MILTON KEYNES
WASTE REDUCTION IN INDUSTRY

FINAL REPORT
SEPTEMBER 2002

DATE: 27TH SEPTEMBER 2002

MILTON KEYNES WASTE REDUCTION IN INDUSTRY PROJECT
FINAL REPORT
JULY 2002

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1.0 ACKNOWLEDGEMENTS

We would like to express our thanks to the following people for their assistance, advice and support during the 6-month development phase of this project and the 12 month period of implementation.

- The Board members of EB Milton Keynes Ltd
- Richard Barnes, Environmental Programme Manager, EB Milton Keynes Ltd
- Bill Pearson, Chief Librarian, MK Central Library
- Gill King, Waste Minimisation Officer, Milton Keynes Council
- Myles Greenhalgh, Environmental Management Advisor, Envirolink UK

2.0 EXECUTIVE SUMMARY

2.1 Project Description and Methodology

EB Milton Keynes Ltd, an ENTRUST registered environmental fund, provided first year funding of £50,000 from landfill tax donated by Shanks Waste Services Ltd. The project started in April 2001. It was the third in a series of linked industrial waste reduction projects managed by Oakdene Hollins and was designed to run for a minimum of 2 years. Reports on the other two projects in Aylesbury Vale and Bedfordshire are available from www.oakdenehollins.co.uk and from the Resource Recovery Forum rrf@residua.com

The aim of the project was to assist manufacturing companies to identify the process changes that would deliver long-term reduction in resource wastage and, where necessary, provide the technical resource to implement the recommended changes. The focus on root causes required that the project be managed by someone with credible manufacturing credentials. We appointed Steve Slater, a former director of manufacturing at Acco UK. He succeeded in rapidly drawing manufacturing companies into the project and in highlighting the lack of coordination from a local Green Business Network. Earlier work in Bedfordshire and Aylesbury Vale had shown the value of these networks in raising the level of participation amongst manufacturing companies.

Initial marketing was carried out by reworking a Business Link database of manufacturing companies in the area and designing and mailing a leaflet promoting the project. Follow-up telephone calls were made to arrange meetings with companies showing an interest in participating in the project.

Using the best practice developed in Bedfordshire, the approach to participating companies was threefold:

> Awareness Meetings. These were initial visits to companies to promote the concepts and methods of waste minimisation programmes and to establish their need for assistance.
>
> Process Reviews. These involved a limited number of days work with each participating company to investigate, research and recommend waste minimisation opportunities. A full report, with detailed recommendations for improvements, was issued at the end of each review.
>
> Implementation Programmes. These programmes of work provided external assistance with implementation of the recommendations arising from the process reviews. Some companies opted to carry out the recommendations themselves using internal resources.

Due largely to a reorganisation of the regional EB structure, funding was not offered for a second year and the project ended on 31st March 2002. The level of company participation and interest far exceeded expectation and it was disappointing that this interest in waste reduction could not be developed as planned. Nevertheless, some important results were achieved and learning points were gained for those organising similar regional projects in the future.

2.2 Successes and Key Results

13 manufacturing companies received 102.5 days of waste minimisation advice and assistance by 31st March 2002. 6 of these participated in a detailed analysis of processes and a further 2 were selected and agreed to participate but a delayed start date took them outside the first and only year of the project. In all, the 13 companies employed 1595 people. The six companies

detailed in this report employed 435 staff and generate nearly 1200 tonnes of solid waste per year. If all of the recommendations made to the participating companies are implemented during year 2 we anticipate that the value of the savings in discarded resource will be £197,000. 185 tonnes of waste will not be generated and disposed including 7 tonnes of special waste.

The project results are detailed in Section 6 of this report, and by Company in Appendix I. They are summarised below:

Measure	**Results**
No of Participating Companies	6 (2 Companies deferred their start dates to post March 2002)
Reduction in Discarded Resource	£197,000
Number of Opportunities Identified	58
Duration of Project	12 months
Funds paid back into the project by Participating Companies	£4,000
Reduction in Site Emissions	185 Tonnes inclusive of: Special waste reduction of 7 tonnes
Increase in Process Performance	See individual company summaries (Section 6)
Employees trained in waste reduction methods	53

Discarded resource is an important term. It is the total value of resources embedded in a product at the point of disposal and not merely the bookkeeping value placed on it. When semi-manufactured goods are discarded it is, at best, the cost of waste disposal and the value of the lost raw material that is identified by a company as the cost of waste. The costs associated with the handling and working up to the point of disposal are almost always ignored and consequently many companies do not consider that waste is a significant budget issue.

The work undertaken in this project was designed to make the changes necessary to measure, track and improve manufacturing processes to identify the significant sources of wasted resources and to avoid them in the future. Sometimes the work required lengthy investigation for little reward. Details are given in this report of the projects undertaken at six participating companies.

2.3 Lessons Learned and Recommended Best Practice

In view of the variety of industries and business cultures encountered during the project it is not possible to identify manufacturing processes that can be put forward as “best practice” for application elsewhere. However, there are two fundamental management practices that need to be in place for waste reduction projects to be successful within any company. They are:

- Gain early buy-in from management and workforce by targeting “quick fix” opportunities and encouraging all improvement suggestions, even if they do not initially appear to be waste related
- Have basic waste measurements in place, without which neither the extent of the problem nor the degree of improvement can be managed.

There follows a number of recommendations designed to assist the organisers of future waste reduction projects. They reflect on the reasons for the early success in winning the attention and interest of the manufacturing sector and the problems with ending a project after one year.

- The marketing costs to start a project should not be under estimated. The quality of databases claiming to be a record of manufacturing companies and their key personnel is generally poor. Omissions were best identified by visiting industrial

estates and errors by phoning the entire list of manufacturing companies. Business Link staff were helpful in identifying businesses with a particular need or interest in waste reduction. In this project 34 person days were required to market the project.

