THE COMMERCIAL IMPACTS OF GREEN PRODUCT DEVELOPMENT

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The Design Innovation Group

The Design Innovation Group (DIG), which was founded in 1979, conducts research on the role of product design and technical innovation in the competitiveness of industry, both in the UK and overseas. The Group, which is part of the Centre for Technology Strategy at the Open University, comprises academics and researchers based in the Design Discipline, Faculty of Technology and at the School of Management, UMIST, as well as at other institutions. The DIG has several research projects and programmes, concerned with the effective management and practice of design and innovation.

These include:

The Design and Innovation Management Programme
• The commercial impacts of design
• Identifying markets that reward investment in design
• Buyer-supplier relationships in engineering design
• Strategic management of design consultants

The Design for the Environment Programme
• Ecolabelling and environmental policy
• Ecodesign: the impact of environmental concerns within British design practice

The Design Studies Programme
• Creativity in design and innovation
• Evolution of designs and innovations.

The research work of the DIG has been incorporated into several OU courses, including Design: Principles and Practice; Innovation: Design, Environment and Strategy; and Managing Design.

Further details and a list of DIG publications may be obtained from the Design Innovation Group Secretary at the address below.

Acknowledgements

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EXECUTIVE SUMMARY

Introduction

This report summarises information obtained in a study of sixteen British, American and Australian firms which had deliberately or incidentally introduced significant environmental improvements to the design of their products, either through the ‘greening’ of existing products or by developing new ‘greener’ products. The study is one of very few to examine green product development projects in small as well as in medium and large businesses. In this report ‘green’ products are those which have a reduced impact on the natural environment arising from their materials, production, use or disposal – as well as satisfying the more usual design factors such as performance, aesthetics, cost, safety, etc.

Method and Sample

The study was based on a series of interviews with senior management, marketing and technical design staff in the sixteen firms, carried out between 1991 and 1995, using a method similar to that developed for an earlier study on the ‘Commercial Impacts of Design’ (CID). As in the CID project, the objectives were to identify design inputs and commercial outcomes at the product/project level and to understand the business and other aims underlying product development. The project sought to include a mixture of sizes and types of company. The small firms were mainly selected from those that had won, or been commended in, the ‘Green Product’ category of the RSA Better Environment Awards for Industry. Larger companies were selected from those participating in the lighting and domestic appliance product groups of the EU Ecolabelling programme, plus firms which made ‘green’ products commended by environmental organisations. Half of the firms were small with less than 100 employees, including some very small start-up businesses, and half were medium or large with 100 or more employees, including UK or overseas divisions of some major multi-nationals.

Main Findings

The sample size was small and the following conclusions should therefore be regarded as indicative rather than firm.

‘Green’ product development

• Most firms in this study did not set out to produce a ‘greener’ product. Instead they aimed to develop a product that would perform better, create a new market, increase or maintain market share, or satisfy market demands or regulatory pressures. Often it was only subsequently that the firms recognised the environmental advantages of their new or improved product. Environmental factors were thus taken into account in pursuit of commercial aims.

• Most companies adopted an ad hoc ‘green design’ approach to the incorporation of environmental factors in product development, focusing on one or two environmental issues. The firms were most often concerned with materials choice and reducing the environmental impacts of production. This
was followed by concern for reducing the energy and pollution impacts of the product in use and with recycling materials at the end of product life.

• A few firms in this study had begun to shift towards a systematic ‘ecodesign’ approach to product development in an attempt to reduce/balance environmental impacts over the whole life cycle of the product from ‘cradle to grave’.

• This study confirms that it is not necessary to have a different product development process to incorporate environmental factors into product design. It is, however, important to adopt best practice in the management of product development, in particular the adoption of team-based, integrated approaches.

**Commercial outcomes**

• With one exception, the firms did not attempt to sell their ‘green’ products mainly on their ‘environmental friendliness’. To be commercially successful the products had to be competitive in terms of specification, performance and quality. For many products value for money and/or reduced operating costs were also important. Improvements in environmental performance thus only become a significant competitive factor once such levels of product performance, quality and value are attained.

• The financial data in this study needs to treated with caution, given that such data was mainly obtained from six of the small companies. Nevertheless some interesting tentative conclusions can be drawn.

  – The ‘green’ products developed by small firms achieved very high annual and total sales growth rates, with a mean sales growth rate of nearly 200% per year. However, these small firms tended to begin from a low or zero sales base. By comparison, where data were available for the medium and large enterprises, sales grew by an average of 28% to 73% per year.

  – Half of the medium and large firms reported that the ‘green’ product was commercially more successful than the product it replaced. The small enterprises were almost all founded on a single product, thus no comparison could be made.

  – The average gross profit margin of the ‘green’ products developed by the small enterprises, at 44%, is similar to the average for comparable ‘non-green’ products from the previous Commercial Impacts of Design survey. This suggests that there is limited scope for firms to ‘price up’ green products. This is consistent with the earlier conclusion that environmental factors only start to convey a competitive advantage to a product after performance, quality and value for money are equal or superior to other products.

  – Due to higher development costs, there is a somewhat longer payback period for ‘green’ products than for comparable ‘non-green’ projects. Repayment on total investment was on average a little more than 2 years for the green products developed by the small enterprises, compared to 15.5 months for similar projects in the CID non-green sample.

  – For the ‘green’ products made by small firms, exports averaged less than 15% of sales while the CID study showed average exports were 19% of sales. But for those firms, large or small, that were operating in certain environmentally-sensitive export markets, the environmental performance of the product was often crucial and enabled them to succeed in exporting a significant proportion of their output.
Indirect Benefits and Impacts

These ‘green’ product development projects had a number of important indirect effects:

- Two-thirds of firms increased their range of products through the application of the technology or design pioneered in the green product development project.

- All firms revealed positive changes in management attitudes towards environmental issues as a result of the green product development project.

- Several firms came to recognise the commercial value of the environmental advantages of their product, and this encouraged the use of green marketing approaches. Some green products generated valuable publicity.

Differences between Small and Larger Firms

Green product development fits into the general pattern of design and innovation in industry as a whole, for example:

- The small firms tended to be more ‘pro-active’, developing innovative ‘green’ products for niche markets with relatively small investments. Larger firms tended to be more ‘reactive’ and to adapt existing products or innovations to satisfy volume markets. This sometimes required major investments in R&D and manufacturing.

- Some of the green product development projects in the small firms were affected by prevalent small business problems of raising finance and developing markets. A quarter of the small businesses failed due to financial problems or difficulties in establishing a viable market for their ‘green’ product.

Environmental Policy and Company Strategy

- Only one of the ‘green’ products in the survey was developed directly as a part of a company environmental strategy. If there was a company environmental policy this was usually developed separately from the green product development project.

- At company level, a focus on materials choice and on energy and pollution from the production and use phases was apparent. In addition, there was a concern with waste management and recycling.

Conclusions

Several other studies have shown that action on environmental issues in industry has focused on reducing pollution from production processes and on waste management, driven by legislation. The development of ‘green’ products that have a reduced environmental impact arising from their materials, manufacture, use or disposal is still relatively rare, especially in the UK and among small companies.

This study has shown that the development of green products can be a very worthwhile activity. The majority of green product development projects were commercially profitable, with small firms creating new industrial/commercial niche markets with innovative ‘green’ products and larger firms developing their consumer or commercial markets with environmentally improved products.

However, the study also shows that to succeed in the market the products had to be competitive in terms of performance, quality and economic value. For well-designed products, good environmental
performance can provide an additional attraction to customers, especially in certain export markets. This provides a commercial incentive for companies to develop green products. But for more widespread development and market acceptance of green products, and for the application of more comprehensive ‘ecodesign’ approaches, some form of regulation is likely to be needed.
1 INTRODUCTION

This report summarises information obtained in a study of sixteen British, American and Australian firms which had deliberately or incidentally introduced significant environmental improvements to the design of their products, either through the ‘greening’ of existing products or by developing new ‘greener’ products. The study was based on a series of interviews with senior management, marketing and technical design staff in the firms, which were carried out between 1991 and 1995 by Stephen Potter, Mark Smith and Robin Roy of the Open University Design Innovation Group, with a contribution from Ken Green of Manchester School of Management, UMIST.

A number of articles and conference papers have been written on the results of this project (e.g. Potter 1992; Potter with Dewberry 1993; Burall 1994; Potter and Roy, 1994; Smith, Potter and Roy 1995; Potter 1996; Roy 1996), covering specific aspects such as the role of SMEs in green product development and the relationship between the consideration of environmental factors in products and processes. This report is intended to present and summarise the project as a whole and to draw general conclusions on how this work relates to the wider literature on the greening of product design.

1.1 Green Design and earlier DIG Studies

The Design Innovation Group (DIG) has for many years undertaken research work in UK and overseas companies to provide systematic information on the advantages and the risks for business of investing in design and innovation. Initial studies aimed at investigating whether companies that produced well-designed products were commercially more successful than randomly-selected companies competing in the same industries. This involved interviews with managers, designers and technical staff across four industry sectors: plastic products, office furniture, domestic heating equipment and electronic office equipment – and involved nine world-leading producers from Denmark, Sweden, Germany, Japan and Canada as well as 91 British companies. In addition comparative studies were carried out in other industries, including lighting, consumer electronics, motor vehicle manufacture, bicycles and railways (see e.g. Walsh et al., 1992).

This project was succeeded by the ‘Commercial Impacts of Design’ (CID) study, carried out jointly between the OU and UMIST. This involved a representative survey of 221 small and medium-sized UK manufacturers which had received government support to employ a professional designer to help undertake a variety of product, engineering, industrial and graphic design projects (see e.g. Potter et al, 1991, Roy and Potter, 1993).

