant financial savings could be made but typically these gains were shared between the participating companies and their advisors. The subsidy provider was not expected to receive any benefit.

The format of the project offered companies up to 42 days of expert on-site manufacturing systems consultancy but only after strict acceptance criteria for admittance to the project had been applied.

The participating companies were required to pay £2,000 at the start of the project. This was used to fund the 10% third party contribution under the rules applying at the time. Each company was invited to make a voluntary contribution at the end of the work based on their perception of the savings the project had generated. The voluntary contributions were used as a snowball fund to extend the project to other areas - in this case to Bedfordshire and Milton Keynes.

In total the project ran for 44 months between May 1998 and December 2001 with 183 person days of on-site consultancy being provided. Marketing the project through radio interviews, newspaper articles, leaflets, phone calls, industrial site visits, presentations and mail shot letters required a further 83 person days. Four companies were selected for an intensive project of on-site work, and a further sixteen companies were reviewed and advice provided for them to implement improvements themselves. The results of this project refer only to the participating companies at which detailed assistance was provided; no claims are made for improvements that took place at the 16 other companies.

£127,000 per annum of resource savings were identified and realised. The project demonstrated that companies are prepared to share the savings created through waste reduction work with the four participating companies paying £30,000 into the project.

Although a small project, the funding provided by the participating companies was used to "snowball" the project into Bedfordshire and Milton Keynes where a further 16 companies received in-depth waste reduction assistance from manufacturing systems experts. Reports on the outcomes of these projects will be finalised during 2002 and will be posted on www.oakdenehollins.co.uk and elsewhere.

During the project much has changed and it is no longer possible to finance "snowball" waste reduction projects in this way using LTCS funds. ENTRUST having amended their interpretation of the Landfill Tax Regulations. Nevertheless, the principle of companies sharing the benefits of a well-targeted waste reduction project has been demonstrated. Government Departments and NGOs committed to providing subsidies to overcome the inertia in industry with regard to "waste" can learn from the design of this project. In particular, it provides evidence that the subsidy targeted at inertia in this type of project can achieve more than is currently demanded of it.

LEARNING FROM THE PROJECT

- "Waste minimisation" is not a helpful term when marketing the project to manufacturing companies. Manufacturers of all sizes misunderstand it and assume that the very modest cost of waste *disposal* is all that is being addressed. The use of "Resource Efficiency" by Envirowise is a more recognisable term for manufacturers.

- When setting up a similar project, the absence of a Green Business Network or similar will add considerably to the time required to launch and promote the project. In general, these projects should be co-ordinated with the plethora of other initiatives aimed at the same target audience by Business Link, the Environment Agency, Envirowise, utilities, universities, local authorities, regional authorities and others. This project required 83 person days of time promoting the project excluding the time taken in preparation of the proposal and meeting the information needs of the funding organisation.

- Companies are seldom able to commit to projects at short notice. Projects need to be offered and delivered over an extended period, typically more than two years. There are clearly economies of scale and a target audience of several hundred businesses is probably the minimum scale on which a project should be planned.

- By selecting companies and publicising this as a feature of the project, it was generally treated with respect. This feature differentiated it from many other subsidised initiatives. The most effective criterion used for selection was that of evaluating management commitment, as it required companies to present board level directors at initial meetings. The least effective criterion was that of organisational stability.

- Subsidies continue to be required to overcome the managerial inertia about "waste". Although an important policy issue nationally, it barely registers on the management agenda of most manufacturing companies.

- Generally, companies most in need of waste reduction advice are least likely to take up the assistance. Poor manufacturing systems are closely associated with weak and defensive management. This reinforces the need to offer assistance over an extended period as management teams change.

- The issue of which performance measures to use is complex. A large section at the front of this report deals with this and matters of definition. We are grateful to many organisations for their advice and research on this issue, in particular the Green Alliance. Professor Chris Coggins and Professor Paul Phillips also offered comprehensive advice on the benefits and shortcomings of various definitions and measures.

- Time spent agreeing which performance indicators to use at the start of the project is important. This project was less focused on reporting details of the type of waste (recognisable to the waste management industry) than on the resource management impacts (recognisable to manufacturing companies). Ideally, both categories of data would be reported.

SUMMARY OF PRIMARY OUTPUT MEASURES FOR THE PROJECT

Number	Output Measure	Unit of Measure
1	Reduction in discarded resource	£127,000
2	Increase in process efficiency	See individual companies
3	Employees trained in waste reduction methods	65
4	Substitution of materials	£8,000
5	Reduction in site emissions	37 Tonnes of 377

SUMMARY OF "SNOWBALL" PAYMENTS INTO THE PROJECT

PayBack	From	Use
£2,000	Klargester Environmental Engineering Ltd	£2,000 used as third party contribution to project
£2,000	Sunalex Ltd	£2,000 used as third party contribution to project
£4,000	Askeys Ltd	£4,000 awaiting use
£22,000	McCormick UK Plc	• £1,840 used as third party contribution to project • £9,506.18 used as a third party contribution to Bedfordshire waste reduction project • £5,376.00 used as a third party contribution to Milton Keynes waste reduction project • £5277.82 awaiting use

ACKNOWLEDGEMENTS

As well as the board members of EB Buckinghamshire Ltd, we would like to thank the following people and organisations for their support during the project;

Brian Paine, Thames Valley Enterprise – Area Manager, Business Link
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Phil Barnes, Buckinghamshire County Council Waste Officer, Buckinghamshire County Council.
Sarah Powell, Team Leader Campaigns, Environment Agency.
Jon Foreman, Environment Agency, Head Office, Bristol.
Dr Mike Walker, Project Manager Regional Projects, Envirowise.
Professor Paul Phillips of Nene College (SITA Centre for waste management)
Professor Chris Coggins

CHAPTER ONE INTRODUCTION

The Aylesbury Vale Waste Reduction in Industry project was launched in May 1998 when EB Buckinghamshire Ltd agreed to provide up to £58,400 to fund the project. The key features of the project were;

1. Focus on waste minimisation within the industrial sector. A Government consultation paper in 1998 (DETR 1998) identified waste minimisation as the best way to reduce the impact of waste on the environment

2. Focus on detailed process changes in manufacturing systems to achieve long-term improvements in waste generation

3. Offer free, 1-day site surveys to all companies as an “awareness raising” exercise. The opportunities identified in the survey could then be realised in-house or with external assistance

4. Provision of up to 42 days engineering expertise to assist five companies that met strict entrance criteria to achieve demonstrable cost / waste savings

5. A voluntary contribution to be paid back into the scheme by the participating companies as a measure of the savings that had been generated as a direct result of the project

6. Links with other research and development programmes and in particular the Waste Minimisation through Reduction, Reuse and Recycling in Industry Programme operated by the EPSRC (Engineering and Physical Sciences Research Council)

The funding from EB Buckinghamshire was provided to set up and manage the project. The life of the project would be dependent on the success of the project manager in negotiating a financial payback from the participating companies.

By offering to firms a no-risk project of up to 42 days of highly qualified assistance, the expectation was that the previously reported management inertia about "waste" would not be an issue.

1.1 OAKDENE HOLLINS LTD

Oakdene Hollins is a consultancy specialising in technology and manufacturing issues. The company coordinates the sustainable technologies initiative (STI) on behalf of the DTI and EPSRC, further details are available on the web site www.oakdenehollins.co.uk

Dr Peter Lee was appointed to both coordinate the Aylesbury Vale project and deliver the detailed engineering consultancy to participating companies. Peter holds a first class honours degree in manufacturing systems and a Ph.D. in tribology; he is apprenticeship trained with industrial experience in the defence and aerospace sectors.

1.2. THE AYLESBURY VALE

Aylesbury Vale is the seventh largest district in England with a population of 146,000. Located in Buckinghamshire between Milton Keynes and Oxford, it is mostly rural except for the principal towns of Aylesbury and Buckingham in which 40% of the population is based. The area offers jobs for 52,000 people of which 15.6% are in manufacturing, the majority of which are in the medium and high wage category.

Major manufacturing employers in the engineering and print sector have declined in recent years leaving a number of medium sized companies of below 500 employees mostly in the food sector (McCormicks, Askeys and Nestle). The growth area appears to be the technology sector with companies such as Dage, ETA Circuits and Airtech/Remec. Companies such as CTP Wipac Ltd based in Buckingham demonstrate that cost-focused manufacturing in the automotive supply sector can still be successful in the region.

During the life of the project several manufacturing companies either closed or downsized considerably. Aylesbury Automation, Kerry Ingredients and Nestle being examples. This trend has been balanced with a growth in smaller manufacturing companies serving distinct market niches.

CHAPTER TWO DEFINITIONS & METHODS

2.1. WASTE MINIMISATION PROJECTS IN THE UK

In 1990 the first use of terms such as "reducing waste at source" were being used in the UK. A Government White paper entitled "this common inheritance" reported:

> *"The Government's priorities are to reduce waste at source or reuse (and recycle) what is left, and dispose of the rest in the most environmentally responsible way".*

However, industrial waste minimisation began in earnest in the UK in 1992. The first waste minimisation project was launched, in the form of the Aire and Calder (river catchments in Yorkshire) project, the savings resulting from the project can be seen in Table 2.1. At a similar time the Engineering Employers Federation (EEF) launched an industrial strategy to help increase the competitiveness of the British manufacturing industry and improved resource efficiency and waste minimisation were two important elements of this strategy (Envirowise, July 1998).