- "Word of mouth" recommendations created by the two preceding projects aimed at manufacturers in adjacent areas helped to reduce the time spent marketing the project. Some of this interest was generated by Myles Greenhalgh of Business Link whose enthusiasm for introducing environmental improvement schemes to manufacturing business highlighted the positive contribution that a few enthusiastic people can bring to projects of this type.
- Of the 13 companies involved in the project, all but five had a clear understanding of the link between waste reduction and resource efficiency. 8 of the 13 had some knowledge of Envirowise. The sector specific publications and best practice guides published by Envirowise were generally well received.
- The decision whether to participate in the project was usually taken by a senior manager. Typically they were concerned about the drain on internal resources by engaging with a consultant. Using a project manager with a manufacturing background helped to overcome these concerns.
- The project funders and the participating companies proved to have different ideas of which performance indicators were important. EB Milton Keynes emphasised that tonnes of waste diverted from landfill was the key performance indicator. None of the participating companies measured resource efficiency in this way. Where this tension exists it needs to be made explicit as soon as possible if the project is to be successful.
- Companies manufacturing products using lightweight materials such as foam and plastics generate significant volumes of off cut waste that have potential for reuse as protective packaging. There may be an opportunity for a regional facility to take these wastes and manufacture a low-value product for sale to other manufacturers, distribution and storage companies.
- Our attempts to exchange various types of waste between companies such as coated papers, off cuts, foams, protective packaging, wooden boxes and various rubber components generated only a few small-scale successes. These clean materials could have been used but were usually presented in a form that was difficult for other companies to use. If these wastes could be reworked there is a potential local market for the output. There are several barriers to starting a company to do this work and the EB's may wish to consider funding these organisations in the future.
- Subsidies continue to be required to overcome managerial inertia about "waste". Although an important policy issue nationally, it barely registers on the management agenda of most manufacturing companies largely because of the inaccurate value put on waste by ignoring the issue of discarded resource.
- The subsidy required could be reduced, as companies are willing to make payments back into a project where there are clear benefits. In this case only £4,000 was paid back. However, had the project continued into a second year and with appropriate incentives we might have expected a payback similar to that achieved in the small Aylesbury Vale project.
- Together, these three projects have demonstrated an effective method for generating interest from manufacturing companies in a regional area. They have shown that coordination with other initiatives is important and that Environmental Business Networks reduce the costs of marketing. They have confirmed the conclusion that two years is a sensible minimum period for a project from Professor Paul Phillips of Northampton University in his recent review of Waste Minimisation Clubs in the UK[1]. Most importantly they show how to minimise the cost of the public subsidy required to implement regional industrial waste reduction projects.

The above recommendations are being discussed as part of a joint Envirowise and Environment Agency conference being held on 2nd October 2002. Envirowise plan to publish guidance on organising waste reduction projects during 2003.

3.0 INTRODUCTION

3.1 The Concept of Waste Minimisation

The definition of the terms "waste reduction" or "waste minimisation" has been the subject of much debate.

The Environment Agency[2] defines waste minimisation as:

"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."

In industry the term has been broadened further to mean the seven wastes developed within the Toyota Production System[3], 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

Reduction of these wastes is addressed through the application of techniques such as lean manufacturing.

The quotation from the Environment Agency, shown above, uses the term "resource efficiency" as an interchangeable term with waste minimisation.

It is the concept of "resource efficiency" that was used during the Milton Keynes Waste Reduction project. This ensured that the focus of improvement work was not only on the physical generation of waste materials but also on the root causes of waste generation, namely the production processes themselves, involving shortcomings in the efficient use of all resources. In this way, long-term changes can be introduced. This is significantly more effective in reducing waste than are techniques that provide only short-term solutions.

3.2 Oakdene Hollins Ltd

Oakdene Hollins is a consultancy specialising in technology and manufacturing issues. The company also coordinates the Sustainable Technologies Initiative (STI) on behalf of the DTI and research councils. Further details are available on the web site www.oakdenehollins.co.uk.

Stephen Slater was appointed in April 2001 to coordinate the Milton Keynes project and to deliver detailed engineering consultancy to participating companies. Stephen holds a Masters Degree in Engineering and Industrial Administration from Cambridge University and was a board member for Acco UK with responsibility for all of the company's manufacturing plants within the UK and Ireland.

3.3 Scheme Background

3.3.1 Project Aims and Objectives

The project was launched in April 2001 when EB Milton Keynes Ltd agreed to provide up to £50,000 to fund the first year of what was planned to be a two-year project. The monies were made available through the Shanks First fund under the Landfill Tax Credit Scheme.

The aim of the project was to identify technical solutions for waste minimisation in manufacturing companies in the Milton Keynes postal area to benefit the businesses, the company stakeholders, and the environment. By focussing on the root causes of waste, and by assisting companies to implement changes that eliminate wasteful processes, long-term environmental and financial benefits will accrue.

The pressure on manufacturing companies to see real financial benefits from the project cannot be over-stated. Experience from the earlier schemes clearly demonstrated the need to convince line management that the benefits from a successful waste reduction intervention should include significant cost savings by eliminating or reducing waste in all its forms.

In practice the project received one year's funding.

The main reason for the loss of the second year's funding was the change in distribution of monies to the EBs in the Shanks First fund. This change resulted in insufficient funds being available to EB Milton Keynes Ltd at the start of 2002.

3.3.2 Previous Waste Reduction Schemes

The marketing of the project, and the approach to waste reduction opportunities in the participating companies, drew on the experience gained by Oakdene Hollins from two previous Waste Reduction projects in Aylesbury Vale and Bedfordshire.

The Aylesbury Vale Project was launched in May 1998 and ran for a period of 44 months to December 2001. In order to promote the scheme and to gain the attention of line managements in local manufacturing companies, an intensive marketing effort was required. This involved newspaper articles, leaflets, phone calls, industrial site visits, presentations and mail shot letters and required 83 person days to accomplish. Four companies (5.7% of the targeted companies) were selected for, and agreed to participate in, an intensive project of on-site work. A further eight companies were invited to join the scheme but declined for various reasons, mainly due to pressure of work. A further sixteen companies were reviewed and advice provided for them to implement improvements themselves.

The Bedfordshire Project, which has spanned two years starting in June 2000, took a similar number of person days to establish and maintain a momentum. A total of eleven companies (10.5% of the targeted companies) participated in active on-site work over the two-year period.

Final reports on the Aylesbury Vale project[4] and Bedfordshire project will be available at www.oakdenehollins.co.uk.

3.3.3 The Approach

Prior to the formal signed contract, some early marketing work was carried out to test the level of interest in an industrial waste reduction project within Milton Keynes. This involved

contacting a number of manufacturers in the area and following this up with visits to promote the project.

Learning from the experience of other waste reduction schemes, the approach to participating companies was threefold:

Awareness Meetings. These were initial visits to companies to promote the concepts and methods of waste minimisation programmes and to establish their need for funded assistance under the Scheme. Based on these meetings, a decision was made whether to offer the companies a review of their production processes.

Process Reviews. These involved a number of days work with each participating company to investigate, research and recommend waste minimisation opportunities. Some "quick gain" opportunities were implemented where time allowed. A full report, with detailed recommendations for improvements, was prepared for each company at the end of the review. Participating companies then had the option of carrying out the recommendations internally, or of calling on external assistance with implementation.

Implementation Programmes. These programmes of work provided external assistance with the implementation of the recommendations arising from the process reviews. They were based upon the understanding that participating companies would agree to pay a voluntary contribution into the scheme at the conclusion of the work.