One crucial aspect of the CID study was that it focused on the commercial impacts of design investment in particular product or project. This was measured in terms of the inputs of professional design expertise and the total costs involved to put the resultant products or designs into production. The outcomes were documented, in terms of product commercial performance, including improved sales, reduced costs, better profit margins, new markets entered, etc. This approach meant that the quality of the products, or of design work itself, did not need to be measured - which is very difficult to do objectively. Both quantitative and qualitative data were gathered, covering the financial outcomes of the projects and the managerial, marketing and other aspects of project implementation. Explanatory factors usually involved the management of the design process and how committed the firm’s senior staff were to the investment in design. Even success and failure were not always clear-
cut; some firms viewed a financially loss-making project as a ‘success’ due, for example, to its indirect impacts such as learning how to select or brief designers, which benefited the firm in general.

1.2 The Green Design Study

The Green Design study is a continuation of this programme of work by the Design Innovation Group. It stems from the CID project in that the method used again focuses upon the product/project level, but seeks to examine an increasingly important factor in the design of products - namely, their environmental impacts. As in the CID project, the main aims are to document design inputs, commercial outcomes and to seek an understanding of what motivated companies to undertake design investment - in this case to ‘green’ their products.

In the same way that the CID project did not depend on measuring the quality of design inputs or outputs, the method adopted for the Green Design study did not need to make a scientific judgement as to how ‘green’ a product was. What was measured were the inputs of staff and other resources required to take environmental factors into account, together with detailed information on why firms decided that environmental factors were important; which factors they chose to focus upon in their product development work (and which they left out); how they went about developing a greener product; what markets they addressed, and how commercially successful the products were.

Although the same general research approach was used as in the earlier CID study, the Green Design project involved a more intensive research methodology in recognition that this was necessary to understand why firms had considered environmental factors in design and how that had affected their strategy and operations. The Green Design study therefore involved a relatively small interview survey (of 16 UK and overseas companies) to investigate:

- What made the company take environmental factors into account?
- The business, environmental, regulatory or other pressures to which the firms responded;
- Which environmental factors were considered important, and why?
- Whether the ‘greener’ product was commercially successful and whether it had any impact on Britain’s balance of trade;
- Whether any design management changes were needed to address environmental factors;
- Whether this project led to changes in the company’s strategy and environmental practices.

The questionnaire developed for the Green Design project was of a structured nature, but allowed for additional responses. It was based on that used in the earlier CID project and gathered information in the areas listed in Box A.
Box A: Topics covered in the Green Design questionnaire

- **Company background**
  History; ownership; number and types of employees; turnover

<table>
<thead>
<tr>
<th>Box A: Topics covered in the Green Design questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• The ‘green’ product development project</strong></td>
</tr>
<tr>
<td>- Business aims of project</td>
</tr>
<tr>
<td>- Criteria used to judge ‘environmental friendliness’ of product</td>
</tr>
<tr>
<td>- Organisation of project</td>
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<tr>
<td><strong>• Markets in which green product competes</strong></td>
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<tr>
<td>- Factors in the ‘competitive edge’</td>
</tr>
<tr>
<td>- Main competitors in the market</td>
</tr>
<tr>
<td><strong>• Cost of developing the green product</strong></td>
</tr>
<tr>
<td>- Research design and development; tooling; new production facilities; marketing; etc.</td>
</tr>
<tr>
<td><strong>• Indirect impacts of the project</strong></td>
</tr>
<tr>
<td>- Other products; materials and manufacturing</td>
</tr>
<tr>
<td>- Attitudes; marketing and product strategy</td>
</tr>
<tr>
<td><strong>• Commercial performance</strong></td>
</tr>
<tr>
<td>- of the green product</td>
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<tr>
<td>- of any comparison product</td>
</tr>
<tr>
<td><strong>• Environmental practices of the company</strong></td>
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<tr>
<td>- Environmental policy of company</td>
</tr>
<tr>
<td>- Responsibility for environmental policy</td>
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<tr>
<td>- Environmental impacts considered</td>
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</tbody>
</table>

Box B: Objectives for a ‘Greener’ Product

- Capable of lessening global environmental problems
  e.g. eliminate CFCs (chlorofluorocarbons); reduce CO₂ (carbon dioxide) emissions
- Energy efficient
- Easily repairable
- Designed to last, or to be reused, reconditioned or recycled
- Generates minimum pollution and waste
- Can be disposed of safely
- Minimal use of materials, including packaging
- Manufactured from renewable or abundant resources, or recycled materials
- Manufactured, if possible, locally and from locally obtainable materials to reduce transport requirements
- Environmental information on product available to purchaser
- Not harmful to human health
- Satisfies a genuine human need

From Roy et al. (1996), freely adapted from a list in Blair (1992).
1.3 Selection Criteria for Green Projects

The intention was to survey companies competing in product areas that were facing a mixture of environmental pressures. It was not intended to identify a sample of ‘best practice’ green product development projects, but to examine a variety of company responses to environmental issues ranging from incremental ‘green design’ through to more radical ‘ecodesign’ approaches in order to understand what led to these approaches and how successful they were.

1.3.1 What is Green Design?

This report concerns the development of ‘greener’ products, so it might be useful to define what is meant by green design. The Office of Technology Assessment in an influential report, *Green Products By Design*, defines green design as: ‘a design process in which environmental attributes are treated as *design objectives*, rather than as *constraints*... green design incorporates environmental objectives with minimum loss to product performance, useful life or functionality.’ (OTA, 1992). Thus, Green Design is simply the *development of products taking account of their impact on the natural environment – as well as the more usual factors such as performance, aesthetics, cost, safety, etc.*

One set of objectives for a greener product include those listed in Box B.

This report concerns products which include both what have been described as *incremental ‘green’ designs* and *systematic ‘ecodesigns’* (Ryan et al., 1992). Green designs are developed to tackle one or two specific, often high profile, environmental problems (e.g. eliminating CFCs, reducing landfill waste) without systematic consideration of their total environmental impact. Green designs comprise the majority of projects in this survey. Ecodesigns, on the other hand, involve designing a product to *consider and balance all the areas of adverse environmental impact throughout its life cycle* from raw materials acquisition through manufacture and use to final disposal (i.e. from ‘cradle to grave’). There are few examples of attempts at an ecodesign approach in our sample.

However, none of the projects involved any attempt to move towards what has been described as *sustainable product development*, in which the function of the product is considered and alternative environmentally sustainable means for providing it are examined – including replacing the product with a service, or even questioning whether the product is really needed (Dewberry and Goggin, 1996; Manzini, 1996).

1.3.2 Business Responses to Environmental Problems

Until quite recently the usual technical response of business to environmental problems involved measures to reduce pollution and wastes *after* they have been produced; for example, by installing factory waste water treatment plant or equipping cars with catalytic converters. However, from the late 1980s onwards some companies began to shift their attention from these so-called ‘end of pipe’ or ‘clean-up’ approaches up the production chain in an attempt to reduce or prevent environmental impacts at source. Initially the focus was mainly on developing ‘cleaner’ *manufacturing processes*, which generate less pollution and waste or make more efficient use of energy and materials. Then, with the growing understanding that many environmental impacts arise from the choice of materials in and the use and disposal, of a product attention began to turn to the design of *greener products.*
There are several pressures that might stimulate firms to incorporate environmental criteria into the
design of their products, including:

- Environmental regulation (existing and anticipated);
- Commercial pressures and market opportunities (existing and anticipated);
- Cost savings from use of different materials and/or manufacturing processes;
- Innovation from the availability of new or improved technologies, components and materials;
- Internal pressures from corporate environmental policy, company ethos or staff concern;
- External pressures from environmental campaigns, ethical investors or insurance companies.

Most studies of these pressures (e.g. Vaughan and Mickle, 1993; Green, McMeekin, and Irwin, 1994)
have shown that the first two factors are usually the most important in stimulating firms to develop
greener products. Regulation includes both existing and anticipated UK/EU legislation and voluntary
agreements. Commercial/market factors include pressures from retailers or purchasers, prospects of
expanding market share, and the actual or expected introduction of green products by rival firms.
At the same time other recent studies e.g. by the National Consumer Council (Gosling, 1996) indicate
that the green consumerism of the late 1980s has declined in importance for many products.

It was also realised that, because of the differing pressures acting on business, designing for the
environment is much better developed in some sectors than in others. For example, the market for
vehicles which can use unleaded petrol is well established, following environmental legislation and
price incentives for buying unleaded petrol. On the other hand, although consumer awareness of
‘green’ detergents is high, the market remains very small because of consumer resistance to the
higher price and/or poorer performance of the product, and a lack of legislation to promote and
improve green detergents (Wong, Turner and Stoneman, 1995). In other sectors, environmental issues
are still only on the fringes of consumer and commercial awareness.

Although not seeking to measure the ‘green-ness’ of a product, or to study the best examples
available, it was still desirable to identify firms that had tried to undertake a serious greening of
design. Firms that had merely repackaged existing products or changed their marketing claims were
not of interest. Therefore an initial group of products was selected from those that had won, or been
commended in, the ‘Green Product’ category of the RSA (Royal Society of Arts, Manufactures and
Commerce) Better Environment Awards for Industry (now part of Queen’s Award for Environmental
Achievement).

Another key aspect was company size. Attitudes towards environmental issues and opportunities to
develop greener products could be expected to vary between small and large firms. Thus the project
sought to cover:

- Small and Medium-sized Enterprises;
- Large, nationally-focused companies;
- Large multi-national companies;
- Large international groups of companies.

The sample from the Better Environment Awards for Industry mainly produced SMEs and so
different selection methods had to be adopted to identify larger companies. This included firms
participating in the lighting and domestic appliance product groups of the EU Ecolabelling
programme, and firms which made products commended by environmental organisations, including
some overseas-owned firms.
Thus, to summarise, three major criteria were used in the selection of the companies and projects, namely that:

- a ‘green’ product could be identified which had a reduced impact on the natural environment arising from its materials, production, use or disposal – as well as satisfying the more usual design factors such as performance, aesthetics, cost, etc.
- the projects examined covered a mixture of pressures for environmental improvement;
- a mixture of sizes and types of company, including some overseas-owned firms, were present.
2 THE FIRMS AND ‘GREEN’ PRODUCTS.