Table 2.1. Savings resulting from the Aire and Calder project as of 31 August 1994 (CEST 1995).

SOURCE	SAVINGS ACHIEVED	
	£'000 PER ANNUM	PERCENTAGE OF TOTAL SAVINGS
WATER	512	15
EFFLUENT	462	14
RAW MATERIALS	1565	47
ENERGY	327	10
OTHERS	484	14
TOTAL	3350	100

In 1994, the Department of trade and industry and the Department of the Environment (now the Department of environment, food and rural affairs) launched the Environmental Technology Best Practice Programme (now Envirowise). The programme was set up to promote the use of better environmental practices that reduce costs for UK industry and commerce.

In 1995, the Government stated in its waste strategy (DFE 1995);

Policies for minimising waste are at the heart of this waste strategy. Waste reduction stands apart from the other options in the waste hierarchy. This strategy is concerned with two kinds of waste reduction: reducing the quantity of solid waste that is produced that would otherwise need to be processed and disposed of by one of the other options in the waste hierarchy, and it is also concerned with reducing the degree of hazard represented by such waste.

In 1998, the Government included waste minimisation in its consultation paper on the waste strategy for England and Wales, which placed emphasis in seven main areas (DEFRA 1998);

- Substantial increases in recycling and energy recovery.
- Engagement of the public in increased reuse and recycling of household waste.
- A long-term framework with challenging targets underpinned by realistic programmes.
- A strong emphasis on waste minimisation.

- Using the waste hierarchy as a guide, not as a prescriptive set of rules.
- Creative use of economic incentives like the landfill tax.
- Increased public involvement in decision-making.

By 1998 there were 45 waste reduction clubs and projects in existence in the UK and a survey undertaken by Envirowise in 2001 concluded that the 138 clubs and projects had generated savings of £45 million. The annual cost savings to industry of the Envirowise programme was put at £150 million and the environmental benefits included the reduction of over 270,000 tonnes of raw material usage per year (Envirowise 2002). After reviewing the interim or final reports from 13 of these projects it was apparent that little investigation had been carried out concerning the contract structure for the subsidy. In particular, the claims of significant financial savings were assumed to have been shared between participating firms and the project managers.

The application to EB Buckinghamshire Ltd was designed to investigate whether there were alternative contract structures that made better use of the initial subsidy. Also whether the financial values ascribed to the savings could be better evaluated by the preparedness of companies receiving the reported cost saving to make a payment into the project to assist other companies.

2.2. DEVELOPMENT OF "WASTE MINIMISATION" DEFINITIONS

Waste minimisation marked a significant change in the way waste was perceived. Much like the revolution that has taken place with quality in industry emphasis was being placed on prevention rather than cure. As discussed in the Governments 1995 waste strategy, the "at source" principles of waste minimisation placed it at the top of the waste hierarchy above the so called "end of pipe" techniques (DETR 2000);

I. Reducing waste;
II. Re-using waste;
III. Recovery (recycling; composting; energy recovery); and
IV. Only then disposal.

Although the benefits of waste minimisation have been clear for all to see the term itself has been the subject of much debate. It has been reported that it should be "used with caution" since it has become such a general term (Coggins. C, 1999). From an environmental perspective the literal definition of waste minimisation does not address issues such as sustainability, hazardous waste, etc. For this reason, definitions have tended to be broadened in order to incorporate such issues. For example;

The Environment Agency defines waste minimisation as (Environment Agency, 1998):

"The reduction of waste at source, by understanding and changing processes to reduce and prevent waste. This is also known as process or resource efficiency. Waste minimisation also includes the substitution of less environmentally harmful materials in the production process."

The Institute of Waste Management defines waste minimisation as (IWM, 1996):

- Prevention and / or reduction of waste generated;
- Improving the quality of waste generated to facilitate recycling and / or reduce hazard;
- Encouraging re-use, recycling and recovery;

- Efficient use of raw materials and utilities such as electricity, water and gas;
- Transport logistics.

The broadening of the meaning of waste minimisation results in an overlap in techniques. For example, in industry Design for Environment (DFE) emphasises environmental consideration in product and process design and includes (Socolow. R, 1994);

- Minimise usage of hazardous and bulky materials as well as materials that involve energy intensive methods of production.
- Maximise usage of materials that are recyclable and environmentally friendly.
- Design products for ease of repair so they are not readily discarded.
- Design products for ease of disassembly after disposal.

In addition, the broadening of the term has exacerbated the ease of misinterpretation. In industry it can be taken as meaning the seven wastes developed within the Toyota Production System (Ohno. T, 1985), namely:

1. The waste of overproduction
2. The waste of waiting
3. The waste of transporting
4. The waste of inappropriate processing
5. The waste of unnecessary inventory
6. The waste of unnecessary motions
7. The waste of defects

It can also be misinterpreted as meaning "waste management", which is perceived as referring simply to "disposal" and since waste costs represent a very low percentage of product cost, as little as one percent, it can be given low priority (Green Alliance May 2001). To overcome this issue new terms have been developed. The quotation from the Environment Agency, shown above, uses the term "resource efficiency" as an interchangeable term with waste minimisation and an initiative recently launched in Northamptonshire is entitled "the Northamptonshire Resource Efficiency Project" (NREP).

"Resource productivity" is a term being used alongside waste minimisation (ACBE 2001). This is said to support the Government's long – term programme for sustainable development in the UK, which requires that progress be made simultaneously in terms of economic, social and environmental objectives and is defined as (DEFRA 20th Nov 2001):

Resource productivity measures the efficiency with which the economy uses energy and materials (the natural resource inputs needed to achieve a given economic output). If the definition of natural resources includes pollution sinks – the capacity of the atmosphere, the land area and the world's oceans and rivers to absorb waste and pollution – resource productivity also measures the economy's ability to produce goods and services relative to its environmental impacts. This wider measure is more useful to policy-makers, because our most pressing concerns relate to the way we are using up the resource provided by pollution sinks, rather than to the scarcity of resource inputs.

Although waste minimisation can be questioned in terms of terminology the benefits of the technique are not in doubt. For this project, a definition used to describe "waste prevention and reduction" was used. This is split into two parts (Coggins. C, 2002);

- Qualitative waste prevention and reduction – using less toxic or less hazardous resources and / or producing less toxic or less hazardous waste.

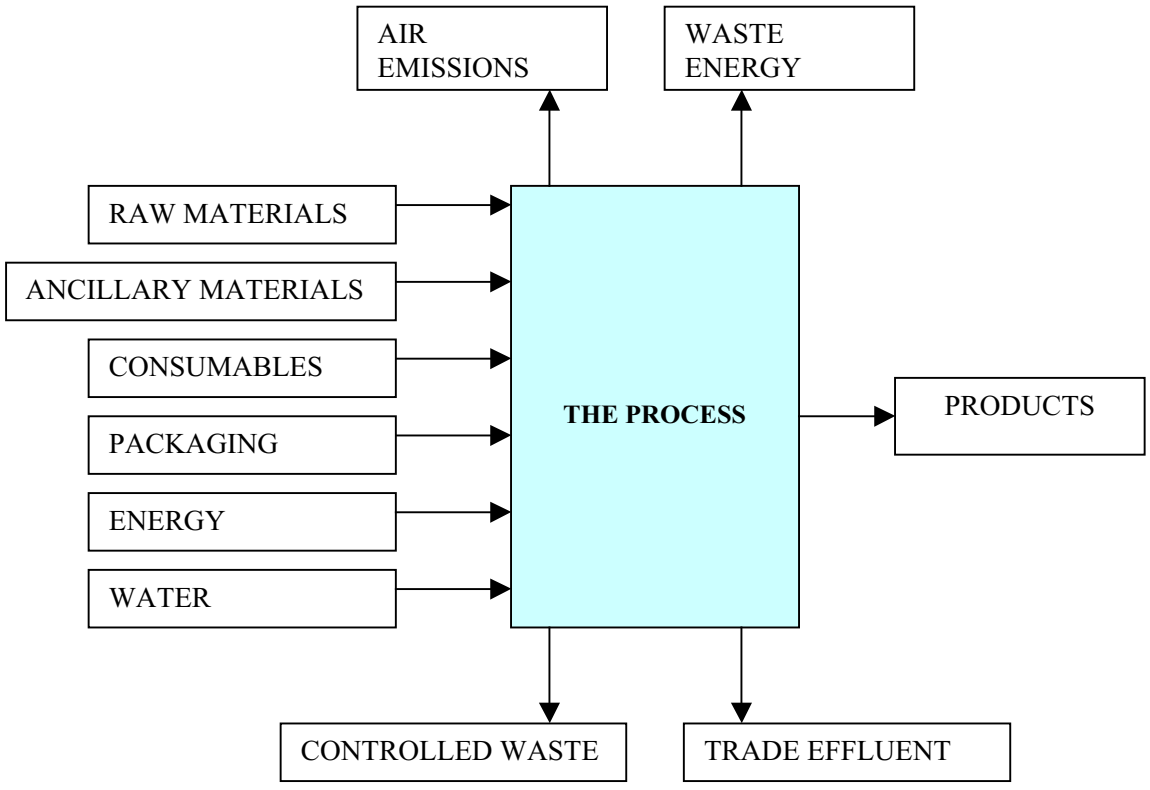
- Quantitative waste prevention and reduction – using less resources and / or producing less wastes in tonnage terms or in terms of resources / waste per unit of product / service.