3.3.4 Timescales and Activity Levels

The schedule of events for the Project was as follows:

April 2001	Pre-contract visits to MK manufacturers. Contract signed.
May 2001	Recruitment and induction of manufacturing engineer. Preparation of database of companies. Started on-site waste minimisation process review with one company.
June 2001	Leaflets printed. First Scheme mailshot. First awareness visits carried out
July, August 2001	Awareness meetings continued. Started on-site waste minimisation reviews with three further companies.
September, October 2001	Started on-site waste minimisation reviews with two further companies.
November, December 2001	Agreed plan for implementation work with two companies.
January, February 2002	Commenced implementation programmes with two companies. Agreed plan for implementation phase with a third company.
March 2002	Second Scheme mailshot. Agreed outline implementation programme for a fourth company.

The elapsed time from the initial awareness visit to a company, through the completion of the process review, to the implementation stage, has been of the order of six to eight months. This is due to a number of factors including:

1. The production workload, especially where seasonal factors increase production flows.
2. The availability of key staff for the early days of a project during which a good deal of internal staff time is required to answer questions and provide data.
3. Other manufacturing initiatives being managed at the same time.
4. The need to win support from several senior managers.
5. The number of companies in the project.

Implementation programmes with the participating companies did not start until January 2002, the tenth month of the project.

The objectives for the first year of the project were as follows:

Stage	Milestone	Target Date
1	Sign contract. Appoint project engineer	April 2001
2	Design and print publicity material and complete first mailout.	June 2001
3	Visit 5 companies, deliver 15 days of direct consultancy. Complete progress report.	October 2001
4	Visit 10 additional companies, deliver 30 days of direct consultancy. Complete progress report.	March 2002

In practice, the activity in the first year exceeded all expectations in that a total of 13 companies had received 102.5 days of waste minimisation advice and assistance by the end of March 2002.

3.4 The Sponsors

The project was sponsored primarily by EB Milton Keynes Ltd, using funds arising out of the Landfill Tax Credit Scheme through Shanks First.

This funding was supported by a third party credit donated by McCormick (UK) Ltd.

3.5 Milton Keynes

Milton Keynes is ideally positioned for manufacturing and distribution operations in the UK, being at the "logistical centre of gravity" of the Country.

The area boasts a young and rapidly expanding labour force of 130,000 who live in the area covered by the Unitary Authority or within a radius of 20 miles of Central Milton Keynes. Some 19% of this workforce is in manufacturing. A wide range of industrial sectors are represented, including Electronics, Food and Beverages, Chemicals, Plastics, General Engineering, Stationery and Printing.

Our research identified 141 significant manufacturers in the MK postal area, bounded by Buckingham in the West and Newport Pagnell in the East. The majority of the companies identified were classified as small to medium sized enterprises (SMEs), although a number of these were local business units belonging to larger holding companies.

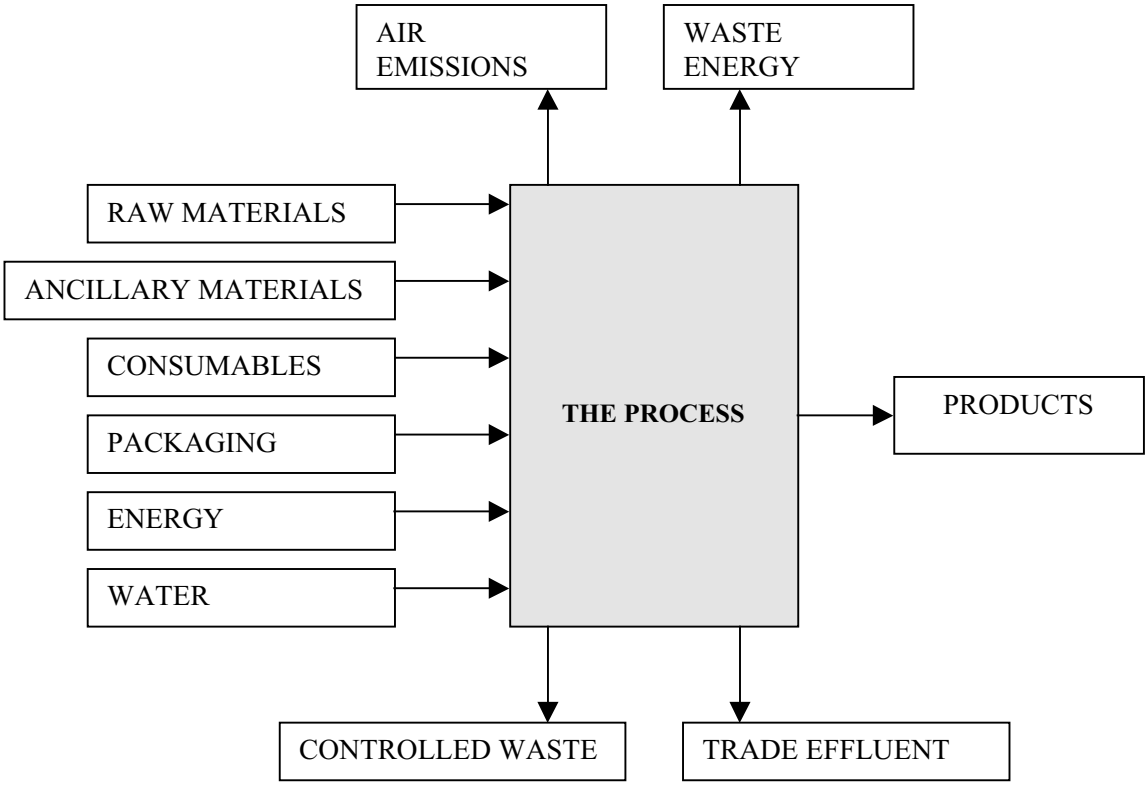
In common with most of UK manufacturing, the overriding need of these companies is to increase competitiveness through reduced costs by minimising waste in all its forms. In many cases, this was seen to be a prerequisite, not just of improved profitability, but of business survival.