The 16 products and companies for which information was obtained are shown in Table 1. This also details the main market sectors in which they operate and whether this is commercial or domestic.

<table>
<thead>
<tr>
<th>Company†</th>
<th>Green Product</th>
<th>Product Area</th>
<th>Main Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitech</td>
<td>Rechargeable battery/lamps</td>
<td>Lighting</td>
<td>Commercial</td>
</tr>
<tr>
<td>Starlowe Lighting</td>
<td>Low energy floodlight</td>
<td>Lighting</td>
<td>Commercial</td>
</tr>
<tr>
<td>GE Lighting</td>
<td>Compact fluorescent lamps (CFLs)/ fittings</td>
<td>Lighting</td>
<td>Commercial/Domestic</td>
</tr>
<tr>
<td>Osram</td>
<td>Compact fluorescent lamps</td>
<td>Lighting</td>
<td>Commercial/Domestic</td>
</tr>
<tr>
<td>GTE/Silvania</td>
<td>Compact fluorescent lamps</td>
<td>Lighting</td>
<td>Commercial/Domestic</td>
</tr>
<tr>
<td>Frigidaire</td>
<td>Low CFC and energy saving refrigerators</td>
<td>Appliances</td>
<td>Domestic</td>
</tr>
<tr>
<td>Hoover Major Appliances</td>
<td>New Wave energy, water and detergent saving washing machines</td>
<td>Appliances</td>
<td>Domestic</td>
</tr>
<tr>
<td>Stelrad Ideal</td>
<td>Condensing gas central heating boiler</td>
<td>Appliances</td>
<td>Domestic</td>
</tr>
<tr>
<td>Atmosol</td>
<td>Compressed gas propelled aerosol</td>
<td>Packaging</td>
<td>Domestic</td>
</tr>
<tr>
<td>SC Johnson Wax</td>
<td>Recycled packaging for Shake n’Vac, etc.</td>
<td>Cleaning</td>
<td>Domestic</td>
</tr>
<tr>
<td>Environmental Paints</td>
<td>Organic solvent-free paints (ECOS)</td>
<td>Paint</td>
<td>Domestic/Domestic/commercial</td>
</tr>
<tr>
<td>Grace Dearborn</td>
<td>Cooling water treatment system</td>
<td>Pollution abatement</td>
<td>Commercial</td>
</tr>
<tr>
<td>Trannon Furniture</td>
<td>Furniture from forest thinnings/coppicing</td>
<td>Furniture</td>
<td>Commercial</td>
</tr>
<tr>
<td>Gestetner Australasia</td>
<td>‘Boomerang’ remanufactured laser toner cartridge</td>
<td>Office supplies</td>
<td>Commercial</td>
</tr>
<tr>
<td>Pax Guns</td>
<td>‘Prometheus’ lead-free air gun pellets</td>
<td>Miscellaneous</td>
<td>Domestic/Domestic/Commercial</td>
</tr>
<tr>
<td>Fibrescreed</td>
<td>Road/runway repair material from recycled tyres</td>
<td>Miscellaneous</td>
<td>Commercial</td>
</tr>
</tbody>
</table>

† Some of the companies have changed name and/or ownership since the study was carried out.
2.1 Review of the Firms and Products in the Study

Before detailing the results of the study, this section introduces the firms and the ‘green’ products in more detail – as they were at the time of the interviews in the early 1990s. This leads into an exploration of the motives and pressures which lead to the development of these products.

As desired in the objectives of the study, the projects covered a wide range of markets and the companies represented a range of and sizes and organisational forms. The firms range in size from a four-person business operating from a shop basement, through to very large international companies, which may have only one division based in the UK. The small firms were typically created to manufacture a particular new design or invention, while the large firms may be extending or complementing their product range, or exploiting a particular technology to gain a commercial advantage. Some of the small enterprises, such as Environmental Paints and Pax Guns, may be in direct competition with much larger, well-established firms. Others, including Nitech, have in effect created an entirely new market - in this case for their high-performance rechargeable batteries and portable lighting. At the other end of the spectrum are large, international firms, including the compact fluorescent lamp (CFL) manufacturers, who already produce other types of lighting, including traditional incandescent lamps. CFLs represent a diversification into new, energy-efficient lighting, originally designed for commercial purposes, and recently adapted for domestic applications. An outline of the firms, brief product descriptions and illustrations are given below.

Nitech – rechargeable batteries and portable lighting

This firm was established in 1981 by the managing director interviewed for this study. He sought to exploit a market boosted by European environmental legislation that demanded higher safety standards in hazardous areas. The firm’s first product was the ‘X-Cell’ rechargeable battery with integral charger, followed from 1990 by a range of rechargeable torches and portable lamps. Each rechargeable battery replaces 2.5 tons of disposable batteries, has very low levels of cadmium and nickel, and is technically superior to conventional rechargeable and disposable batteries. The batteries, torches and lamps are sold via mail order and specialist retailers to commercial, professional and ‘enthusiast’ users, including British Airways, British Telecom and emergency services. The X-Cell battery won an RSA Green Product Award in 1990.
**Starlowe Lighting – ‘Omni-Lite’ low energy floodlight**

Starlowe was started in 1988 by an electrical engineer who had been investigating the potential for low energy lighting since 1984. The company was set up to manufacture and market a range of fittings for low energy bulbs, including the ‘Omni-Lite’ exterior wall and sign floodlight unit. The main markets are for commercial premises, sign companies, security contractors and electrical wholesalers. The Omni-Lite was shortlisted for an RSA Green Product Award in 1990. Manufacture of the Omni-Lite was subsequently taken over by Securilight Emergency Lighting Systems.

**GE Lighting, Osram and GTE – compact fluorescent lamps**

GE Lighting is part of a group controlled by a US-based parent company. The company manufactures the ‘2D’ range of compact fluorescent lamps (CFLs). After General Electric’s take-over of Thorn in 1989, the company adapted the Thorn 2D CFL technology, originally aimed at commercial users, for the domestic market, and is now sells CFLs under the Mazda name. Osram are part of the Siemens group, based in Germany. The UK division originally manufactured lamps, but now import and distribute the Osram Dulux EL range of CFLs. GTE is the UK subsidiary of Sylvania Lighting International, based in Geneva, Switzerland. The company manufactures a range of CFLs at its Shipley plant in Yorkshire, some of which are exported.

All three firms have been involved in the discussions regarding the EU Eco-labelling criteria for lamps as representatives of their industry trade association.
Compact fluorescent lamps (CFLs) come in a range of sizes and shapes and are five to six times as energy-efficient and last eight to ten times as long as conventional incandescent lamps.

Shown are 2D lamp with separate ballast and Osram Dulux CFL with integral ballast.

**Hoover – washing machines**

Hoover European Appliance Group are a major British-based manufacturer of domestic appliances, bought in 1995 by the Italian appliance manufacturer, Candy, from its former US owner Maytag. In 1993, following a four year research, design and development programme, the Hoover Major Appliance Division launched the 'New Wave' range of washing machines (for details see Roy, 1996). This range was designed with particular consideration given to reducing energy, water and detergent consumption of the machine in use, but reductions in environmental impacts of manufacturing, transport and disposal were also achieved through the use of different materials and new production methods and equipment. The New Wave range is among the most energy-efficient washing machines available in Europe, and in 1993 was awarded the first, and until mid 1996 the only, EU Eco-label. Before that the firm had been involved in developing the Eco-labelling criteria for washing machines, dishwashers and dryers. In 1996 Hoover won a Queen’s Award for Environmental Achievement for the design and manufacture of the New Wave range. Also in 1996 the improved New Wave Plus 5 range, with increased capacity and a system for automatically adjusting water levels according to the wash load, was introduced.
Top of the range Hoover New Wave Plus 1500 spin speed washing machine exceeds EU Eco-label criteria for wash performance, energy and water consumption and detergent loss
**Frigidaire – domestic refrigerators**

Frigidaire was founded in 1916 in Detroit, and was taken over by Electrolux in 1987. The company is the third largest manufacturer of white goods in the USA and recommended for inclusion in the study because of a new strategic interest in environmental issues following the change in ownership. Frigidaire have redesigned their range of refrigerators, with reduced levels of CFCs in the foam insulation material, and improved energy efficiency gained through improved compressor design, better gaskets and seals and the use of smaller and multiple doors. By 1993 Frigidaire were also beginning to design their products to facilitate disassembly and recycling by the US materials recycling industry. (For further details see Potter, 1996).

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**Stelrad Ideal – domestic gas boilers**

Stelrad Ideal is the trading name for Caradon Heating, a market leader in supplying domestic boilers in the UK. The ‘Ideal Turbo’ condensing gas central heating boilers exceed all current and proposed EU legislation on emissions and energy efficiency. Conventional gas boilers allow the hot combustion gases to escape into the atmosphere. Condensing boilers use the heat in the flue gases to supplement the heat produced by the boiler’s gas burner, boosting the efficiency from 80% to over 90% when in the condensing mode. The Ideal Turbo condensing boiler was an entry for the 1989 RSA Green Product Award.
Atmosol – aerosol system

Atmosol was established in its own right as an offshoot of a design company founded on a range of packaging products. Atmosol is an aerosol system which enables alternative propellants, such as compressed nitrogen or air or dissolvable gases such as carbon dioxide (CO₂), to replace conventional propellants. It was developed in response to external pressure arising from a need to develop an efficient, alternative aerosol system in the wake of the CFC ban, and to reduce the hazards associated with liquefied gas aerosol propellants such as butane. The system comprises a regulator and ball valve designed as an economic replacement for existing spray delivery mechanisms, and manufactured under a licence operated by the British Technology Group. The Atmosol aerosol was shortlisted for a RSA Green Product Award in 1989 and for the Prince of Wales Award for Innovation in 1990 and 1992.
SC Johnson Wax – household cleaning products

SC Johnson Wax is a US-owned company, established in 1886, and is one of the world’s leading manufacturers of homecare products. The company is well-known for its long tradition of being a philanthropic business and has adapted this ethic to embrace environmental issues. In 1990, the company set a series of environmental targets, including one that aimed to phase in the use of recycled material to 50% of total packaging by the end of 1995. Their first initiative was to develop a method for converting the Shake n’ Vac carpet and room freshener container to 100% recycled pre-consumer waste plastic.