This definition incorporates the principles detailed in the environment agency definition whilst also taking into consideration the objectives of "resource productivity".

2.3. METHODOLOGY

The environment agency and Envirowise have developed waste minimisation methodologies and both use the material flow analysis technique called mass balance, see Figure 2.1. This works on the principle that what goes into the process must come out, albeit usually in a different form. This is a clear way of showing that along with the desired output, i.e. the product, a number of unwanted outputs are produced. In addition, using the diagram it is very easy to explain the relationship between process inputs and process outputs.

Figure 2.1. The mass balance diagram (Environment Agency 1998)



The diagram also shows the areas of interest from both an economic and environmental standpoint. From a business / economic perspective the reduction in the level of inputs required to produce a unit of production (output) is attractive since the costs associated with the purchase of resources (the inputs) is a significant part of the overall product cost. The scope of opportunity in

this area from a business / cost reduction standpoint is evident by the growth of such techniques as lean manufacturing (Bicheno. J, 2000), which works on a very similar principle to waste minimisation.

As outlined in the Governments definition of resource productivity, discussed in Section 2.2, from an environmental perspective "the Governments most pressing issue is the using up of the resource provided by pollution sinks, rather than the scarcity of resource inputs". Therefore, the by-products of the process, i.e. the outputs other than products, are seen to be of greatest significance.

One criticism of the diagram is the assumption that all "product" is desirable. Finished goods, sub assemblies, etc could be produced on a "make to stock" basis rather than "make to order" in which case the product is stored until a customer places an order. If no such order comes to light then the product is either discarded prior to ever being in service or it stays in the stores. In addition, companies often make products based on the "economic batch size" rather than the size of the customer order, which again can lead to a build up of finished stock.

The method used by the environment agency, Envirowise and ISO 14001 (Gilbert. M 1998) uses the principles of the PDCA continual improvement cycle, see Figure 2.2. PDCA stands for plan-do-check-act and has also been called the Shewhart cycle, after its developer A.W. Shewhart. It is sometimes also referred to as the Deming cycle after W. Edwards Deming, the person who popularised it.

Figure 2.2. The PDCA problem solving cycle (Roberts H et al 1998).

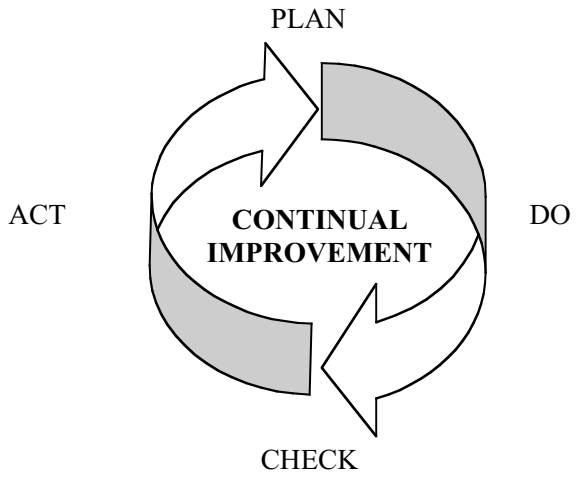


Table 2.2 shows the approach to waste minimisation used by the environment agency and Envirowise and how they both can be integrated into the PDCA cycle. Accurate measurement is a fundamental requirement of the system and a quotation reiterates this point (Nicholas. J, 1998);

> *"For whatever we seek to improve or wastes we seek to eliminate, measurement is necessary to know exactly where we are, where we have been, and where we are going. Measurement is fundamental to the PDCA cycle in both the plan stage (collect data) and the check stage (collect data). Any area for which improvement is sought must be initially measured to establish a baseline against which to measure progress".*

Table 2.2. The environment agency and Envirowise approaches to waste minimisation.

PDCA	Environment Agency Approach	Envirowise Approach (Envirowise 1998)
PLAN	1. Collect basic data. 2. Assess the scope of savings. 3. Identify legal obligations. 4. Get commitment.	1. Give someone responsibility for waste management 2. Establish the size of the waste problem
DO	5. Individual process mapping 6. Quantity and cost determination. 7. True cost of waste 8. Prioritising issues 9. Generating options for improvement	3. Analyse the information 4. Consider the waste minimisation options available 5. Produce an action plan to set targets 6. Implement the action plan
CHECK	10. Opportunity assessment	7. Review the progress
ACT	11. Project implementation and maintaining momentum	Complete the closed loop / continual improvement cycle returning to step 3

For the Aylesbury Vale project the basics from both the Environment Agency and Envirowise methodologies were used for the initial appraisal of company processes since the two approaches are so similar and have both been extremely successful. It was helpful in identifying the areas of waste generation that presented opportunity for change.

CHAPTER THREE PERFORMANCE INDICATORS

DEFRA's performance and innovation unit (PUI) reported that the suitability of different measures depends primarily on three factors (DEFRA, 20th Nov 2001):

- Robustness, in terms of the reliability, defensibility and sensitivity of the theory;
- Practicality, in terms of the technical feasibility, data availability and the ease of communication; and
- Usefulness to policy makers, in terms of the identification of targets, gaps and trends.

The report also stressed;

"It is important to choose measures that are as appropriate as possible to the situation, while maintaining a full awareness of their limitations. In general terms, those measures that might be the most robust and useful have a tendency to suffer from difficulties in terms of their practical availability".

One of the problems with waste minimisation projects is the diversity of the audience / stakeholders. For a number of stakeholders the indicators are there to measure the performance of the waste minimisation project whereas participating companies want the indicators to measure their internal performance. In addition, the information required is also diverse.

The Environment Agency takes a holistic approach to waste looking at issues from sustainability to waste disposal. People living near landfill sites will primarily be interested in seeing the volume of waste to landfill being reduced since this will have an impact on the number of vehicles passing by their doorstep. Table 3.1 shows that UK local authorities have a wider interest but still places "reduced landfill needs" as the most significant reason for encouraging waste minimisation. Manufacturing companies on the other hand have a primary focus on short-term measures of productivity and efficiency.

Table 3.1 (Read. Adam, 1998)

Reason for encouraging waste minimisation	% of UK authorities who agree
Reduced landfill needs	95
Environmental concerns	90
Cost savings	80
Public relations	79
In line with government policy	75

Within the project we were especially keen to ensure that once the period of external assistance was over that a continuous improvement methodology was in place so that the work could continue internally. To achieve this, focus was placed on the training of individuals within each of the participating companies and they would be the torchbearers to deliver future environmental benefits.

From a long list of 15 performance indicators, 5 primary indicators were selected, see Table 3.2, and a further 4 secondary measures, see Table 3.3, to balance the needs of each audience.

Table 3.2. The primary performance indicators

Number	Description	Unit of Measure
1	Reduction in discarded resource	£
2	Employees trained in waste reduction methods	Number of individuals
3	Substitution of materials	£
4	Reduction in site emissions	Tonnes / grams
5	Increase in process performance	Quality * efficiency * throughput

Table 3.3. The secondary performance indicators

Number	Description	Unit of Measure
6	Number of consultancy days delivered to companies	Number of person days
7	Funds paid back into scheme by participating companies	£
8	Further R & D opportunities created	Number of successful proposals
9	Months during which project operated	Number of months

3.1. BACKGROUND EXPLANATION OF PRIMARY PERFORMANCE INDICATORS

- **Reduction In Discarded Resource**

This measure is included within the indicators developed by both DEFRA and the Green Alliance (Green Alliance 2001).

To be accurate this measure needs to take into consideration the "value added" element of a manufacturing process. The process converts raw material into either product or waste. Not surprisingly the return on investment of raw material converted to product is much higher than that of the material turned into waste. This is especially the case when assessing products rejected at the end of the manufacturing process. At the point of rejection this material is transformed from a high value added product to a high value added waste. The cost of waste is therefore more than the proportional cost of the raw material or the disposal cost. For each participating company the point at which waste occurred was determined and a conservative estimate of the added value at the point of rejection was made, i.e. "value stream mapping" was undertaken. None of the participating companies used production data to do this. Using this baseline data we identified methods for eliminating or reducing the waste beginning with the waste to which most value had been added.