4.0 METHODOLOGY

4.1 The Mass Balance Technique

The Environment Agency and Envirowise have developed waste minimisation methodologies and both use the material flow analysis technique called Mass Balance, see Figure 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 1. The Mass Balance Diagram



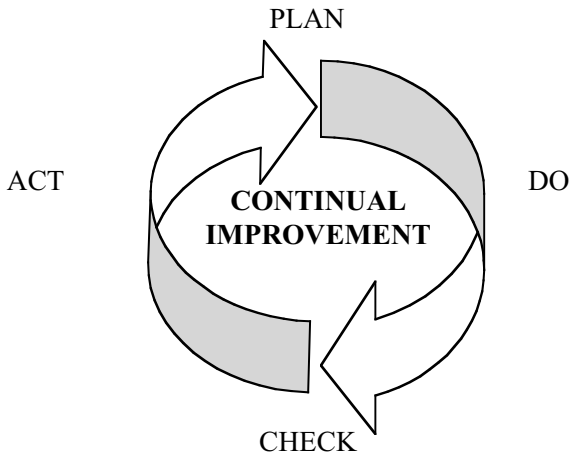
The diagram also shows the areas of interest from both an economic and environmental standpoint. From a business/economic perspective the reduction in the level of inputs required to produce a unit of production (output) is attractive since the costs associated with the purchase of resources (the inputs) 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 the techniques of Lean Manufacturing (Bicheno. J, 2000[5]), which work on a very similar principle to waste minimisation.

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. This build up of stock inevitably leads to the disposal of excess product, invariably to landfill.

4.2 Implementing Improvements

The implementation methods used by the Environment Agency, Envirowise and ISO 14001 (Gilbert and Gould 1998[6]) use the principles of the "plan-do-check-act" (PDCA) continual improvement cycle, see Figure 2.

Figure 2. The PDCA Cycle



The following table shows the approach to waste minimisation used by the Environment Agency and Envirowise and how they both can be integrated into the PDCA cycle.

The Environment Agency and Envirowise approaches to waste minimisation.

PDCA	Environment Agency Approach	Envirowise Approach
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	8. Complete the closed loop/ continual improvement cycle returning to Step 3

Accurate measurement is a fundamental requirement of the system and a quotation reiterates this point (Nicholas J, 1998[7]):

"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 and the check stage. Any area for which improvement is sought must be initially measured to establish a baseline against which to measure progress".

For the Milton Keynes project the basics from both the Environment Agency and Envirowise methodologies were used for the initial review of company processes since the two approaches are so similar and have both been extremely successful.

4.3 Engaging SMEs

Learning from the experience of the first two waste reduction schemes conducted by Oakdene Hollins, in Aylesbury Vale and Bedfordshire, the following approach was adopted as the best way to gain the attention and commitment of manufacturing executives.

1. Initially, a database of all significant manufacturing companies in the area was compiled using data from a number of sources including:
    a. Oakdene Hollins' records.
    b. Milton Keynes and North Bucks Chamber of Commerce database of manufacturers.
    c. The Milton Keynes Business File.
    d. Physical survey of the area noting new and relocated premises.
    e. Internet searches.
    f. Telephone calls to establish contact names. The ideal contact would be the Managing Director or the executive in charge of production. Failing this, the Environmental or Quality Assurance Manager was a suitable contact.
2. In parallel to this research, a leaflet was designed covering the essential elements of the Milton Keynes Waste Reduction Scheme and providing a fax-back form for interested companies.
3. Once the database was accurate, the leaflet and a covering letter were sent to all of the 141 target businesses and this was followed up with telephone calls aimed at setting up site meetings with managers from companies interested in participating in the project.
4. Further publicity opportunities included media coverage after a press release, the placing of leaflets in libraries, council offices and the Materials Recycling Centre and through membership of the committee of the Milton Keynes Green Business Club.
5. Site visits took the form of meetings between the manufacturing engineer and the companies' executives to raise the awareness of the project itself and to demonstrate the advantages of waste reduction programmes. Where appropriate, they included a factory tour that enabled the engineer to make a quick assessment of the potential opportunities in each company.
6. The opportunities identified in the site visits formed the basis of an offer of a detailed review to companies that met strict entrance criteria. This entailed the provision of a number of days' (typically 10 days) free engineering expertise to participating companies to carry out a review of the company's processes to identify, and implement where time permitted, process improvements aimed at achieving cost and waste savings.
7. At the end of the process review, a detailed report was issued setting out recommendations for process improvements. The participating company could decide to implement the improvements in-house or to call on external assistance.
8. Where a company decided to use external assistance under the project, an offer of up to a further 20 days consultancy was made, subject to the company agreeing to pay a voluntary contribution back into the project following the successful conclusion of the project.

The benefit of this three-stage approach was that managers could agree to a process review with no fears that there was some "catch" behind the offer. The only cost to them during the review was their own time and that of their employees. Furthermore, they would only have to commit to financial outlay, in the form of a voluntary contribution into the project for

assistance with implementation, once they were confident that they had achieved a real benefit from the work. Alternatively they could proceed to implement recommended improvements without external assistance, based on confidence that the process review report was sufficiently detailed and relevant to their needs.

4.4 Project Measures

Key measures covering the administration and activity levels of the project are as follows:

Measure
No. of participating companies
No. of days consultancy delivered:
Duration of project (months)
Funds paid back into the Scheme by participating companies

The first year consisted mainly of awareness meetings and process reviews. Implementation work had started with two of the participating companies when funding was stopped.

The key project performance measures of the project are shown in the following table. For the purposes of this report, we have estimated the benefits that would accrue at each company if the recommendations of the process reviews were to be carried out in full.

Measure	Unit of Measure
Number of opportunities identified	No.
Reduction in discarded resource	£ p.a.
Reduction in site emissions	Tonnes/Cu. Mtrs. p.a
Increase in process performance	See individual companies
Employees trained in waste reduction methods	Nos. of Staff

A description of each measure follows:

- **Number of Opportunities Identified.** The number of key recommendations for improvement that were made during the process review. Minor and detailed opportunities are excluded from this figure.
- **Reduction in Discarded Resource.** This is the total value of resources embedded in a product at the point of disposal. The cost of waste is more than the cost of the raw material plus the disposal cost and this measure takes into consideration the "value added" element of a manufacturing process. This is especially significant when assessing products rejected at the end of the process. At the point of rejection this material is transformed from a high value added product to a high value added waste.
- **Reduction in Site Emissions.** This refers to all outputs from the process other than the saleable products themselves and includes physical material wastes, effluents, and emissions to atmosphere.
- **Increase in Process Performance.** A programme to install cellular flow techniques to a production line, whilst not initially directed at the reduction of material waste, will lower inventory and improve quality, which in turn will lead to reduced obsolescence and less scrap, both of which will impact the physical waste stream.
  The waste minimisation work is therefore not only addressing the point at which waste arises, but is concerned with dealing with the root causes of waste in the manufacturing process. To this end, any increase in process performance is deemed to be a key measure of success of the project. The actual measure varies from company to company.

- **Employees Trained In Waste Reduction Methods** DEFRA report that including an indicator on the number of staff trained enables focus to be placed on future developments and not simply on past performance (DEFRA, Nov 2001[8]). It was considered important to use the project as a platform for continuous improvement. To achieve this employees were given on-site training and coaching to enable them to continue the project once the consultation period was completed.