Recycled plastic Shake n’ Vac carpet and room freshener container

Moulding machine. The finished bottles emerge on a conveyor to the right, the chute on the left returns reject bottles to be reground

Environmental Paints – paint and inks

Steyport produce printing inks, adhesives and lacquers mainly for wallpaper manufacturers, and as part of a diversification programme launched the ‘ECOS’ range of low solvent paints. ‘ECOS’ is an acronym for Environment Conscious Odourless Solvent-free, produced by a Steyport subsidiary, Environmental Paints. Conventional paints contain glycols, formaldehyde and other volatile organic compounds (VOCs) which can result in tangible health risks during and after application. Because of the health and environmental concerns, Environmental Paints have eliminated these slow release solvents and the consequent atmospheric emissions. The inventors of Ecos won a Daily Telegraph/NatWest Bank Clean Technology Award in 1990. Unfortunately, due to the difficulty of establishing a viable market, the company ceased production of ECOS paints in 1995, but a similar product was produced by another company.
Trannon – furniture

An industrial designer, formerly a plastics consultant to ICI, set up the firm as a partnership with two other designers in 1991 to produce high quality furniture made from locally-grown forestry thinnings and coppiced wood. The company are able to convert an under-used material into a high-value product. Trannon Furniture had to develop new steam bending techniques for bending and shaping thinnings, and identify which woods could be shaped while still green. The company distribute mainly to architects and other commercial buyers through direct catalogue sales, contract orders and furniture shops. Trannon furniture has been displayed at many exhibitions of good design. The Trannon stacking chair won the Green Seating Award at the SIT ‘94 exhibition.

Trannon chair made from forestry thinnings and coppiced wood

Pax Guns – air gun pellets

The proprietor of this firm was formerly a heating and ventilation engineer whose hobby was guns, sporting and target shooting, which became his job when he started a gun shop in 1977. The ‘Prometheus’ plastic and zinc airgun pellet emerged from a desire to make a better, and at the same time, a lead-free pellet (approximately 1500m lead pellets are sold annually in the UK alone). The pellet is designed for hunting and field target sport. Some 80% of Prometheus pellets are exported, and Indonesia is a large market, where farmers use guns for pest control in paddy fields. The Prometheus zinc/plastic pellet prevents lead from entering the food chain. Waste plastic from the production of pellets is recycled to produce packaging. The Prometheus pellet was commended in the RSA Green Product Awards for 1990.
**Gestetner, Australasia – office supplies**

Gestetner was originally founded over 110 years ago to make stencil duplicators. The main business is the distribution and service of office supplies and products (mainly photocopiers and laser printers). In 1990 Gestetner Australasia established a small division to produce and supply the *Boomerang*, a laser printer toner cartridge, remanufactured from spent toner cartridges to a quality equal or better than that of new cartridges. Supply of the Boomerang cartridge was subsequently taken up by a specialised remanufacturing company, Boomerang Imaging Supplies, headed by a former Gestetner employee who had been responsible for the project within Gestetner. An important consideration was the imposition of landfill costs for non-biodegradable waste in Sydney – remanufacturing used toner cartridges avoided this penalty. The Boomerang was included in a specialist database as a good example of an Australian-made ‘green’ product.

![Boomerang laser printer toner cartridge remanufactured from used cartridges to a quality equal or better than that of new cartridges](image)

**Grace Dearborn – waste water treatment**

This firm is part of the European Division of a company founded by W.R. Grace in the US in 1933. They produce *Topaz*, a biodegradable, low toxicity waste cooling water chemical treatment system with applications in controlling scale, corrosion, slime and sedimentation fouling. Grace Dearborn are different from the other firms in this sample, in that their product offers an ‘end of pipe’ solution, specifically designed to improve environmental quality, rather than a ‘greener’ product. As such, the firm was commended in the 1987 RSA Pollution Abatement Technology category of the Better Environment Awards for Industry.
Fibrescreed – road repair material

The firm’s managing director launched ‘Fibredock’ in 1981, which was originally a road surface dressing using glass fibre. This product was replaced with ‘Fibrescreed’, a novel highway and runway repair material based on shredded discarded vehicle tyres. The ‘Fibrescreed Membrane’ incorporates metal and rubber from worn tyres mixed with bitumen and grit. It replaces aggregates, aids flexibility and gives the product extra tensile strength. The firm won an RSA Green Product Award for Fibrescreed in 1990.

Fibrescreed made from recycled tyres mixed with bitumen and grit used to repair cracks and potholes in a Sussex road
2.2 **Size and Status of the Firms.**

As noted in the Introduction, the size and status of the companies in which the products were developed was one aspect to be investigated. Overall the 16 studies cover a range of sizes of firms, competing in a combination of commercial and domestic markets, both in the UK and overseas (see Table 2).

<table>
<thead>
<tr>
<th>Size (number of employees)</th>
<th>UK-owned independent/ Part of UK-owned group</th>
<th>Part of overseas-owned group</th>
<th>Total</th>
<th>Size of Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>5 (Nitech; Trannon; Atmosol; Pax; Environmental Paints)</td>
<td>0</td>
<td>5</td>
<td>Small (8)</td>
</tr>
<tr>
<td>20-99</td>
<td>3 (Starlowe; Fibrescreed; Gestetner/ Boomerang Divn.)</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>100-499</td>
<td>0</td>
<td>3 (SC Johnson, UK; Grace Dearborn; GTE/Silvania, UK)</td>
<td>3</td>
<td>Medium and Large (8)</td>
</tr>
<tr>
<td>1000+</td>
<td>1 (Stelrad Ideal)</td>
<td>4 (Frigidaire, Hoover Major Appliance Divn.; GE Lighting Europe; Osram)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>7</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

NB: The table shows the size and status of the companies at the time of the interviews, in most cases between 1991 and 1993. This information may have changed subsequently.

A distinction is frequently made between small and medium-sized enterprises (with below 500 employees) and larger firms. In this study, the break between small (under 100 staff) and medium and large enterprises appears to be more significant. With half of the firms in each category, this also provided a reasonable sample in each for the qualitative investigations in this project.
All the UK-owned firms, with the exception of Stelrad Ideal, the domestic boiler manufacturer, employ fewer than 100 people and most employ fewer than 20. All the medium and large firms, except Stelrad, are part of overseas-owned groups, each with over 100 staff.
2.3 Long-term Commercial Pressures

Before exploring the environmental aspects and pressures addressed by the projects, it is instructive to examine the general long-term issues which, at the time of the interviews, the firms in this survey believed would affect the company as a whole in the future.

Two dominant themes emerge from the responses:

- **Regulation**, including the introduction of standards (e.g. BS 5750, the Quality Assurance standard), product liability, waste disposal and other environmental legislation.

- **Commercial pressures**, including market opportunities and the potential threat of market domination by larger, rival firms.

One interesting feature of the firms in this survey was that many tended to have a pro-active approach to legislation, including environmental directives which may serve to expose commercial opportunities. However, concerns were not exclusively limited to European environmental regulations, but included wider aspects such as health and safety issues. For example, Pax Guns expressed the opinion that a possible European ban on lead air gun pellets could potentially open up an export market for their lead-free pellets. Similarly, Nitech considered that the introduction of European regulations covering lighting conditions in hazardous working areas would increase sales of their portable lighting. Stelrad and Frigidaire both mentioned the commercial importance of not just complying with current legislation, but also anticipating future standards; indeed Frigidaire had deliberately rejuvenated its entire product range for precisely this reason. Stelrad were concerned about meeting minimum industry standards for appliance safety, boiler emissions and potential minimum energy efficiency standards. The lighting manufacturer Osram were anticipating potential product liability issues, including disposal and recycling costs, because of the mercury content of CFLs. More positively, they did identify the market advantages conferred by the recent introduction of ergonomic lighting standards for the workplace which operated in favour of CFLs. The management of Starlowe, which made CFL fittings, also observed that vital export markets were dependent on the firm registering for BS5750 (Quality Assurance). The effects of BS7750 (the Environmental Management Systems standard) and other standards and product labelling schemes will be discussed in greater detail in Section 6.4.

Several firms expressed concern that they faced increased pressure from rival companies, and a consequent threat to their market share.

It is therefore within a long-term, changing business context – in which a range of regulatory and environmental issues with important commercial implications were emerging – that the companies had sought to develop ‘greener’ products.
3 ENVIRONMENTAL IMPACTS ADDRESSED

This section explores the impacts addressed through the ‘green’ product development projects, and then examines the general environmental issues addressed by the companies in this survey.

3.1 Product Life Cycle Analysis

It is useful to use a Life Cycle Analysis (LCA) approach to categorise both the environmental issues addressed in the projects and by the firms in general. LCA is a methodology which enables the identification of the environmental impacts arising from all stages of the life of a product, from raw material extraction, through production and use to final disposal, reuse or recycling. The environmental impacts addressed can be presented by tracing the product through a simplified life cycle as summarised in Table 3.