Measuring this in financial terms rather than resource inputs and emissions is regarded by DEFRA as a "proxy measure" and it is used when the direct environmental impact of the activity cannot be measured (DEFRA, Nov 2001). In this case, the issue is one of practicality since it would be extremely difficult to quantify all the resource inputs and outputs up to the point the product were rejected.

- **Substitution Of Materials**

This is a measure of qualitative waste prevention and reduction, as discussed in Section 2.2, i.e. the substitution of materials for lower value, less complex, more sustainable products. For example, the substitution of a solvent, lubricant or adhesive for a simpler product that has a similar performance.

- **Reduction in Site Emissions**

Site emissions refer to all outputs from the process other than the saleable products themselves, see Figure 2.1. In a number of waste reduction projects this has been a major focus of the work due to the level of opportunity. For example, in the Project Catalyst scheme (Atkins. W. S. 1994) H J Heinz Company Ltd had water and effluent charges amounting to around £2 million per annum.

Care was taken to ensure that only the change in site outputs attributable to our work was measured and not to confuse this with changes occurring elsewhere in the production process in response to production variation or other initiatives. The weight of waste involved was modest although in one case, the avoidance of solvent emissions to atmosphere, whilst small in national terms, improved local air quality for the workforce. Estimates were made of the solid waste sent for off site disposal, emissions to atmosphere and, where appropriate, liquids sent to sewer. In one case, emissions to atmosphere involved very small quantities of spices. Although the quantity was small and represented no recognised health hazard, local residents regarded the smell from the spices as a nuisance.

- **Increase in Process Performance**

This measure was considered important from a business perspective to show that waste minimisation can result in improved productivity. The three factors measured were quality, throughput (performance) and process efficiency (availability) and these three factors are the key elements of overall equipment effectiveness (OEE)(The Productivity Development Team 1999). Improving quality can reduce waste in terms of reduced scrap levels. Improving overall performance can either limit or delay the need for capital expenditure (if demand is greater than the current level of capacity) or it enables working hours on this operation to be reduced (if demand is equal to or less than current capacity).

Each operation / process has an ultimate capacity and the objective is to make the actual capacity as close to the theoretical (ultimate) capacity as possible. Figure 3.1. shows this in the form of a section through a pipe with the pipe diameter (outer ring) representing the ultimate capacity. The aim is to take each of the issues listed in turn and develop solutions to eliminate the impact they are having on efficiency. Often a significant number of the issues are procedural and hence would remain even if equipment were upgraded.
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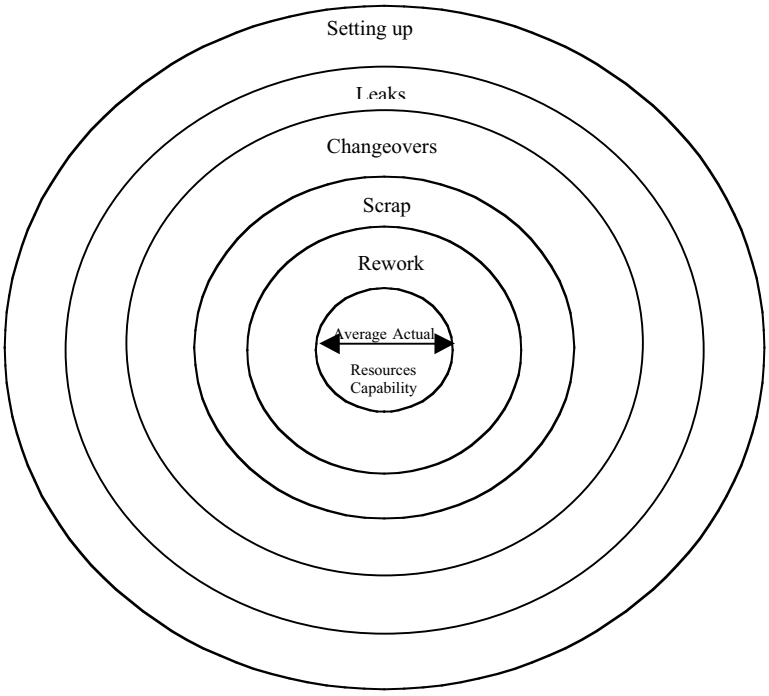
Figure 3.1. A comparison between ultimate capacity and actual capacity



Source: Adapted from Source:- Mather. H (1999) Competitive Manufacturing, Prentice Hall.

- **Employees Trained In Waste Reduction Methods**

DEFRA report that including an indicator on percentage of staff trained enables focus to be placed on future developments and not simply on past performance (DEFRA, Nov 2001). It was considered important to use the project as a platform for continuous improvement and self-sufficiency. To achieve this employees were given on-site training to enable them to continue the project once the consultation period was completed.

3.2. OTHER INDICATORS

A more comprehensive list of performance indicators was considered including measures such as estimates of reduction in carbon dioxide emissions, reduction in toxicity and measures of water usage (the latter because of concern in 1998 about the sustainability of water supplies in the Thames Valley region).

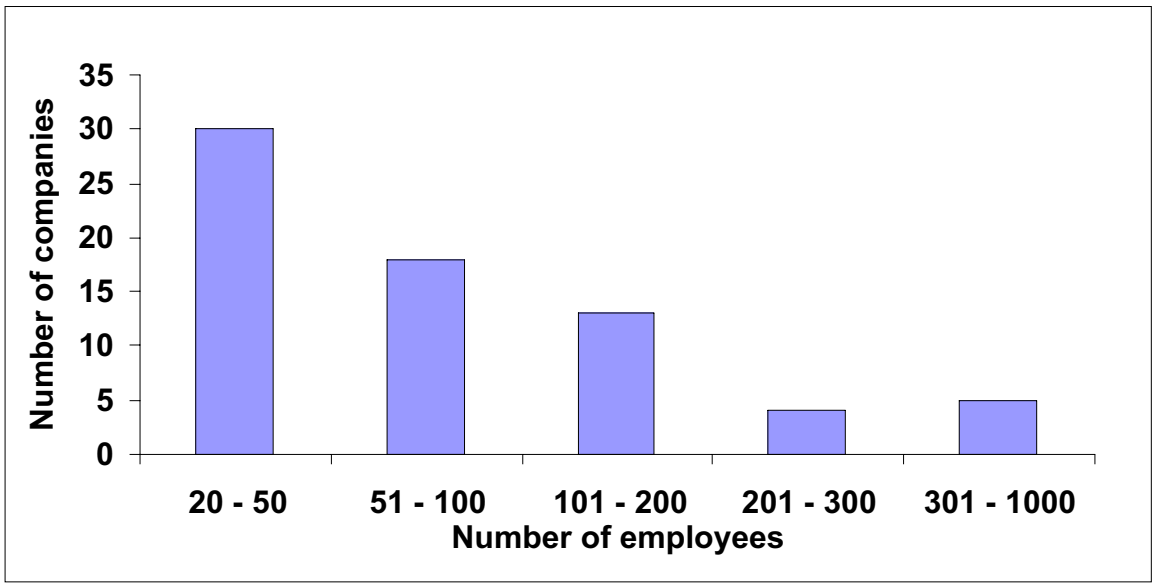
We opted to reject a more comprehensive list of indicators on the basis that some (carbon dioxide) relied too heavily on estimates and could not take account of substitution effects elsewhere in the economy, others (water) were considered to be less relevant since none of the local manufacturing companies were large scale users of water.

As an overall measure of value added we asked participating companies to make a financial contribution to the waste reduction work. Our view was that whilst we might calculate a range of performance measures, the act of making a financial contribution was a transparent performance indicator and signals whether the company would continue with waste reduction work in future years.

CHAPTER FOUR MARKETING

The initial focus was placed on existing marketing channels through Business Link and the local authorities. Leaflets were designed, printed and distributed to a target group of 70 companies, on four occasions over the period of the project. Each was followed up with phone calls. Interviews were also undertaken on the local commercial radio station (Mix96) and articles in the local press assisted in the publicity for the project. Figure 4.1 shows the make-up of the 70 companies in terms of number of employees. There are no big employers in the area with all the companies contacted having less than 1000 employees and only 5 companies having more than 300 employees.

Figure 4.1. The number of employees in the 70 companies initially contacted.