5.0 MARKETING RESULTS

5.1 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, and that not all companies expressing an interest in the project would be offered this funded assistance. This principle was communicated through the mailing leaflet and discussed further at the initial awareness meetings.

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.

Experience in the Aylesbury Vale and Bedfordshire projects led us to place much less importance on the third criterion. Whilst important, we found that we rarely had sufficiently accurate information on which to judge long-term stability.

5.2 Awareness Meetings

As a result of the marketing campaign, awareness meetings were arranged with 13 manufacturers. Offers of a process review under the scheme were made to 10 companies and accepted by eight. Details of these companies are follows:

Company/Activity	Offer Made ?	Offer Accepted ?	Comments
Alps Electric Ltd	✗		Moving production to Czech Republic
Balzers Ltd	✓	✓	
Basell Polyolefins UK Ltd	✓	✓	A reorganisation caused a delay in the start date
Beardow and Adams (Adhesives) Ltd	✓	✗	Could not gain Chief Executive's commitment
Buckingham Furniture Ltd	✗		Low price imported competition threatens future
Custom Foams	✓	✓	
FCC (Europe) Ltd	✗		Interested but unable to gain Board commitment
Goldschmidt UK Ltd	✓	✓	
HMC Brauer Ltd	✓	✓	
McKey Food Service Ltd	✓	✓	
Spillers Speciality Feeds Ltd	✓	✓	
SMC Pneumatics (UK) Ltd	✓	✗	An outstanding company with superb systems
Terrapin Ltd	✓	✓	Start date delayed due to sickness of key staff

5.3 Participating Companies

Of the eight companies with whom a process review was agreed, two were forced by events to postpone the start of the review, taking them outside the 12 months of the project.

Basell Polyolefins, having signed up to the project, was informed that the parent company had planned a major rationalisation programme which involved moving a significant amount of manufacturing capacity into the Milton Keynes site from another location. This project, which was due to take 6 months, would take up a large amount of time of key managers at Milton Keynes who would not then be able to commit time and resources to the waste reduction review.

Terrapin signed up to participation in the project, but wished to postpone the review until the receipt of a major contract that was expected at the start of 2002. Further postponement of the review occurred with the retirement of the Operations Director due to sickness.

However, six other selected companies, namely Balzers Ltd, Custom Foams, Goldschmidt UK Ltd, HMC Brauer Ltd, McKey Food Service Ltd. and Spillers Speciality Feeds Ltd were provided with assistance to reduce their level of resource waste. Together, these companies employed 435 people and send approximately 3500 tonnes of solid or liquid waste to disposal annually.

6.0 PROJECT RESULTS

6.1 Balzers Ltd

The Balzers Group provides a technical tool coating service to a wide range of international customers. There are two UK sites, one in Milton Keynes and one in Elland, West Yorkshire. The Milton Keynes site employs 60 people.

The Waste Reduction project concentrated efforts in the ultra-sonic cleaning and unpacking departments. Given the nature of the business, only a small quantity of physical waste was being generated. However, this included some special wastes arising from the use of chemicals in the cleaning process.

It was established that the efficient use of the key resources of electricity, water, detergent and other chemicals was directly related to the operating efficiency of the production flow lines. By improving throughput, the wastage of these resources would be reduced and this would subsequently improve the company's environmental impact.

The process review provided an outline of the opportunities and a starting point for longer-term improvements. The project then moved on to implement a number of the improvements.

- **Special waste**. The cleaning process used to prepare gear hobs for coating creates approximately 600litres of waste solution per month. This has to be disposed of as special waste. We recommended the use of a bench-top processor that is capable of breaking down the solution so that it can be disposed of to mains sewer. This will virtually eliminate the special waste.

- **Ultrasonic wash line.** All products went through this process and it was an area of significant resource usage. The line throughput was affected by the tank dwell times and the method of loading and feeding cradles to the line.
  A gain in throughput was achieved by training the operators to optimise the packing of cradles and by balancing the flow of work to the line. In addition, changing the computer controlled sequence in which the arm lifts and drops the cradles will further increase throughput.

- **Unpacking department layout**. Following the training of 10 operators, and with the support of the logistics manager, a new unpacking layout was developed and implemented. These changes have eliminated the need for separate quality checking (a non-value adding, double handling activity), reduced operator movement in the unpacking and packing area and encouraged effective processing. Furthermore, the changes have saved a significant area of floor space and released a number of transit containers that have been diverted to act as re-usable packing containers, thereby avoiding the necessity of purchasing new ones.

- **Summary**. The layout changes, subsequent operator training and the implementation of the supporting recommendations have significantly increased throughput of the wash line and achieved a corresponding reduction in resource wastage.
  In addition, changing the times at which the ultrasonic wash line was turned on and off to reflect the current running times reduced the water heating by 16%. Further savings arose from manually shutting off the cleaning line when it was no longer being used.
  Specifically, the training of staff was in problem solving and process improvement techniques. Whilst this training was focussed on the projects identified, it clearly also

gave the staff the techniques and the confidence to address other opportunities for waste reduction in the future.

In summary, the performance measures for this project are as follows:

Measure	Results
Reduction in Discarded Resource	£7,000
Number of Opportunities Identified	11
Reduction in site emissions	6 Tonnes general waste Special waste reduction of 7 tonnes
Increase in process performance	12% increase in wash line throughput, with associated savings in energy, water, chemicals and transit containers
Employees trained in waste reduction methods	10

6.2 Custom Foams

This Company, a division of Kay Metzeler Limited and part of the British Vita group, is a processor of synthetic polymer foams. It converts block foam into finished components through a range of processes including cutting, pressing, laminating, coating and gluing. Its products have a range of end uses, including sound absorption, filtration and packaging. The Company employs approximately 45 people, mostly in manufacturing.

The Company's processes create a significant tonnage of foam scrap and off cuts. Half of this is returned for recycling into "chipfoam" with the remainder going to landfill. The management of the waste is a major issue given its relative bulk.

Following the process review, a full report was issued detailing a number of recommendations. The main objectives were to reduce the considerable amount of scrap foam that was going to landfill and to improve the productivity and quality performance of the labour force. The key points from the report were as follows

- **Measurement**. Because of the nature of the product, a large proportion of all incoming foam became waste in one form or another and yet there were no site-wide or specific measures in place to monitor it. Similarly, there was a need for standard operating times for the measurement of labour performance. It was soon established that, even for these customised products, some material and labour standards could be put in place as a basis for identifying where wastage is occurring, for quantifying losses and for monitoring improvements. A method for setting material and labour standards was recommended and a process put in place for establishing basic measures.