Table 3 Environmental Impacts Addressed in the Green Product Development Projects

<table>
<thead>
<tr>
<th>Life Cycle Stage</th>
<th>Environmental Impact</th>
<th>Number of Firms</th>
<th>Percent total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-production/Production</td>
<td>Materials used in product</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Energy used in making product</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Pollution/waste from making product</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Use</td>
<td>Energy consumed by product use</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Environmental impacts of product in use</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Disposal</td>
<td>Potential for recycling</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Pollution/waste in disposal</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Design for reuse</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>63 †</strong></td>
<td>**101 ***</td>
</tr>
</tbody>
</table>

Total sample n = 16 † Most firms mentioned several criteria * Total exceeds 100% due to rounding errors.

Almost half (43%) of the responses concerned the environmental impacts of production. A significant proportion of responses (21%) indicated that materials selection was an important aspect of production. Similarly, for legal compliance reasons, pollution and waste arising from production was a significant factor in 9 firms, and most of these were small businesses. Pax Guns, for example, ingeniously incorporated waste plastic from the manufacture of the pellets into the boxes in which they were sold. Environmental Paints and Hoover both reduced VOC emissions. In the first case this was through the use of an alternative formulation for their paint. In the latter reduced VOC emissions were achieved by Hoover using pre-coated rather than spray-painted steel for their washing machine casings.
firms, including Starlowe and Trannon. Trannon had moved to a new energy-efficient factory, and in addition to energy conservation measures, heated their premises by burning waste thinnings from their production process. It is possible that many firms were unaware of the scope for reducing energy costs.

A quarter (26%) of the firms’ responses were concerned with the energy consumption and other environmental impacts of the product during use. Not surprisingly, consideration of the energy consumed by the product in use was dominated by the lighting, appliance and heating manufacturers since energy consumption produces the main environmental impact of such products. Reduced operating costs via energy efficiency was one of the most strongly promoted attributes of these products. Indeed, the high initial costs of CFLs, compared to conventional tungsten filament lamps, have been justified on the basis that the life-time costs of CFLs are considerably lower. For an equivalent light output, CFLs consume much less energy and materials, as well as requiring less frequent replacement.

Only two firms had considered designing their product for reuse. Nitech’s batteries are rechargeable, thus considerably extending the product life, and reuse was the prime intention of Gestetner’s ‘Boomerang’ cartridge, which merely required some minor modifications to the previous design to allow remanufacturing. Design for recycling was also becoming more widespread in the white goods industries in this sample; half the large firms were aware of the need for conserving raw materials. Frigidaire and Hoover redesigned their goods for practical disassembly, material identification and recycling in a way that could be achieved by the recycling materials industry. Hoover, for example, substantially reduced the number of parts and variety of plastics in its New Wave washing machine range, and where possible substituted snap fits for screws in assembly, with benefits both for ease of manufacture and of disassembly/recycling.

There was a general recognition of the importance of avoiding toxic and other waste arising from product disposal, notably the CFL manufacturers who appreciated the need to control mercury residues, and prevent this highly toxic metal entering the waste stream. Gestetner’s decision to remanufacture toner cartridges was partially influenced by the local authority in Sydney, who intended to restrict inert waste disposal in landfill sites.

Table 4 develops the life cycle stage analysis in terms of the main areas of environmental impact, illustrated with some examples drawn from the survey.
<table>
<thead>
<tr>
<th>Environmental focus</th>
<th></th>
<th>Main Life Cycle Stage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRODUCTION</strong></td>
<td><strong>USE</strong></td>
<td><strong>DISPOSAL</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ENERGY</strong></td>
<td>Energy efficient production processes. Reduced distribution/transport. e.g. Trannon furniture made from locally sourced materials to reduce transport to the factory.</td>
<td>Reduce energy consumption of products in use. Use renewable energy sources. e.g. energy-efficient compact fluorescent lamps, energy-efficient washing machine, fuel-efficient gas boiler.</td>
<td>Non-energy intensive disassembly. Energy from waste. e.g. Trannon waste wood from furniture manufacture used as fuel.</td>
</tr>
<tr>
<td><strong>MATERIALS/RESOURCES</strong></td>
<td>Minimise use of raw materials. Use of recycled or waste materials. Use of renewable resources. e.g. Pax Guns and SC Johnson Wax make packaging from recycled plastics; Nitech rechargeable batteries; Fibrescreed road repair material from used car tyres.</td>
<td>Design for durability. Reduce the need for repair and maintenance. Reduce resource consumption in use. ‘Classic’ designs. e.g. Long life compact fluorescent lamps; water and detergent saving washing machines.</td>
<td>Design for disassembly. Cascading material cycles. e.g. Frigidaire and Hoover design for disassembly and recycling; Gestetner remanufacture laser printer toner cartridges.</td>
</tr>
<tr>
<td><strong>POLLUTION/TOXIC WASTE</strong></td>
<td>Reducing emissions from manufacture. Eliminating toxic or hazardous materials. e.g. Fibrescreed aim to reduce bitumen plant emissions; Hoover use pre-coated steel to reduce VOC emissions.</td>
<td>Eliminate hazardous emissions and toxics from use of product. e.g. Environmental paints produce low VOC emission paint; Atmosol aerosol eliminates hazardous hydrocarbon propellants; Pax Guns lead-free pellet.</td>
<td>Appropriate disposal regarding grade of waste, safe landfill disposal as last option! e.g. Frigidaire reduce use of CFCs in refrigerators.</td>
</tr>
</tbody>
</table>

After Dewberry and Goggin (1995); Roy et al. (1996)

Tables 3 and 4 present just two methods of analysing the environmental impacts addressed by the products in this survey, and it is useful to compare the environmental factors taken into account at the product design level with the responses to the questions that were asked about company-level environmental concerns. A similar product life cycle approach to that employed to construct Table 3
can be applied to the assessment of the environmental impacts of the broader company operations. The results from the survey are presented in Figure 1.

Figure 1  Company-level Environmental Concerns

![Bar chart showing company-level environmental concerns.](image)

Total sample n = 16 and total responses = 69.

NB. Several companies were concerned with more than one area of environmental impact. The ‘General Operations’ category above includes ‘Finance’ and ‘Other’.

Table 3 showed that at the product level over one third of firms’ responses were concerned with reducing the environmental impacts of production (other than energy use in manufacture), including the appropriate choice of materials and components and control of pollution arising from manufacture. The use of toxic materials were reduced or avoided where possible. Inevitably, all the manufacturers of energy-consuming products expressed interest in promoting the energy efficiency of their products. There was equal concern for other environmental impacts generated during the product’s useful life. Waste disposal is another high profile concern, and this has been addressed through product durability to reduce resource depletion, or designs which enable disassembly or recycling. It is worth noting that, apart perhaps from Hoover, none of these firms systematically considered the environmental aspects of product design over the whole life cycle from ‘cradle to grave’. As indicated earlier, these were ‘greener’ products rather than ‘ecodesigns’.

Moving to the broader company level, similar environmental concerns dominate. A third of the firms’ responses were concerned with environmental impacts at the production stages. A minority of firms (4) expressed interest in transport or distribution impacts. Some have reduced packaging to cut the
amount of goods moved, which produces direct economic gain as well as cutting the environmental impact of transport. The most interesting response came from Trannon, which sought to reduce the transport impacts of their raw materials by sourcing locally grown wood. Hoover commissioned a new design of trailer for transporting its washing machines to enable more machines to be carried in each load, thus reducing vehicle movements in distribution.

There is an interesting discrepancy between the number of firms (8) which noted energy efficiency as an important area to tackle at a product level, while only 5 mentioned this at a company operations level. For example, on more than one occasion a company making an energy-efficient product was noted to be operating from obviously energy-inefficient premises.

In general, the concepts of design for reuse and materials/component recycling are not very widespread among these companies, being mentioned by 9 firms. A similar number (8) of firms were concerned about waste disposal issues. Only two firms claim to have considered nearly all aspects of product environmental performance as a matter of company policy.

3.2 Environmental Impacts – Summary

• Over the product life cycle, the firms in this survey were most often concerned with selection of materials and reducing the environmental impacts of production with the aim of limiting manufacturing waste, conserving raw materials, and avoiding pollution for reasons of legal compliance.

This was followed by concern for reducing the energy and pollution impacts of the product in use, and attempts to design for recycling. Improving energy efficiency was, however, only a concern of those firms specialising in the production of energy-consuming products.

• At a company level, a similar focus on materials selection and on impacts from production and use phases was apparent. In addition, there was a concern with waste management and recycling. Although relatively few considered the environmental consequences of transport and distribution, several firms appreciated the commercial advantages of reduced packaging.

• Although most of these firms had undertaken serious ‘green’ product development, none of them had systematically considered environmental impacts over the ‘cradle to grave’ life cycle from the outset of the project.

The long term commercial pressures acting on these firms have already been discussed in section 2.3, and the environmental aspects of both products and company performance have also been considered. We will next examine in more detail the how the strategies the adopted by the firms lead to the development of these ‘greener’ products.
4 PRODUCT AND MARKET STRATEGIES

4.1 Business Aims of the ‘Green’ Product Development Projects

A major aim of the interviews was to identify the business aims underlying the decision to develop a new product in order to understand the part played in this by the product’s environmental performance. The reasons underlying the decision to develop a new product or range are diverse, and the environmental implications will be explored later (in Section 6); this section considers purely commercial and market considerations, which are summarised in Table 5.

The strategies adopted by a company that sought to take advantage of future or imminent legislation, attempted to win new markets with a new or improved product, regardless of the environmental benefits, or wished to maintain or expand their market share through the introduction of design improvements we have identified as ‘proactive’. Conversely, ‘reactive’ strategies were those adopted by firms which aimed to comply with existing legislation, or developed new, improved or updated products in response to market leaders or to demands from consumers, retailers or specifiers. Note that many firms indicated more than one response, which implies a diversity of aims.