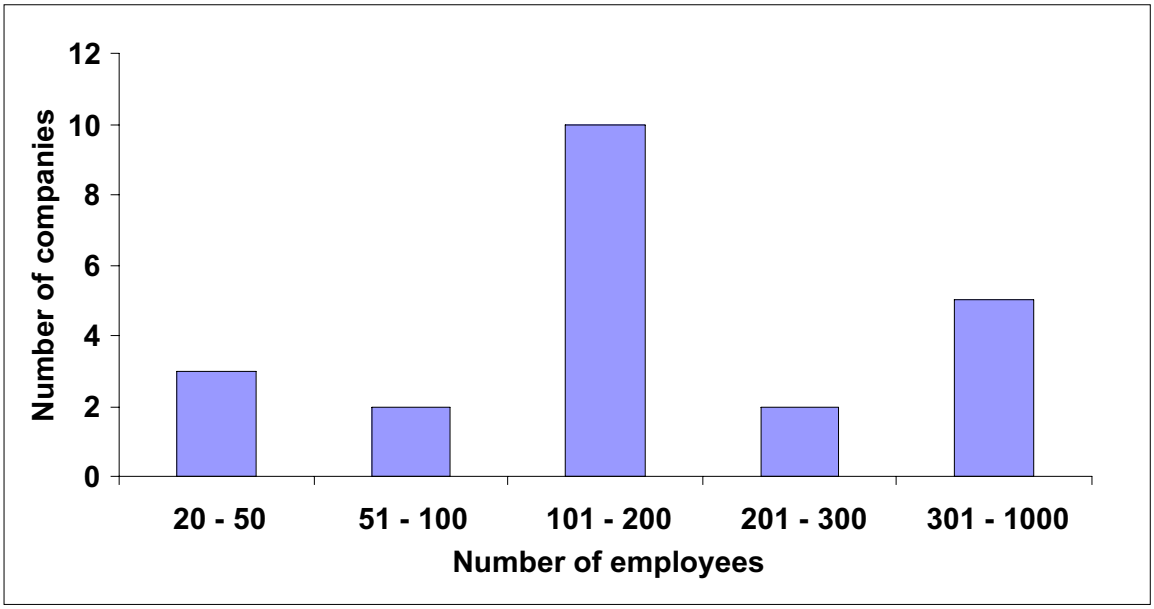


The phone calls were found to be the most successful means of selling the project since the concerns and questions of each company could be discussed. The calls revealed that very few people were aware of the fundamentals of waste minimisation. In numerous cases the initial phase of the conversation was to discuss the difference between waste minimisation and traditional waste management, i.e. rather than simply diverting the waste you have produced from the skip prevent the resource from becoming waste in the first place.

In total, 24 of the 70 target companies (34.2% of target group) were interested at this stage, meetings were held with each and site surveys and process reviews were undertaken at 17 of the companies. The most significant reason given for companies declining assistance was that they were “too busy” and it was evident that the majority of companies that responded positively were the larger companies in the area. Figure 4.2. shows the make up of the 24 companies. The lack of response from the smaller companies concurs with a survey of SME’s undertaken in the East Midlands that showed that only 2 out of 92 (2.1%) companies had any commitment to a waste minimisation initiative. The two main reasons given for this was that they could not appreciate the financial benefits of waste minimisation and the lack of time since most SME’s operate at the limit of human resource (Gronow. B, et al, 1998). Similar results were experienced in the North Wales Waste Network where only 15 enquiry’s were received from a mail shot of 500 (3%) with

the perception that few benefits can be achieved from waste minimisation and that it takes too much time (O'Brien. C, 1999).

Figure 4.2. The number of employees in the 24 companies interested in the waste minimisation project



Additional reasons companies declined included;

- moving away from manufacturing into distribution
- not having a "waste" problem
- having ISO 14001 and a focus on continual improvement
- having too many initiatives under way

Selection Criteria

A key element of the management of the project was to make it clear to companies that they were being selected through a process of evaluation, not that we were looking for any one with a vague interest in getting something for free. The selection criteria used were:

1. Evidence of senior management commitment to the project.

2. Manufacturing processes with a potential for change and improvement to reduce waste generation.

3. Long-term stability of the business, process or management team.

Table 4.1. shows that 12 of the 24 companies were invited onto the scheme in one form or another. At a number of companies there was an inverse relationship between criteria 1 and criteria 2. Two companies that scored highly on criterion 2 had poor defensive management and on both occasions we were informed that there was "nothing that needed improving here" only to find a multitude of opportunities during the site survey. The opposite scenario also happened on

two occasions when companies that were concerned with their processes were actually performing extremely well and had limited scope for improvement (Hozelock and Bucks Colour Press).

Table 4.1. A breakdown of the results from the 24 company meetings

Outcome Of Meeting	Number Of Companies
Invited Onto Project	12
Failed Criteria 1	5
Failed Criteria 2	4
Failed Criteria 3	3

The volatility of the manufacturing sector was evident within two companies invited onto the project. In the time between them accepting our invitation onto the project in principle, at the meeting stage, and the formal letter of engagement being signed off one company had been acquired and the other faced major restructuring. A further company invited onto the project was undergoing restructuring at the time of the meeting but viewed the project as a medium term opportunity. However a corporate initiative put the project back further and beyond the timescale of the scheme.

Six of the 24 companies interested in the project were subsidiaries and only 1 of the 6 had the full authority to commit to the project without the authorisation from head office.

Presentations were made to business clubs such as the Rabans Lane business association - a group of companies on the Rabans Lane industrial park in Aylesbury.

In the absence of an existing green business network, the time taken to market a project of this type should not be underestimated. For many companies it is not unlike trying to sell them a new and complex product about which they are understandably sceptical and uncertain. Several months will be required to move from leaflets and phone calls to the first on-site activities.

4.1. PARTICIPATING COMPANIES

4.1.1. The Companies Receiving 30 To 42 Days Intensive Assistance

- **McCormick (UK) Plc based in Haddenham**

Betsy Byrd (Factory Manager) welcomes David Fitzsimons of Oakdene Hollins to McCormick.

McCormick is the world leader in the production of herbs and spices. The Haddenham site is the European headquarters with 500 staff and 18 production lines. They were the first company to join the scheme in September 1998 and the 42-days consultancy was completed in March 1999. Senior management commitment was evident from the outset with the Vice President Operations – Europe, Manufacturing Director and Facilities Manager attending the initial meeting. The company had specific projects they wished to be addressed within the project and the focus of our initial work was to improve the performance (resource productivity) of one of their major production lines.

The issue of off-site emissions tested our performance criteria immediately. Local residents had complained about the smell from the factory and the company was about to invest in an end of pipe solution to the problem. Our review suggested that improvements could be made by reducing the amount of product spilled within the manufacturing environment. However, the quantity of waste material involved was very small and the time required establishing the process changes would be unacceptable as McCormick management were keen to deliver a real improvement for local residents.

The company has incorporated a re-use system into their retail products (Schwartz jars) in the form of refill packs. This enables the jars, caps, labels and sifters to be used more than once.

- **Sunalex based in Bierton**

Sunalex joined the project in January 1999 and 42 days consultancy was completed in April 2001. The company was only one of three in the 20 to 50 employees category, see Figure 4.2, to show an interest in the project. They manufacture a range of task lighting equipment. Although a much smaller company than the others selected for the extensive project it scored highly in the initial selection process in terms of senior management commitment and long-term stability. The participation of Sunalex on the scheme was also viewed as an opportunity to show that SME's could benefit from waste reduction projects.

The company operate a returnable packaging scheme with their most significant customer (RS components) which was commended.

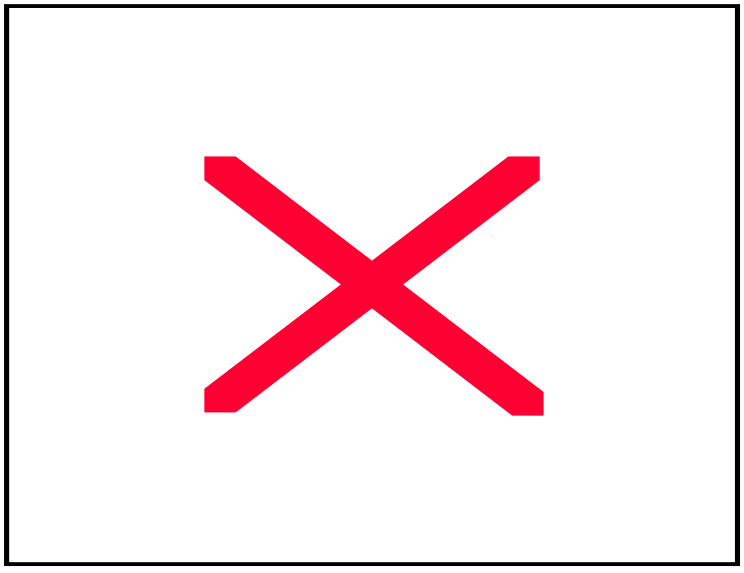
The company disposed of little regular waste off-site but an initial review highlighted the costs of one-off clearances from redundant stocks. Something that we found to be a consistent feature in the high-growth small manufacturing sector making technology products.

- **Klargester Environmental Engineering Ltd based in Aston Clinton**

Klargester manufacture a range of underground sewage and water management vessels and employs 207 staff. Work began at Klargester in September 1999 and 42 days consultancy was completed in September 2000. The initial meeting was held with the Managing Director, which demonstrated the commitment of the senior management. Consumables were identified as a significant area of opportunity although there were several other areas that deserved attention. Management was defensive over reviewing some of these areas and consumables offered a route in to demonstrate the value of the project.

- **Askeys Ltd based in Aylesbury.**

Chris Fallon (Production Manager) welcomes Steve Slater of Oakdene Hollins to Askeys.