- **Continuous Improvement**. A contributory factor to the creation of waste was identified as the lack of the appropriate resources to promote a programme of continuous improvement. Ideas for improvements, generated from the production operatives or from any other source, required an effective vehicle for implementation. A formal programme of continuous improvement, covering the entire workforce, was recommended and initiated.

- **Receiving Quality**. As a result of Group policy, the company has limited alternative sourcing options if they receive poor quality or service from their main suppliers. Incidents of poor raw material quality led to excess material waste in production. The type of problem included trapped air within a block of foam that was revealed once

work started on it, inconsistent colours and misshapen blocks. The recommendations were to both increase the pressures on the suppliers, and to tighten quality controls at goods inwards and on the shop floor in order to ensure that material that is out of specification is rejected and that all internal faults are credited in full by the supplier. By emphasising input quality checks, an overall reduction in waste will occur.

- **Stock management**. Due to the fast moving nature of the business and the openness of the stores area, the accuracy of stock data was running at an unacceptable level in the first six months of the year. This caused both overstocking and stock-outs. Firm recommendations were made to limit the number of personnel authorised to receive and issue materials and to tighten up the stock movement booking procedures. Following this, appropriate procedures were put in place with corresponding improvements in stock count accuracy. With accurate stock data, production planning has improved considerably, leading to reduction in waste through:
    - Reduced stock levels, and therefore less handling damage and obsolescence, and
    - Better material availability, leading to fewer "panic" jobs with associated lowering of set-up waste and quality rejects.

- **Quality system.** The number and cost of errors caused by failures of the quality system were identified as a target for improvement. In particular, errors occurred in the transposition of the customer's technical requirements to the factory worksheets. The system of "contract review" needed to be tightened to ensure that these are picked up at source thus avoiding the waste associated with making to an incorrect specification.

- **Housekeeping and Workplace Organisation.** The losses through material damage, labour productivity and energy consumption were occurring as a result of below standard housekeeping and insufficient organisation of individual workplaces. At the workcentre level, tools and consumables required for the job in hand were not always readily available for the operator, and in some cases they were inappropriate. A formal programme of workplace organisation, based on the lean manufacturing "5S" principles, was recommended and initiated.

- **Training.** A general briefing in the meaning of waste and the application of waste reduction and lean techniques was given to virtually all personnel. Training in the detailed techniques was given to the management team of 6. A total of six projects were commenced, involving the further detailed training of 13 employees in problem solving and waste reduction techniques.
  By way of an example, it is noted that one such project increased the throughput rate of a bottleneck machine by some 50%. This will lead to reduced overtime running with proportionate reductions in wasted utilities and consumables.
  The general effect of the training is that the use of continuous improvement processes is now part of the Company's culture and this will facilitate the development of future waste reduction projects.

- **Summary**. The above recommendations, when implemented in full, will together yield a number of improvements in resource efficiency, including significant reductions in the amount of waste material that is sent for recycling or landfill. As a minimum, a 20% reduction in this waste will be achieved.

The performance measures for this project are as follows:

Measure	**Results**
Reduction in Discarded Resource	£71,000

Number of Opportunities Identified	13
Reduction in site emissions	34 tonnes synthetic polymer foam and general factory waste
Increase in process performance	Performance of bottleneck machine increased by c.50% Stock count accuracy improved from 60% to a projected 95%
Employees trained in waste reduction methods	43

6.3 Goldschmidt UK Ltd

Goldschmidt UK Limited, part of the Degussa group of companies, employs approximately 50 staff at its factory in Milton Keynes, producing a range of speciality liquid chemicals.

A review of their production processes was carried out to identify potential areas for waste reduction and environmental impact improvements. In particular, the management team believed that opportunities lay in the following areas:

Material yield
Packaging
Energy consumption
Water consumption
Effluent quality

The production process is essentially the mixing, and/or reacting, of liquids, powders, pellets and melted solids in either of three vats, two of which can be heated. The liquid produced is either packed in drums, in industrial bulk carriers (IBCs), or transferred to bulk storage tanks on the site. The products are grouped into two basic types, namely betains and "hygiene" products.

It has recently been decided to transfer the production of the hygiene products out of the Milton Keynes site. This was not known at the outset of the review and some of the findings and recommendations were made on the assumption that these products will continue to be made at the site.

The key recommendations arising from the review were as follows:

- **Material waste**. The loss of material within the blending processes was measured. Whilst great attention was paid to minimising spillages etc, it was recommended that more could be achieved through more accurate control of the blend and the finished specific gravities. It is expected that a 10% reduction in this loss can be attained.

- **"Giveaway".** This is the amount of finished product in the final pack that is in excess of the nominal net pack weight. This was measured for packaged products. It was recommended that up to half of this excess could be saved by better control of the filling operation. By reducing product giveaway, less raw material is consumed in the production process and therefore overall consumption and transportation of material in the supply chain is minimised. Resource efficiency, in this case the efficient use of raw material, is increased.

- **Packaging**. There were a number of factors favouring the use of IBCs over smaller drums in the supply of raw materials. These included less chemical residues, which require washing out to waste from pipes and containers, and more recyclability of the containers themselves.

It was recommended that a full study of the relationship between the initial purchase costs, and the return transportation and laundering costs, be carried out, in liaison with the suppliers, to arrive at a more cost-effective method of supplying materials in IBCs.

- **Environmental impact**. The main area of concern was the high chemical oxygen demand (COD) level of the effluent. It was believed that the main causes were either unreported spillages or retained chemicals in the concrete floor of a bund area that was breaking up. These chemicals could be leaching into the rainwater prior to dumping to the effluent storage tank.
  Following research into a number of improvement options, it was recommended that controlled trials be carried out to confirm the leaching effect of the retained chemicals in the bund area, and, if proven, that the area should be re-sealed.
  Arising from our process review, we have also made a firm recommendation for the further treatment of the effluent by a novel small-scale reed bed system, which will greatly reduce effluent contamination levels. This treatment technology is a pioneering application of a well proven method of harnessing a naturally occurring process to clean up effluents and polluting substances. It is a low cost, fully containerised system which can be applied to treat many industrial effluents with little disruption to existing processes and virtually no civil works. Its use is fully supported by the environmental body Urban Mines Ltd.
  A further minor contributor to effluent COD levels was delivery tankers with faulty pumps or with poorly trained drivers. These were causing both direct spillages and excessive foaming of the surfactants, which can have the same consequences. It was recommended that the freight companies be notified that pumps are required to be operational on all delivery tankers and that they will be turned away if this is not the case on arrival.