Table 5 Business Aims of the ‘Green’ Product Development Project

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Business Aim</th>
<th>Number</th>
<th>% Total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive</td>
<td>To move into new market</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>To increase market share</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>To maintain market share</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Reactive</td>
<td>Response to consumer demand</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Response to competition</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Response to environmental regulation</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Response to retailer/specifier demand</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>‘Other’ *</td>
<td></td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>29</td>
<td>100</td>
</tr>
</tbody>
</table>

Notes: * See text for examples

In this study, the most common reasons for developing new or improved products were to create new markets or to increase market share, strategies classified as ‘proactive’. Thus, nearly half the firms aimed to use the new product as a means of creating an entirely new market and, of these, all except one firm was a small enterprise. More than a quarter aimed to expand their existing market share through the introduction of a better product.
In the context of this survey, reactive strategies included;

- The pressure to match a competitor's range.
- Product or process changes in response to increases in costs imposed by changes in costs of raw materials and energy.
- Reaction to existing or future environmental regulations.

Only three of the 16 firms were responding directly to pressure from anticipated environmental regulations, which at least for this sample, contradicts the earlier observation that one of the principle long-term pressures on industry was likely to result from increasingly stringent environmental regulations. This suggests that many firms are frightened by regulation, which is generally viewed as a threat, rather than a stimulus for innovative solutions. However, three firms, Atmosol, Grace Dearborn and Environmental Paints, were very conscious of the commercial potential presented by environmental legislation. Consumer and retailer pressure were also an important stimulus for new product development.

‘Other’ business reasons for developing new products included;

- There was a deliberate intention to create ‘green’ products, partly based on company ethical judgements.
- There was the aim of improving corporate image; the product could be marketed to demonstrate environmental consciousness.
- The project was a feasibility study, with implications for the rest of the product range.

The strategic commercial intentions of new product development outlined in Table 5 have been condensed to illustrate the principal drives, and are illustrated in Figure 2.

**Figure 2. Business Aims of the ‘Green’ Product Development Project**

![Pie chart showing business aims of green product development project](chart.png)

Percentages are of total responses n = 29
Although the drive to proactively develop and exploit new markets is well established, the reactive firms in this survey were more likely to be responding to market-driven demands than to regulation. It is possible that the companies featured in this study are less influenced by environmental legislation, and instead are searching for business opportunities whether they are ‘green’ or simply commercial.

We were interested in exploring the relationship between the business strategies adopted by different sized firms, and this required a more detailed examination of the strategies outlined in Table 5. The proactive and reactive business strategies have been disaggregated by company size based on the classification of small and medium/large firms used in this study, and the results are shown in Table 6.

**Table 6 Business Strategy and Company Size**

<table>
<thead>
<tr>
<th>Business Strategy</th>
<th>Small enterprises</th>
<th>Medium and Large enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive</td>
<td>10 (35%)</td>
<td>3 (10%)</td>
</tr>
<tr>
<td>Reactive</td>
<td>4 (14%)</td>
<td>6 (21%)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (10%)</td>
<td>3 (10%)</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>12</td>
</tr>
</tbody>
</table>

Percentages are of total responses n = 29

Although covering only 16 companies, it appears that in our survey the small firms (with <100 employees) were more likely to adopt proactive strategies than the larger enterprises.

The differences between the strategies of large and small companies is nicely illustrated by two of the firms in our study, both of which sought to address the same environmental problem – that of CFC and other propellants in aerosols.

Atmosol’s innovative design (see Section 2.1) required pre-launch testing, and by coincidence SC Johnson Wax had also been experimenting with alternative propellants. In the mid 1970s SC Johnson Wax was the first company to stop using CFCs in aerosols in advance of international regulations to phase out their use. The firm originally switched to liquefied butane, a traditional propellant, but being an inflammable hydrocarbon, represents a non-renewable resource and also presents some safety problems. After a four year research and development programme that commenced in 1989, the company succeeded in producing a compressed air aerosol.

Atmosol developed and launched its compressed gas (e.g. nitrogen) aerosol ahead of imminent US legislation designed to reduce the level of VOCs in aerosols by 30%. SC Johnson’s present solution is a redesign of the nozzle, while Atmosol have developed a new type of regulator and ball valve. Because SC Johnson Wax are a market leader, their move away from conventional propellants has given a ‘green light’ to other manufacturers who must follow their lead. The Atmosol system is to be relaunched through the British Technology Group (BTG) who have the authority to issue licences for production. It is interesting to note that legislation has had several effects. SC Johnson Wax have sought to push current aerosol technology to its limits, but are aware of certain performance
disadvantages of using of compressed air as a propellant. Atmosol have taken an alternative route, and produced an innovative design which addresses these problems.

This example shows that SC Johnson Wax, constrained by its existing processes and production technologies, sought incremental greening improvements. Atmosol as a new small business was free to develop a more radical solution, but then had the problem of selling the innovation to industry. Even with BTG backing this has taken several years. By way of contrast, SC Johnson Wax has such a dominant position, such that suppliers and the market takes note when it instigates a change.

Overall, there are clearly a number of issues which influence a company’s decision to develop a new product, or modify an existing range. These strategies may have been influenced by direct commercial goals, or in response to external pressure.

4.2 Environmental Factors in Competition

Turning now from the company-level motivations, it is useful to examine more closely the qualities and attributes of a product range that these firms associate with commercial success. These are the elements which give a product a competitive advantage.

Specific information was gathered in order to establish a more precise picture of competition factors in the ‘green’ product’s market. Each respondent was asked to select three key attributes from a list of eleven which in their opinion conferred a competitive edge when the product was launched on the market. The results are presented in Table 7, which shows the factors ranked in order of significance derived from the total number of responses.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specification/Performance</td>
</tr>
<tr>
<td>2</td>
<td>Quality/Reliability</td>
</tr>
<tr>
<td>3</td>
<td>Value for Money</td>
</tr>
<tr>
<td>4</td>
<td>Environmental Friendliness</td>
</tr>
<tr>
<td>5</td>
<td>Price</td>
</tr>
<tr>
<td>6</td>
<td>Marketing/Promotion</td>
</tr>
<tr>
<td>7</td>
<td>Styling/Visual appearance</td>
</tr>
<tr>
<td>8</td>
<td>Customisation</td>
</tr>
<tr>
<td>9</td>
<td>Ergonomics/Safety</td>
</tr>
<tr>
<td>10</td>
<td>Response/Delivery Time</td>
</tr>
<tr>
<td>11</td>
<td>After-sales Support</td>
</tr>
</tbody>
</table>

In this study, it is clear that features pertaining to performance, quality and reliability are most highly rated attributes of a competitive product. Quality and reliability characteristics included longevity and
low maintenance. These aspects may also confer environmental advantages due to a reduction in material resources needed to replace and maintain products, but may not be marketed as an environmental benefit or even perceived as such.

Environmental-friendliness ranked fourth and although it is not the most crucial factor in competition, it is significant that it is rated more highly than price alone. As an illustration, Trannon’s furniture gains its competitive advantage not from its price, but because it is of high quality and well-designed, as well as being made from coppiced wood, a renewable and under-utilised resource.

Other examples drawn from the small enterprises in this survey are also relevant. The priority is designing for performance first – Nitech’s batteries, pellets from Pax Guns and Starlowe’s lighting system technically outperform rival products. Unlike large, established firms, they do not have an image to defend, but like SC Johnson Wax and Frigidaire, performance is the primary competitive feature rather than the environment. As one interviewee commented; ‘we did not design it to be “green”, but to be a good product.’

The survey also sought to determine how much of each product’s commercial performance could be attributed to the environmental issues it addressed, and how much was dependent on other characteristics. In the great majority of cases (11 or 69%) environmental issues alone were insignificant. Trannon noted they had only sold very few chairs because they are ‘green’. In fact at the time of the interviews, only Environmental Paints attributed the commercial performance of their VOC-free paint predominantly to its environmental features, but emphasised that its performance must be as good as non-environmentally friendly paint. Subsequently, the firm came to recognise the need for competitive pricing in the green paint market, but this was too late to save the firm.

This contrasts with most other firms whose responses included:

- SC Johnson Wax, which deliberately did not communicate to consumers any environmental premium associated with their recycled Shake n’Vac packaging (see Section 5.3.3 below).
- GE, Osram, GTE, Starlowe and Nitech, which all considered product longevity, reliability, low maintenance and cost savings of their lighting products as more valuable attributes.
- Stelrad and Gestetner emphasised the importance of cost saving to the user as the primary incentive to purchase their ‘green’ products. ‘Environment is a “comfort factor”, a reinforcement to the basic motivation of buying because running costs are low’.

Nitech and Fibrescreed both observed that environmental factors were mostly insignificant in customer choice, but attitudes towards environmental issues in industry are changing. Fibrescreed, for example have reported growing environmental interest expressed by the British Airports Authority and some local authorities in their recycled runway/road repair material: ‘We wanted to make Fibrescreed technically better and show a concern for recycling issues and this would assist in marketing – government departments are more aware of environmental concerns in issuing contracts.’ GE estimated that about 50% of sales may be attributable to environmental concerns, but only if EU Eco-labelling is introduced for lighting.

The Hoover ‘New Wave’ washing machine has gained share in the environmentally-aware German market. In the UK, where consumers are generally less environmentally motivated, prior to the award of the Eco-label the machine was promoted through its money-saving features. Hoover announced in
May 1994 that its market share of machines in the £420 plus price bracket (which includes the ‘New Wave’ models) had doubled in 1993, and claimed that the Eco-label was one factor that contributed to this success. This recognises the existence of more environmentally-conscious consumers in the upper range of the UK washing machine market, but also that product performance, quality and appearance are also crucial to success, even among ‘green’ consumers.