Askeys are best known for their range of ice cream cones and wafers although they also manufacture dried food products (soups and desserts) to balance the seasonal demand for their traditional product lines. They employ 150 staff. Work started in October 2000 and 30 days of on site assistance were completed in September 2001. An initial meeting in June 1999 revealed that they were undertaking a lean manufacturing initiative with Cranfield University focused on cone and wafer manufacture. Askeys were keen to be part of the project and it was agreed that to achieve maximum commitment it would be advantageous to delay the start until the work with Cranfield was complete. Focus would then be placed in the dry mix area to complement the work undertaken by Cranfield in the cone and wafer area.

4.1.2. Companies Provided With A Process Review And Recommendations

- **Hozelock Ltd based in Aylesbury**

Hozelock manufacture garden fittings and accessories. They were visited in July 1998 and were one of the companies who failed criteria 2 – manufacturing processes with a potential for improvement. The factory was purpose built applying lean manufacture from the design stage. They had silos storing raw materials and dedicated feeds (pipework) to each injection-moulding machine. This minimised manual handling and packaging. Sprueless injection or integrated reclaim grinders for parts where sprueless injection had not yet been developed minimised the level of product waste and increased resource utilisation.

- **Kerry Ingredients (UK) Ltd based in Aylesbury**

Kerry is a worldwide food producer with a small factory in Aylesbury with 120 staff. They were visited in July 1998 when it was voiced that there was uncertainty over the future of the site. They were primarily interested in the literature available on waste minimisation and hence were directed to the Environmental Technology Best Practice Programme (ETBPP now Envirowise) and the reports from the waste minimisation projects; Project Catalyst, Dee Catchment and Aire and Calder. The site was subsequently reorganised with the loss of manufacturing functions.

- **TRW Fastenings Systems based in Aylesbury**

TRW Fastenings is part of a large US based engineering group that manufactures metal and plastic fasteners, to the automotive industry, at its Aylesbury plant. It employs 568 staff. A visit to their factory in July 1998 revealed a number of significant opportunities for waste reduction, e.g. mixed plastic waste from injection moulding machines, rinse water for coating operations and solvent usage. The company was invited onto the project but during the duration of the project have undergone major restructuring whereby the metal fastening part of the business was transferred to its German sister plant. In addition, they have undertaken a corporate wide lean manufacturing process (ALPS – Accelerated Lean Processing Scheme).

- **Spicer Hallfield based in Haddenham**

Spicer Hallfield manufacture presentation products for the photographic market. They were visited in July 1998 and a process review and site survey identified a number of opportunities with regard to raw material utilisation and stock management. Advice was given on how these opportunities could be realised in-house. At the time of the review the management were

defensive, subsequently Spicer Hallfield has worked with CEAC on a waste reduction project and have become enthusiastic supporters of waste reduction projects.

- **Acco Rexel based in Aylesbury**

Acco Rexel is the world's largest supplier of office products and employs 320 staff at its Aylesbury site. The company was first visited in August 1998 when they had just recruited a new environmental engineer who was fully conversant in waste minimisation methodologies. She had identified a number of significant opportunities and was keen to exhaust her own ideas before seeking external assistance. Contacts were given to assist her in the implementation of waste minimisation.

An invitation to join the project was not taken up as the company was able to introduce improvements without external assistance.

- **Masterfil Ltd based in Aylesbury**

Masterfil manufacture liquid filling machines and capping machines and employs 54 staff. They were first visited in August 1998. The company is small with the manufacturing facility being a job shop structure as the products made are customised one-offs. The Managing Director was very committed to cost savings and as the process review highlighted no significant opportunities to reduce waste.

- **M & J Seafoods Ltd based in Aylesbury**

M & J Seafoods are primarily distributors of frozen fish and employ 102 staff. They were first visited in October 1998 when a specific issue with packaging was identified. The process review was highly complimentary of the management and its commitment to continuous improvement. We referred the company to the ETBPP to resolve the issue of reusing food packaging as there were some technology choice issues to be addresses. The company was subsequently sold to a larger group although continues to operate from the same site.

- **Nestlé (UK) Ltd based in Aylesbury**

Nestle manufactures a range of dried food products and employs 180 staff. They were first visited in December 1998 where it was established that they had very similar opportunities to those identified at McCormick, namely, the method of packaging and line efficiency. Unfortunately the visit coincided with the announcement that a SAP system was to be implemented worldwide. Management changes following the introduction of the SAP system made it difficult to start a waste reduction initiative.

An announcement was made in February 2002 that the plant will close later in the year.

- **Buckingham Colour Press based in Buckingham**

Buckingham Colour Press specialise in colour printing. In March 1999 the General Manager visited our trade stand at the Buckingham exhibition. He stressed that the company were committed to environmental improvement and had implemented ISO 14001. The standard of operation was excellent and we subsequently used the company for printing the project literature.

- **Dage Ltd based in Aylesbury**

Dage Ltd assembles IT equipment, employing 313 staff. Following a process review in May 1999 that identified packaging and consumable use as areas of opportunity, a provisional offer to join the project was made. However, Dage were so busy meeting rising customer demand that the project did not register with the management team and the opportunities were pursued internally.

- **Aylesbury Automation Ltd based in Aylesbury**

Aylesbury Automation manufactures fasteners (primarily rivets) and employs 129 staff. They were first visited in May 1999. They scored especially well on criteria 1 and 2. Meetings with the Managing Director and Quality Manager showed senior management commitment and the initial review showed that machine utilisation offered a significant opportunity for waste reduction.

However, during 2000 the company was purchased and the Aylesbury factory closed to release the land for housing development.

- **CTP Wipac Ltd based in Buckingham**

CTP Wipac is a major employer in the Buckingham area and supply products into the automotive sector. The company employs 321 staff and was visited in June 1999. They have a dedicated Improvements Engineer who is committed to continuous improvement. The site survey revealed a number of modest opportunities most of which the company had in hand over a projected time scale of 1 to 2 years. An invitation to join the project to accelerate the time scale was offered.

However, in June 2000 the company started to implement ISO 14001 and it was agreed that trying to operate both projects at once would stretch internal resources.

This is an excellent company working in an environment where cost pressures demand innovative ways of producing a relatively low added value product for the automotive sector.

- **Europa Safety Products based in Aylesbury**

Europa Safety Products is a small company employing 15 and manufactures such safety equipment as dust masks. The company contacted us in July 1999 following our article in the Rabans Lane (Industrial Site) Review and assistance was provided to divert their cardboard waste from landfill and to increase the level of returnable packaging being used.

- **Danielson Ltd based in Aylesbury**

Danielson employ 103 staff and manufacture membrane switches. At the time of meeting the company in July 1999 they were awaiting a request by a major customer to seek ISO 14001 approval. Advice was given on 14001 and the site survey was aimed at highlighting the most significant environmental aspects. Although there were concerns about the commitment of the management to implementing the project, they were invited onto the project with a focus on the development of the Initial Environmental Review. However, once the prospective customer removed the pressure for 14001, the company moved onto other short-term priorities and our offer was withdrawn.

Danielson was advised about problems encountered when seeking to substitute solvent-based screen printing inks with more environmentally benign products. They have been unable to find a

suitable ultra violet curing ink since those on the market have a high opacity. The Envirowise project has been investigating this problem since it is having an impact on a large number of companies.

Danielson have undertaken trials on a number of different UV curing inks and are willing to assist Envirowise with further trials.

- **Lund Halsey based in Aylesbury**

Lund Halsey is a small company employing 20 and manufacturing one-off customised broadcasting furniture. Following a review of operations in July 1999 a number of modest opportunities were identified such as the implementation of selective assembly to overcome the variability in incoming raw materials (natural – timber products). The company is small and subject to external pressures that make it difficult to implement long-term waste reduction opportunities.

- **ETA Circuit Breakers Ltd based in Aylesbury**

ETA manufactures circuit breakers, controls, sensors and instrumentation and employs 86 staff. However, manufacturing operations are located in Manchester. A meeting was held following the Rabans Lane business association event in August 1999. The management of this company is excellent and supportive of the project. The review indicated that packaging waste offered the major on-site waste reduction opportunity and advice was provided on implementing returnable packaging systems. This opportunity was pursued without further assistance from the project.

Meetings with Airtech, Cheverton Laidler, Hypnos and Sterling Process Engineering were also held but no specific advice was given on how to reduce waste. In the case of Hypnos, the senior management made it clear at our brief meeting that they saw no need for the project and that their manufacturing methods were as good as they could be expected to be.

CHAPTER FIVE RESULTS

This section contains the results from the four companies who were selected for the extended programme of work, i.e. 30 or 42 days. The results from the companies where only a process review with recommendations was carried out are not included in this report. The purpose of this project was not to proclaim that all improvements carried out by manufacturing companies visited during the project were a direct result of our input.

The approach used at each of the four companies involved initial focus being placed on building an improvement team and then tailoring the subsequent steps to the project in question.