In summary, the performance measures for this project are as follows:

Measure	**Results**
Reduction in Discarded Resource	£22,000
Number of Opportunities Identified	7
Reduction in site emissions	50% reduction in COD of effluent
Increase in process performance	Not known
Employees trained in waste reduction methods	Nil

6.4 HMC Brauer Ltd

HMC Brauer is a privately owned engineering company producing tooling clamps, air movers and industrial wheels and castors. It is a part of the Glentay Group of companies. The company employs 82 staff in total, of which 62 are in production.

The product range of standard and own brand clamps and accessories is extensive, with c.900 individual finished items on offer from stock. The wheels and castors business is more bespoke, with many customer variants being derived from standard components. Air mover products are mainly Brauer standard items.

Resulting from the large product range, considerable overproduction and overstocking was evident, leading to high stock obsolescence. Typically, the stock was subjected to occasional write offs and then discarded.

Key recommendations arising from the review were as follows:

- **Product Range**. The combination of the wide product offering and the current batch production processes gave rise to considerable non-value-added activity and high stock levels, particularly within clamp production. These problems in turn led to a general waste of resource, in particular significant material waste through quality, damage and product obsolescence. Options for improved management of the product range were recommended.

- **Cellular manufacturing**. By categorising the wide product offering into product groups with similar production operations, it is possible to take some complexity out of the planning and production processes. This leads naturally to the implementation of manufacturing cells. The benefits would be:
  Simpler production planning
  Shorter lead times
  Lower stock levels
  Improved quality and
  Reduced waste overall, particularly through eliminating product obsolescence.

  A trial clamp assembly cell was proposed for approximately half of the total number of clamps sold. The proposal included a system for eliminating the need to hold customer's own-brand clamps in stock. It was further proposed that this concept be extended in the future to cover more clamps and other products and processes as confidence in the concept increased.
  The immediate quantifiable benefit of this trial cell was assessed at a minimum stock reduction of one-third of the total stocks associated with the range of clamps in the cell.

- **Stock Rationalisation** An analysis of the finished clamp and accessory stocks in one warehouse showed that a number of lines were either slow- or non-moving. It was recommended that these items were reviewed individually with a plan to either conversion to standard product, sell off without conversion, or disposal, and that this exercise should then be extended to the other component stocks and to the wheels and air mover product lines.

- **Set-up Reduction.** The present changeover times for the bar stock machines, the press shop and the CNC department, were identified as targets for improvement. It was recommended that a formal programme of set-up reduction be introduced in order to significantly impact changeover times in these areas. The benefits of this programme would be:
  Increased throughput
  Greater flexibility with smaller batch sizes and
  Lower component stocks.

- **Other Opportunities**. It was recommended that the above initiatives be accompanied by a site-wide training and improvement programme in related waste reduction techniques. Priorities were identified as:
  Problem Solving
  Workplace Organisation
  Statistical Process Control
  Preventative Maintenance
  Overall Equipment Effectiveness

In summary, the performance measures for this project are as follows:

Measure	**Results**
Reduction in Discarded Resource	£26,000
Number of Opportunities Identified	9

Reduction in site emissions	26 tonnes mixed metal components, turnings, etc. 70 cu. mtrs general factory and office waste
Increase in process performance	15 % improvement in productivity 20% reduction in inventory
Employees trained in waste reduction methods	Nil (Implementation programme not started)

6.5 McKey Food Service Ltd

McKey Food Service Ltd. is part of the international OSI Group of companies. It employs 130 staff at its Milton Keynes factory, manufacturing frozen meat patties for one customer only, namely McDonalds fast food restaurants. This is a high volume specialised process with little product variability. In consequence, the factory is close to state-of-the-art both technically and operationally.

The factory achieves close to optimum material yield with only minor "shrinkages" due to blood loss, moisture content, etc. Finished goods stocks are controlled by McDonalds. Raw materials are supplied daily as required and invoiced only when used. There was, therefore, little to be gained by reviewing these aspects.

In view of the above, it was agreed that the process review would focus only on energy and utilities consumption with a view to recommending waste reduction opportunities and environmental impact improvements. In particular, it was noted that the company is a big consumer of nitrogen and carbon dioxide gases which are used in the freezing and chilling processes.

The process review focused on the correlation between energy and water consumption and production output levels. Detailed statistical analysis revealed that the production processes were substantially under control with only a few areas of concern. These were presented to the management team, and a total of 5, mostly minor, recommendations made. It was clear from our meeting, however, that most of the issues had been already noted and actioned, apart from those requiring either a high level of technical input or significant capital costs. It was therefore agreed that any further work by Oakdene Hollins would be unlikely to yield significant waste reduction opportunities.

In summary, the implementation of the recommendations would result in the following performance measures for this project:

Measure	**Results**
Reduction in Discarded Resource	£7,000
Number of Opportunities Identified	5
Reduction in site emissions	Nil
Increase in process performance	Nil
Employees trained in waste reduction methods	Nil

This project was an example of investing time and effort to review and improve a process only to find that the systems were robust and that there were very few opportunities to improve on them. A theme that we have seen amongst many of the best-managed businesses has been an openness and enthusiasm to be inspected.

6.6 Spillers Speciality Feeds Ltd

Spillers Speciality Feeds Limited is an independent company producing a range of equine and other animal feeds at their mill in Milton Keynes.

Throughput is in excess of 50,000 tonnes p.a. the majority of which is manufactured, and the balance is factored or re-packaged. Some feeds are produced or packaged for third party companies. The operations workforce is 36 of a company total of 70.

A review of the production processes was carried out to identify potential areas for waste reduction. In view of the scale and complexity of the mill and due to the lack of existing plant layout diagrams, a significant amount of the review time was taken up establishing material and process flows through the plant.

The key recommendations arising from the review were as follows:

- **Process Control.** From observations and measurements taken as part of the review and from top-level data supplied, it was estimated that the annual raw material losses were low in percentage terms, but due to the volumes involved, this represented a significant tonnage of materials going to waste. This was broken down as follows:
  - "Giveaway", i.e. excess of actual weight sold over nominal weight
  - Declared waste via skips
  - Unaccounted losses, e.g:
    - Unmeasured waste, i.e. general waste disposal
    - In-process loss, mainly moisture
    - Dust to atmosphere

  The relatively low loss percentage is a result of the system of recycling the majority of reworkable product through the plant as "redress" rather than scrapping it off. However a considerable amount of redress material is created throughout the processes and especially at the packaging section which is the point at which maximum value has been added.
  These operating losses needed to be addressed in order to reduce waste and to improve the overall effectiveness of the mill. The main recommendation arising from the review was that a formal method of process control be introduced in order to measure and monitor what is happening within the various stages of the processes. This information would be used to set up a formal programme of waste minimisation through continuous improvement.
  This programme will achieve a 50% reduction in the amount of feedstuff and general factory and office waste going to landfill, equivalent to approximately 88tonnes. It will also reduce product giveaway by 25%. (The contribution to overall resource efficiency of reductions in giveaway is discussed under Section 6.3 above.)
  Furthermore, by focussing on in-process losses, whilst not directly affecting waste to landfill, will improve resource efficiency by reducing the amount of material and utilities consumed in the production processes.
  In all a reduction in discarded resource of £25,000 is expected.