Pax Guns also observed that environmental performance is of significance only in certain export markets, notably Sweden, otherwise it is the superior performance of the product which determines purchasing decisions. But they did carry out a survey of their air gun pellet users to ascertain the degree of environmental concern among customers. This involved a competition to write a ‘jingle’, of which the winning entry was: ‘They’re fast and consistent, non-toxic and clean, so me and my gun are environmentally “green”.’

This indicates again, in a different context, the importance attached to product quality (Pax pellets are more accurate than lead ones), which may be augmented by environmental performance. Environmental performance in isolation is clearly regarded as insufficient incentive for the successful marketing of a ‘green’ product, even to environmentally-aware consumers.

It is clear that the products had to be up among the leaders in terms of specification, performance and quality to be competitive. Improvements in environmental performance only become a significant factor once such levels of product performance and quality are attained.

A general feature of many of these products was that they were aimed at mid to up-market segments and often specialist commercial and professional users. In such markets, design and performance are generally more important than price. One major exception to this was Frigidaire, which mentioned how, in the strongly price-competitive US white goods market, price acted as a constraint on designing for the environment.

The broad conclusion that can be drawn from these observations is that environmental performance of a product is not usually the highest priority in terms of competitive advantage and other attributes are more crucial to commercial success. In order to compete effectively, products need to work well, be of high quality and offer value for money. Environmental factors come next on this list of requirements. This conclusion is similar to that reached in other studies of products such as ‘green’ detergents and recycled paper (Wong, Turner and Stoneman, 1995). It helps to explain the frequent company strategy regarding ‘greening’ existing product lines rather than establishing separate ‘green’ product ranges, and confirms that the firms in this survey focused on designing for performance and quality.

4.3 Design and Innovation Management

Having examined the factors motivating firms to improve the environmental performance of their products, and the general competitive factors within which this greening takes place, it is useful to examine how the product development process was managed from concept to commercial production. A sequence of questions was therefore asked in the interviews to reveal how the firms managed product development.

About half the firms interviewed had developed a written brief for the design team which specified the desired product characteristics. Most of these companies were medium and large enterprises. For example, in one larger company, the brief specified an exhaustive list of features for the proposed
lighting product. These included considerations of aesthetics, energy efficiency, specific light output, rapid payback period for the customer, long product life and cheap maintenance.

Small firms tended to rely on informal, verbal briefing. In one firm a written brief was needed to satisfy the requirements of a Department of Trade and Industry (DTI) grant award.

All medium and large companies in this survey employed Research and Development (R&D) teams, with responsibility for innovation being a function of senior management. For example, Stelrad’s business manager instigated the development of the ‘Turbo’ condensing boilers to complement the range of products offered, in response to a perception that customer requirements had changed. In contrast, in small companies, new products were generally developed by company managers/proprietors who in some cases established the company specifically to develop, manufacture and market their own concepts and inventions. External consultants were employed by five of the small firms to assist with developing some aspects of the product. All the larger companies attained similar goals using in-house expertise and experience.

Two examples serve to illustrate the importance of design and innovation management which in one case reflected a wider corporate cultural shift. In the case of Frigidaire, ‘greening’ their product range meant a fundamental shift in design management. Before they were taken over by Electrolux in 1987, the company competed mainly on price, and had according to one of their industrial designers ‘a culture of churning out cheap products’. The new management sought to transform the company into a ‘customer-focused culture’, with investment in industrial design being a crucial element in the process. An immediate result was that all design was concentrated at a new Design Centre in Ohio, and a product development strategy adopted, which raised the priority of environmental factors. The aim was to produce an integrated range of well-designed, high quality refrigerators, washers, dryers, dishwashers and stoves. Thus this new design-led strategy represented a dramatic culture change to the company (see Potter, 1996).

In the case of Hoover, development of the ‘New Wave’ range of washing machines involved serious consideration of environmental factors in design for the first time. This was aided by having a small, closely knit product development team with members from R&D, engineering, industrial design, manufacturing and marketing. However, apart from the more integrated, team-based approach, no changes to the product development process were required to incorporate environmental factors into design. No environmental specialists were involved and the team ‘learnt as it went along’. Nevertheless, the environmental objectives added some difficult design problems to be solved. Again the team-based approach, involving frequent interaction between design, manufacturing and marketing staff, helped in solving these problems (see Roy, 1996).

4.4 Product and Market Strategies - Summary

This survey suggests there are some broad observations which can be made regarding the nature of the firms interviewed, the commercial and environmental pressures which resulted in new products, and the competitive edge.

• Even in this small sample of firms there is a wide variety of ‘green’ products and there appeared to be a significant split between small (<100 staff) and medium and large
enterprises. The small firms tended to be more proactive, which enabled them to exploit new markets or expand their existing base.

- Although several of the firms expressed concern about future environmental regulations and commercial survival, many were aiming to establish entirely new markets created through the ‘green’ product. There were a mix of motives for developing new products, and although environmental factors were not at the forefront, they are part of set of product characteristics that needed addressing.

- Small firms were typically established to develop and manufacture the owners’ own concepts, while medium and large firms needed a more strategic approach to product planning and development. In some instances, this demanded fundamental changes to the design process, and impacted on entire product ranges. Both large and small firms had difficulties integrating environmental performance into their product strategies.

- It is a generally held opinion of the firms interviewed that good environmental performance alone does not guarantee commercial success. To be competitive, a product needs to work well, be of high quality and offer value for money before environmental factors start to have an effect.

- Some firms used green issues more than others for branding and marketing purposes.

5 PROJECT OUTCOMES

All but one company in this survey had, at the time of interview, established markets for their ‘green’ products. This section comprises an analysis of the commercial outcomes, including direct financial returns, international trade effects and market performance. The interviewees were also asked about the indirect effects of improving the environmental performance of their products, such as the development of further products, and, where relevant, how the ‘greener’ product compared in commercial performance to the product it replaced.

5.1 Commercial Performance of the ‘Green’ Products

A series of questions was designed to ascertain the direct and indirect commercial impacts of these projects, including:

- Annual sales of the product (value and number of units sold);
- Gross profit margin achieved;
- Profits per annum on the product line;
- Market share of product;
- Exports of product.

Information was also gathered on the costs of developing the product from concept through to market launch, including all design, development, plant, tooling and initial marketing costs. The costs, sales and profit data permitted the payback period of the project to be calculated. This was measured in terms of the amount of time from product launch it took for the total investment in the project to be recouped. If detailed financial data were not available, respondents were asked to provide a qualitative indication of the commercial success of the project.
The commercial performance of the products is summarised in Table 8, which shows the averages and ranges for each indicator. The data are presented as general observations to respect confidentiality, and in some cases was too sparse for analysis.

**Table 8  Summary of the Commercial Performance of 'Green' Products for Small Enterprises and Medium and Large Companies**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Small enterprises</th>
<th>Medium and Large enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Sales (value)</td>
<td>Data suggests an average in excess of £2m p.a., but a wide range (from £120,000 to over £7m p.a.)</td>
<td>Difficult to estimate, but probably far greater than for small enterprises</td>
</tr>
<tr>
<td>Exports (%)</td>
<td>15% on average, but ranges from zero to &gt;65% for one firm</td>
<td>Ranges from zero to 90%; in one case all imported</td>
</tr>
<tr>
<td>Gross Profit Margin (%)</td>
<td>43.8% average&lt;br&gt;Ranges from 20% to 50%</td>
<td>Confidential data; ranges from ‘unsatisfactory’ and ‘worse than before’ through to ‘very satisfactory’</td>
</tr>
<tr>
<td>Market Share (% volume)</td>
<td>Typically very low, less than 6%; but ranges from less than 1% to 85%</td>
<td>Typically in excess of 20% and as high as 50%, only one less than 10%</td>
</tr>
<tr>
<td>Total investment in Project (£)</td>
<td>Less than £150,000 on average</td>
<td>Very high; minimum was £500,000</td>
</tr>
<tr>
<td>Payback on total investment in project</td>
<td>From just over 7 months to more than 5.5 years, and typically in the range 1.5 to 2.5 years; average of 2 years.</td>
<td>Indeterminate; insufficient data</td>
</tr>
<tr>
<td>Average annual growth (%) of sales *</td>
<td>Mean 195%/year&lt;br&gt;Ranges from 5%/year to 375%/year</td>
<td>Few responses, but lower than for the small enterprises.</td>
</tr>
</tbody>
</table>

* Calculated as:  Average sales/Year 1 sales - 1

The financial data obtained strongly suggest that for the ‘green’ products developed by small firms (with <100 employees), there were very high sales growth rates and a rapid payback on investment. For example, both Nitech and Starlowe recovered their design, tooling and other investment costs in under two years. Nitech recorded five-fold sales increases over seven years and sales of Starlowe’s ‘Omni-lite’ tripled in just three years, while Trannon quadrupled sales in four years trading.

However, the small firms tended to begin from a low base (or even none at all, as some products were the company’s first). The ‘green’ product represented a much higher proportion of the small companies’ turnover than that of large firms, in a number of cases it was the sole basis of the company. The small enterprises were typically ‘start-up’ or single product firms, with a turnover
ranging from £120,000 to over £7 million, averaging at £2 million. For larger firms with a turnover ranging from £1 million to £100 million, the green product was typically a relatively minor part of the business.

Spectacular overall and annual growth rates therefore tend to be combined with a small market share. The exception was Nitech, which created and dominates the industrial rechargeable battery market, with some 85% share. By comparison, where data were available for the medium and large enterprises, sales grew by 160% to 228% over the three year period prior to the time of the interview. These firms were generally well established, with significant market share. This category of firms was dominated by the CFL manufacturers, and the development costs of such products were generally very much higher than for small enterprises.