5.1. McCORMICK (UK) PLC

McCormick assigned the Facilities Manager as the "team Champion" and he was given ultimate responsibility for waste management, in line with step 1 of the Envirowise approach, detailed in Table 2.2. The tonnage of material disposed off-site was estimated at less than 165 tonnes with supplier packaging being the most dominant waste form. McCormick was already investigating the feasibility of having the main ingredients supplied in a different format, e.g. silos for flour and salt, not only to reduce the level of waste being produced but also to improve the production effectiveness, i.e. reduce the loading time of blenders, etc. Unfortunately, this would involve considerable capital investment and the study was still being undertaken after the project was completed.

On a somewhat smaller scale McCormick were looking to optimise the size of the incoming raw materials. Unfortunately, there was little scope for improvement since the unit size is dictated by both suppliers and the maximum permissible lifting limit (25Kg).

In – process packaging in the form of polythene and paper bags was also a significant contributor to off site waste and reusable containers were recommended and implemented in a number of areas.

Raw materials were being wasted in the form of spillages and extraction waste. Local residents had complained about the nuisance caused by atmospheric emissions that carried the smell of spices. The quantities of waste materials were not significant in terms of tonnes or known hazardous properties but local residents would have placed a high value on reducing the nuisance caused to them.

The initial review took this issue into account, as it was possible to reduce the amount of food material spilled during manufacturing by changing processes, albeit over an extended time period. McCormick chose to pursue a belt and braces approach to the issue by investing in an abatement system and improving process systems to reduce product wastage during manufacture.

The approach taken to reduce in – process raw material waste was to place initial focus on one area of significant wastage, i.e. one of the packaging lines. "Best practice" would then be developed in this area and the learning from this would be expanded to the other areas. Rather than focussing solely on yield rates within the process it was considered appropriate to implement the methodology "Overall Equipment Effectiveness" (OEE) to ensure a continuous improvement approach was adopted rather than a more one off project type approach. As discussed in Section 3.1. OEE involves the measurement of quality, process efficiency (availability) and throughput

(performance). Assessing all three factors rather than focussing specifically on just one ensures that a true improvement in the line occurs rather than an improvement in just one of the three factors.

5.1.1. Availability

This refers to the availability of resources during planned production time and can be measured in terms of process efficiency, i.e.

$$\frac{\text{Actual production time}}{\text{Planned production time}} * 100\% = \text{Process efficiency}$$

The first step at McCormick was to determine the accuracy of the data that was used. The efficiency was calculated using downtime sheets that were filled out by the team leaders on the line, i.e.

$$\frac{\text{Planned production time} - \text{logged downtime}}{\text{Planned production time}} * 100\% = \text{Process efficiency}$$

The two main causes of downtime were: -

- Unplanned stoppages
- Product changeovers

Focus was placed on developing and implementing solutions to overcome the significant causes of unplanned stoppages and to reduce the time the line was down due to changeovers. Fallen jars were a particular problem, i.e. a jar going down the conveyor horizontally rather than vertically, since they caused frequent short stoppages and contributed to spillages. Sensors were positioned on the line, which stopped the line every time a fallen jar was detected.

The first step in improving this process was to introduce an additional set of sensors prior to one of the major operations on the line since fallen jars were entering and jamming or smashing in the equipment causing prolonged stoppages and adding to the level of waste being produced. Escape trays were then introduced to the line so that fallen jars would roll off the conveyor into the tray automatically rather than sitting on the line waiting for the intervention of the operator. A tally chart was then developed to identify the position where the most jars were falling. The cap sticker machine was identified as the most significant cause of fallen jars since it had a contact type applicator. Modifications were made to the applicator and the number of fallen jars in this area fell dramatically.

The improvements made in this area resulted in process efficiency being increased by 11%.

5.1.2. Performance

This refers to the speed or throughput of the line and is generally measured in terms of actual throughput divided by target throughput. Placing focus on the bottleneck operation, within the packaging process, enabled the performance of the whole line to be increased by 5%.

5.1.3. Quality

The calculation used to determine quality is the number of saleable units produced divided by the total number of units produced. This has a direct impact on the waste to landfill since all rejected material (product, jars, caps, etc) is sent to the skip, damage en route was seen to add to the atmospheric loading that was subsequently extracted from the manufacturing area.

The labeling operation was identified as the most significant cause of quality rejects and a brainstorming session was undertaken and a cause and effect diagram developed. Improvements were then developed in such areas as label storage, the packaging of labels from the supplier and label application.

5.1.4. McCormick Results

Table 5.1. shows the results of the work undertaken at McCormick. Staff at all levels were committed to the project and receptive to change. A significant proportion of the reduction in site emissions came in the form of waste product being diverted from landfill (40 yard containers collected by Grundon). As a result of the savings made McCormick paid £20000 back into the scheme.

Table 5.1.

Number	Description	Unit of Measure
1	Reduction in discarded resource	£62,000
2	Increase in process efficiency	11 % on one line
3	Employees trained in waste reduction methods	23
4	Substitution of materials	£ nil
5	Reduction in site emissions	6 Tonnes of 163

5.1.5. McCormick further work

It was recommended that the waste minimisation work be extended to further lines and areas of the factory. By December 2001 waste minimisation had been applied to a further 7 lines and a project had been undertaken to reduce the level of consumables being used. Focus is continuing on the performance of operations and work has begun on the development of an energy strategy with focus on energy consumption.

5.2. ASKEYS

The production manager took up the mantle of “team champion”. The initial review identified a maximum of only 115 tonnes of wastes sent off site for disposal and as with McCormick supplier packaging was the most significant form of waste. Changing the type of packaging used on a significant raw material from cardboard boxes to reusable totes had a major impact on the overall waste levels. Unfortunately, as with McCormick there was limited scope for optimising the size of incoming goods due to Suppliers / maximum lifting limits.

The proximity of housing and a nearby canal and brook raised issues about the relative significance given to certain sorts of generally light, non-hazardous food materials. This led us to

consult with Professor Ann Smith at Hertfordshire University who has extensive experience of waste reduction work in the food and drink sector.

The review in the dry mix area involved discussing ideas with the operators and observing the process. From a manufacturing perspective, this revealed the batching / blending area as the bottleneck operation. Any improvement in the throughput of batching would therefore have a direct impact on the overall throughput of the department, i.e. the potential for a 7.5% increase in the department throughput.

In addition, there was no automated feedback mechanism between the filling head and the checkweigher. The operation of regulating the fill weight was undertaken manually, which frequently resulted in significant levels of give-away, i.e. the actual fill weight being greater than the nominal fill weight. From a mass balance perspective (see Figure 2.1.) this refers to waste within the product itself. In terms of resource productivity it results in less products being made per batch of raw material. This also results in the poor utilisation of the other process inputs associated with making the batch, i.e. energy used to run the blenders, raw material packaging, etc.

5.2.1. The batching area

On observing the batching operation and discussing opportunities with the operators it was noted that there were a great number of small improvements that could be made. One such opportunity was a metal inspection sock, which was held in place by four small nuts and bolts. The intricate task of removing the sock for inspection had to be undertaken after each batch, which was both time consuming and presented a foreign body risk. The solution was to replace the four bolts with an integral quick release clasp.

In line with the principles of Kaizen, performance indicators were put in place and junior managers were empowered to make the necessary small changes, defined in Kaizen as “incremental step improvements”, without going through the time consuming and resource inefficient justification process.

5.2.2. Give-away

The level of product give-away was just one issue with regard to product fill weight the other was the high level of process variability. The variability in the process caused sachets to be rejected for either being too light or too heavy. When this is the case the product is reclaimed through a “rip and tip” operation and the respective film is disposed of.

To address these issues an awareness-training course was developed to train the operators in basic statistics to support the waste reduction project. The training and associated improvements reduced the level of give-away to 0.2% and reduced the number of sachets being reclaimed by 11%.

5.2.3. Askeys results

Table 5.2. shows the results from the work undertaken at Askeys. The Production Manager took up the mantel of "project Champion", which greatly assisted the overall company commitment to the project. Askeys paid £4000 back into the scheme as a result of the savings made.

Table 5.2.

Number	Description	Unit of Measure
1	Reduction in discarded resource	£18,000
2	Increase in process efficiency	4% on two lines
3	Employees trained in waste reduction methods	26
4	Substitution of materials	£4,000
5	Reduction in site emissions	23 Tonnes of 114

5.2.4. Askeys further work

It was recommended that the Kaizen work continue in the batching area and be expanded to the whole of the dry mix area. This would enable both economic and environmental improvements to be made at very little cost.

5.3. SUNALEX

The management of Sunalex were committed from the outset to making improvements to their small-scale manufacturing business. The company scored highly on all three selection criteria although we were concerned that the company was simply too small to justify the investment, in terms of both time and money, to make the improvements that were possible.

The production manager was given the role of "team champion". The level of waste produced was estimated at 15 tonnes per annum. Unlike the other three companies the waste was disposed of via euro carts on a rear end loader and the 15 tonnes was estimated based on two lifts per week. The most significant form of waste was once more supplier packaging and based on small orders from a multitude of different suppliers was difficult to improve.