- **Packaging**. The control of the stocks of paper and plastic bags used for packaging the finished product needed to be tightened for the following reasons:
  1. Incidents of bulk disposals of bags were occurring as a result of obsolescence following re-printing for a marketing change.
  2. A mass balance exercise revealed that unaccounted losses of bags were significant.
  3. Bags of the same nominal weight were not all a standard shape and size. This sometimes caused operational problems at the packaging machines.

4. Stock levels of bags at the time of the review were deemed to be unnecessarily high and this added to the likelihood of obsolescence.

It was recommended that the range of bag styles be rationalised where possible and the buying pattern of the bags be improved in order to minimise purchase costs and to reduce stock holdings. This would improve throughput and minimise potential losses through damage and obsolescence. Furthermore, procedures for issuing the bags needed to be improved.

A 25% saving in bag waste will be achieved by the above improvements, leading to a reduction in recycling waste of 7 tonnes and a reduction in discarded resource of a further £27,000.

- **Energy.** An approximate analysis of electricity consumption indicated that 80% of the power taken by the mill was used in just three main areas, namely the presses, cyclones and grinders. It was believed that 10% savings could be achieved from a formal comparison of power off-take to throughput for these machines leading to more efficient operating conditions and procedures. The study may also provide justification for some capital outlay which could yield acceptable pay-backs.

  A number of specific electricity saving initiatives, backed up by a general energy efficiency publicity programme, were recommended.

In summary, the performance measures for this project are as follows:

Measure	**Results**
Reduction in Discarded Resource	£64,000
Number of Opportunities Identified	13
Reduction in site emissions	88 tonnes waste foodstuffs, plus 7 tonnes paper and plastics packaging materials
Increase in process performance	0.5% improvement in material yield 10% saving in energy usage, equivalent to 320 MWh p.a.
Employees trained in waste reduction methods	Nil (Implementation programme not started)

7.0 DISSEMINATION OF THE REPORT

A requirement of funding from EB Milton Keynes Ltd was that the outcome of the work should be disseminated effectively.

We propose to provide a copy of this report to Environmental Data Services Ltd. (ENDS) who has reported on the waste minimisation movement since the earliest studies in the 1990's.

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 the South East Environmental Development Agency (SEEDA), to Business Link, and to Milton Keynes Council.

Nationally, the Resource Recovery Forum will distribute the report. Articles based on this report and those in Aylesbury Vale and Bedfordshire are being prepared by Professor Paul Phillips at the University of Northampton and David Fitzsimons of Oakdene Hollins.

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

8.0 REFERENCES

[1] Phillips PS. Waste Minimisation Clubs in the UK: Key Issues for Possible Future Developments.

[2] Environment Agency, (1997). Waste Minimisation and Waste Management. An Environmental Good Practice Guide For Industry. Solihull.

[3] Ohno T. (1985). Japan Management Association, Kanban: Just in Time at Toyota, Productivity Press.

[4] Lee P. (2002). Aylesbury Vale Waste Reduction in Industry Scheme, Final Report.

[5] Bicheno J. (2000). The Lean Toolbox, 2nd edition, PICSIE Books.

[6] Gilbert M and Gould R. (1998). Achieving Environmental Standards. 2nd edition. Financial Times Management.

[7] Nicholas J. (1998). Competitive Manufacturing Management. Irwin / McGraw - Hill

[8] DEFRA, (November 2001). Environmental Reporting. General Guidelines. Section 4: Environmental Performance Indicators.

Summary of Company Data

Company/Activity	Nos. of Staff	Tonnes p.a. Total Waste Solid	Tonnes p.a. Total Waste Liquid	No. of Opportunities Identified	Tonnes p.a Reduction in Site Emissions	£'000 p.a. Reduction in Discarded Resource
Detailed Review Carried Out:						
Balzers Ltd	60	140*	25	11	6 + 7 special	7
Custom Foams	45	170	nil	13	34	71
Goldschmidt UK Ltd	50	110	2300	7	(50% reduction in COD of effluent)	22
HMC Brauer Ltd	80	440*	30	9	43	26
McKey Food Service Ltd	130	120	nil	5	nil	7
Spillers Speciality Feeds Ltd	70	205	nil	13	95	64
Sub Totals	**435**	**1185**	**2355**	**58**	**185**	**197**
Awareness Meetings only:						
Alps Electric Ltd	400					
Basell Polyolefins UK Ltd	80					
Beardow and Adams (Adhesives) Ltd	55					
Buckingham Furniture Ltd	90					
FCC (Europe) Ltd	45					
SMC Pneumatics (UK) Ltd	430					
Terrapin Ltd	60					
Sub Totals	**1160**					
Grand Total	**1595**	**1185**	**2355**	**58**	**185**	**197**

* Assumes density of general office and factory waste is _ tonne per cu. mtr.

APPENDIX I

APPENDIX II

Project Staff
Experience and Qualifications

Peter Lee
BEng (Hons) PhD

Peter completed an engineering apprenticeship at Royal Ordnance and moved from fitting to inspection and quality systems during his ten years with the company. He then obtained a first class honours degree in manufacturing systems and a PhD on the influence fluids have on sliding metal surfaces, both at the University of Hertfordshire.

Areas of expertise include tribology; waste minimisation; process efficiency optimisation, particularly in the food and engineering industries; environmental management standards.

Tara Galloway
BEng (Hons)

Tara has a BEng in Mechnical Engineering and Management from Bradford University. She worked for four years for BTR Sealing Systems (UK) during which she trained as a process improvement consultant as part of the Rover Variation Reduction programme. As a BTR manufacturing engineer she concentrated on continuous process improvement, introducing new products and production methods and supporting manufacturing activities.

Areas of expertise include waste minimisation; continuous process improvement, particularly in the area of automotive supply chain.

Steve Slater
MA, MInstD

Steve holds a Masters Degree in Engineering and Industrial Administration from Cambridge University. Following an initial period in quality engineering in the aerospace industry with Plessey, he moved into manufacturing management in consumer durables with Acco UK. As a board level director, he was responsible for the strategic direction of the company's manufacturing within the UK and Ireland where he implemented major rationalisation and total quality programmes. More recently he has worked with a range of blue chip companies improving business performance through team development and training in management and leadership skills.

Areas of expertise range from strategic planning and implementation to the development of best practice processes in manufacturing and the minimisation of waste.