The stock management system was seen as an area of opportunity from both a business and waste perspective. The need for change came as a direct result of business growth. Forecasting was extremely difficult due to the infrequent and unpredictable orders and stock replenishment was undertaken based on a mix between "gut feel" and the traditional re-order level / re-order quantity methodology. The aim was to formalise the stock management system with a target to reduce stock holding by 20% without causing an adverse effect on the 100% delivery promise given to customers.

Initial focus was placed on obsolete stock with the aim being to ensure that a greater proportion of the raw materials left the process as product rather than controlled waste. The first step was to develop a list of all slow moving and obsolete items.

The second step was to evaluate the system itself. One goal is to move to a non-stock system. This is possible if the customer order lead-time is longer than the order to delivery lead-time

(procurement lead-time, processing lead-time and delivery lead-time). There are four simple structures for manufacturing systems (Wild R, 1985).

1. Make from stock, to stock, to customer, i.e. all input resources are stocked and the customer is served from a stock of finished goods.

2. Make from source, to stock, to customer, i.e. no input resource stocks are held, but goods are produced to stock.

3. Make from stock direct to customer, i.e. all input resources are stocked but goods are made only against and on receipt of customers' orders.

4. Make from source direct to customer, i.e. no input resource stocks are held and all goods are made only against and on receipt of customers' orders.

These four structures are in order of preference with the first showing both raw materials and finished goods being stocked prior to receipt of a customer order. This puts extreme pressure on forecasting and can lead to both raw material and "value added" finished goods being obsolete. The fourth structure represents the other extreme with no raw material or finished stock being carried and the system responds to customer orders. This eliminates the need for forecasting (capacity planning would still be required) but puts greater emphasis on the supply chain and effective production. To achieve this the company needs to review all its lead-times and then to implement a production lead-time reduction programme which entails such activities as reducing; set-up times, order processing time, changeover time, etc. Increasing customer order lead-time is not recommended since this can be part of a company's competitive advantage.

To assist the improvement process a monthly status report was developed that covered four main areas.

- A breakdown of the monthly transactions. This showed an overview of the stock movements within the month and comprised of a bar chart showing goods received, goods issued and opening stock level. The aim during a stock reduction project is to see the goods issued higher than the goods received each month, which indicates that the stock level is decreasing.

- Determination of the top 20 stock items being held in terms of financial value. These 20 items represent the most significant opportunities for savings. Each item was reviewed in turn to determine why they are on the list. Some items represented bulk buys and discounts from bulk buying can only be reaped if enough products are sold. People can be drawn to picking up "a bargain" irrespective of whether it is actually required. In addition, storage costs and space utilisation needs to be taken into consideration. In other examples safety buffers were set far too high meaning that more stock than necessary was being carried.

- Determination of the accuracy of the stock management system. A stock check was undertaken each month to determine the accuracy between the physical stock and the stock detailed on the system. The top 5 discrepancies were highlighted each month and focus was placed on these items to determine why the discrepancy and how can it be prevented from happening again. This item is of extreme importance since there must be confidence in the system before reducing safety buffers, discussed above.

- A list of all slow moving items. Identifying these items at the earliest possible point will keep the most options open.

The report allows for continuous improvement since the list of stock items generated is associated with the current month and hence continuously relates to up to date data.

5.3.1. Sunalex results

Table 5.3. shows the results from the work undertaken at Sunalex. Although savings were made the work at Sunalex highlighted the extreme pressure SME's are under. The primary role of the "team champion" in the other three companies was to keep the team together, maintain the project momentum and progress the work during the periods when the advisor was off site. For SME's it is often unrealistic to assign a key member of staff to such a task since they can be overwhelmed with the day to day running of the plant. In an extended project it is difficult to make the time to meet the external advisor on a regular basis let alone progress the project when they are off site. This makes the implementation process very difficult and the external advisor must be willing to roll their sleeves up and to get stuck in since they represent the additional resource necessary to instigate change.

Table 5.3.

Number	Description	Unit of Measure
1	Reduction in discarded resource	£7,000
2	Increase in process efficiency	5%
3	Employees trained in waste reduction methods	3
4	Substitution of materials	£ 1,500
5	Reduction in site emissions	nil of 15

5.3.2. Sunalex further work

The work on the improvement of the stock management system is in itself a continuous improvement process and hence the recommendation was to reap the full benefit from this process.

5.4. KLARGESTER ENVIRONMENTAL ENGINEERING LTD

The production manager was given the role of "team champion". Klargester have an annual waste of 85 tonnes with processing by-products being the most significant form of waste. The initial review revealed consumables to be an area of opportunity at Klargester and in particular the use of acetone.

5.4.1. Acetone

Acetone was used for cleaning production tools and equipment. Its usage is a global issue with regard to emissions to atmosphere as well as a more local issue in terms of health and safety standards and disposal of residues to special waste licensed landfill. Acetone is classified as a Volatile Organic Compound (VOC), which contributes to the formation of harmful ground level ozone and in the depletion of the protective high-level ozone layer.

A list of acetone users had been developed and each received either 15 or 20 litres of acetone per shift. A recycling system was in place to process used acetone with a recycling rate of less than 15%. Unfortunately, alternative cleaning solutions and methods had been tested recently without success so the objective was to reduce rather than eliminate acetone consumption.

The first step in tackling this project was to improve the procedure for booking acetone in and out of the stores. A form was developed to indicate when each operator had collected acetone, the volume of acetone collected and when the acetone was returned for recycling. This showed that some operators never returned acetone for recycling and others used the acetone until it had solidified in the bucket and could not be recycled. An awareness programme was implemented to optimise recycling and acetone usage (each operator receiving the quantity they required rather than a standard amount). This resulted in the recycling rate reaching 31% and acetone consumption being reduced by 22%.

This project emphasised the importance of good housekeeping systems. There was no capital requirement to reduce waste levels.

5.4.2. Consumables

Consumables in their nature are disposable and although they generally do not represent a high volume waste they are made from valuable / unsustainable materials. The Environment Agency uses the term consumables (shown in Figure 2.1) to relate to the materials for offices (paper and toner cartridges), sales (brochures and samples), and personal protective equipment. In many companies the consumables budget can include packaging materials (bags, shrink wrap, etc) and ancillary equipment (cleaning materials, adhesives, etc). In fact, the consumable budget can include almost anything that is not included on the Bill of Materials (BOM) for each product. A 5-step approach was used, namely:

1. Check data accuracy. This involved checking that all transactions were booked to the correct budget codes. This cannot be regarded as a waste reduction exercise but ensures the accuracy of the starting point / base measurement.

2. Develop a means of monitoring consumable use / spend. This involved the development of a monthly status report detailing the consumable transactions (goods received, goods issued and consumable stock levels) and the individual transactions of the top 10 consumables (in consumption terms).

3. Investigate whether the usage of individual consumable items can be minimised / reduced. Acetone was the most significant consumable and its usage was reduced using the method discussed in Section 4.4.1.

4. Investigate the use of alternative materials. This involves the determination of the primary and secondary functions of each item and then looking for alternatives.

5. Negotiate price reductions with existing suppliers or seek new / cheaper suppliers. As in the case of step 1, this cannot be regarded as waste minimisation and hence were not included within the evaluation of savings made from the scheme.

5.4.3. Klargester results

Table 5.4 shows the results of the work undertaken at Klargester. Difficulties were experienced at Klargester due to the company being acquired with just 3 days of the 42 days consultancy left. After acquiring the company, Kingspan PLC carried out an extensive programme of reorganisation including management changes and involving significant capital investment in new systems and production methods. Unfortunately this undermined a lot of the work undertaken on the waste minimisation project since, as part of the initial remit, focus was placed on improving the performance of existing systems with either no or minimum capital expenditure. As a result the company declined to pay a voluntary contribution back into the scheme.

This highlighted the risk associated with offering extended projects to companies on the basis of paying a voluntary contribution to prolong the project at the end of the consultation period.

Table 5.4.

Number	Description	Unit of Measure
1	Reduction in discarded resource	£40,000
2	Increase in process efficiency	0%
3	Employees trained in waste reduction methods	13
4	Substitution of materials	£2,500
5	Reduction in site emissions	8 Tonnes of 85

During the project we were able to recommend that Klargester take part in a Link funded project of research and the funding application was successful. The new management at the company decided not to pursue the research opportunity and a competitor replaced Klargester on the research project.

5.4.4. Klargester further work

It was considered inappropriate to make further recommendations due to the major changes that were to be undertaken and an on-going health and safety executive investigation following the death of a worker on site.

CHAPTER SIX DISSEMINATION

A requirement of funding from EB Buckinghamshire Ltd was that the outcome of the work should be disseminated effectively. We are proposing to do so by providing this report to the Resource Recovery Forum, Envirowise and Dr Paul Phillips at Nene College Northampton. ENDs has reported on the waste minimisation movement since the earliest studies in the 1990's and we will provide a copy of the study to ENDs.

At a regional level we propose to offer the report to the egeneration site www.egeneration.co.uk that is growing strongly with the support of SEEDA and many of the constituent local authorities. The report is to be provided to Business Link and a presentation made to parish councils close to the landfill sites in the area.

A copy of the report will be available on our own web site www.oakdenehollins.co.uk

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