5.1.1 Comparison to a Previous Product

Evaluating the commercial performance of a product ideally requires some form of ‘benchmarking’. The survey therefore specifically included a comparison with either the product or range that the ‘green’ product replaced, or a comparison to a comparable ‘non-green’ product of the respondent’s choice.

More than half of the firms interviewed already had an existing range of products, so a comparison was possible of the ‘green’ product’s performance relative to its predecessor. This largely involved the medium and large enterprises. The small enterprises were almost all founded on a single product, without a pre-existing product base, and in many cases no other products as well. Thus no comparison could be made.

Half the medium and large firms reported that the ‘green’ product was more successful than the product it replaced. This is a strong result, in spite of the small numbers involved, and included Grace Dearborn, Gestetner, Hoover, Osram and GTE. In some cases the ‘green’ product required further refinement, for example Grace Dearborn had to resolve some problems of replicating laboratory results for different types of water. Osram observed that, following the introduction of more compact and lightweight CFLs offering higher wattage, improved efficiency and light output, sales were some three to four times greater than for its older, bulkier lamp designs, although overall market penetration of CFLs remained poor. GTE had also recorded a dramatic rise in sales for their lamps, which were outselling their conventional tungsten lights in value.

Hoover believed that the company’s environmental approach supported by the Ecolabel has been an important factor in the success of the New Wave range compared to previous washing machines, most notably in the environmentally-aware German market in which the company doubled its market share in 1994, and they viewed similar opportunities for export to Scandinavia. Even so Hoover found it necessary to produce lower priced, but less environmentally efficient, models for the volume UK and Southern European markets.

Stelrad believed that the ‘Turbo’ condensing boiler made no overall impact on their range, as it complemented their range of products, and accounted for some 5% of their boiler sales.

Only SC Johnson Wax considered that their introduction of recycled packaging materials was not commercially successful. At the time of the project the cost of recycled polymer was 16% higher than virgin plastic. As the consumer was unaware of any alterations, and there were development costs, the
gross profit margin was reduced, such that the short term commercial performance suffered. The real benefits must be viewed not at the product level, but as an investment in the company’s image and a commitment to environmental standards. This project acted as a mechanism for integrating environmental issues within their overall product strategy, and in this case had a direct impact on their packaging raw material costs.

The data suggests that ‘green’ products can be commercially successful replacements, providing that they match or outperform previous products. Alternatively, as in the example of SC Johnson Wax, the development of greener products can be used to justify long term company objectives.

5.1.2 Comparisons to the CID Survey

A second form of commercial performance benchmarking was provided by the earlier Commercial Impacts of Design (CID) study (Potter et al, 1991). Given the similarity in methodology between these two surveys, the CID study provides a useful benchmark, based on a sample of some 100 typical ‘non-green’ products for which we obtained detailed financial data, with which to compare the commercial performance of these examples of ‘green’ products. The ‘green’ products were matched as closely as possible to the most relevant product categories in the larger CID sample.

The average gross profit margin of the ‘green’ products developed by the small enterprises in this survey, at 43.8%, is similar to the average for the CID products (37% before the design project and 46% after it) and is within the margin of error for such a small sample. This suggests that environmental features do not add much value to a product and hence there is little scope for firms to ‘price up’ green products (especially given that in some cases production costs of these products were reduced through energy and material conservation). This is consistent with the earlier conclusion that environmental factors only start to convey a competitive advantage to a product after performance, quality and value for money are equal or superior to other products.

One difference was that the cost of developing the ‘green’ products was higher than for typical ‘non-green’ products. The cost of product and engineering design projects in CID averaged £60,000 and in this survey the cost of developing ‘green’ products in the small enterprises were considerably higher. Because both types of product experienced similar profit margins, the ‘green’ products therefore experienced a longer payback period. Repayment on total investment was on average a little more than 2 years for green products from the small enterprises in this survey, compared to 15.5 months for similar projects in the CID ‘non-green’ sample.
5.2 Market Impacts

The nature of the markets that these firms entered with their ‘green’ products is presented in Figure 3.

![Figure 3: Market Impact of ‘Green’ Product]

- Entered new market: 32%
- Expanded in existing sector: 31%
- Consolidated existing market: 6%
- Other: 31%

Sample n = 16

It is illuminating to compare this chart to the original business aims of the project (Section 4.1), where 24% of the firms expressed interest in entering a new market, 17% hoped to increase their market share, and 4% to consolidate their position. These results indicate that in general the firms have achieved commercial success in excess of their original aims, with 32% competing in entirely new sectors, and 31% gaining market share.

The firms in this sample which have created completely new markets include Pax, Starlowe, Nitech, Trannon and Environmental Paints. It is perhaps significant that they are all small enterprises, capable of identifying and creating new markets with innovative products. However, not all managed to establish a sufficiently large market to survive. Environmental Paints ceased production after three years because its ECOS paints, although favoured by hospitals and local authorities, could not be produced to a sufficiently low price for such commercial customers. Nor could it establish sufficient demand in the retail market against competition from large paint suppliers.

In this survey, the firms which expanded in existing markets include Fibrescreed, Frigidaire, Gestetner, Hoover and Stelrad. These products are improvements or substitutes for existing products.

5.2.1 Effect on Competitors' Sales

The ‘green’ products have indirectly influenced a range of business decisions, from initiating new projects through to changing marketing strategies. Such innovative products have also demonstrated average or better than expected commercial performance. One possible explanation for such performance is that these markets are dynamic, and constantly developing. It is instructive to examine how the firms have fared against direct competition and what effect the ‘green’ products have had on their competitors’ sales.
All the enterprises, with one exception, compete in markets where there are at least three other established competitors. Trannon have virtually no competitors; the closest (geographically) are Scandinavian furniture makers. SC Johnson Wax actually supply retail chains with ‘own brand’ cleaners, which compete directly with their own brands.

In this survey two companies, SC Johnson Wax and Grace Dearborn, reported that their products had no adverse effect on their competitors. However three firms, Fibrescreed, Nitech and Stelrad considered that their products had made sales gains at the expense of other firms. Fibrescreed have simultaneously benefited from increased trade as the demand for their products has increased. Five companies, including Nitech and the domestic CFL producers, have all similarly gained from expanding markets. Atmosol are in the unique position of a firm with a product with considerable sales potential depending on the performance of the licensing arrangement.

What is most striking, even in this small sample, are the number of firms which are competing in expanding markets. This suggests that there are considerable commercial opportunities for products such as Nitech’s ‘X-Cell’, which are able to command continued high growth rates and a dominant position in the market.

5.2.2 International Trade Impacts

From the strategic perspective of the national economy, the international trade impacts of the ‘green’ products deserve some consideration. Even from the perspective of the individual company, diversifying into export markets spreads risk more widely and provides opportunities for growth, and so represents an commercial benefit. A series of questions explored this issue, including exports of the ‘green’ product, and strengthening of the firms’ market position against import threats.

It might be expected that ‘green’ products would perform well in export markets. The benchmark CID study showed average exports were 19% of sales, with product design projects exporting 10% and engineering and industrial design projects exporting a higher proportion (41%). The latter is the most appropriate category to compare with most of the ‘green’ products in this survey. However, a direct comparison was rendered difficult as 60% of firms in the CID survey were small with <100 employees and most of the remainder employed <500, while in this study most export information was obtained only from the small firms.

For the ‘green’ products made by small firms, exports averaged less than 15% of sales (which is fairly typical for small firms), but there was a large range, from no exports through to a proportion in excess of 65%. For medium and large enterprises, where the data was made available, exports accounted for 33% of sales. However, of these, one firm concentrated exclusively on the UK market, and another acted as a distribution centre solely for imported goods.

Interestingly, in two out of the 16 cases, there was virtually no international trade in their products. Stelrad in the UK and Frigidaire in the USA compete in very isolated markets. The UK domestic boiler market demands different types of appliances to continental Europe. (The UK market opts for small, wall-mounted boilers, whereas larger, floor-mounted boilers are preferred elsewhere.) Thus UK designs do not sell abroad and developing new designs just for overseas markets represents a considerable risk. Equally the uniqueness of the UK’s desire for small, wall-mounted boilers, means that very few overseas companies try to sell their boilers here. Frigidaire observed that the nature of
the markets for white goods in the US and Europe are markedly different, producing contrasting design constraints. This has prevented the diffusion of some technologies from one market to the other, as well as little by way of transatlantic trade. However, between European white goods manufacturers, international competition is intense.

By way of contrast, for firms that were operating in certain export markets, the environmental performance of the product was often crucial. Hoover’s ‘New Wave’ machines were targeted at the German market, where 'green' products are more acceptable than non-green alternatives. Nitech also had a good export performance and won the Exporter of the Year award in 1992.

Overall, competing internationally was only one of a number of strategic market objectives pursued by the firms in developing their ‘green’ products. There was a wide variation in strategies and results among the 16 cases, with some firms concentrated on the UK market, while others exported the majority of their products. For those in export markets ‘green’ appears to be an increasingly significant factor.

In addition to direct exports, international trade impacts can arise from import substitution, where domestic sales are captured from overseas competitors. There are also markets where imports are already high and increasing. For example, all the firms involved in manufacturing energy-efficient lighting reported that imported lamps account for the great majority of sales (typically 70% plus). In such situations, a new product could enable the company to hold its own against further penetration of the UK market. In the CID survey of general products, import substitution accounted for 21% of the products considered and the maintenance of UK sales against high import penetration a further 25%.

In this study there were no such clear-cut results, but an unanticipated category of import substitution regards that not of the product itself, but of the raw materials used to manufacture the product. If the change to a ‘greener’ design results in UK-sourced materials substituting for imported materials, then this produces a net beneficial trade impact. Questions were not specifically asked about this aspect, but in the interview at SC Johnson Wax it was established that the recycled polymer plastic feedstock in the Shake n'Vac container was from a UK manufacture, whereas the virgin feedstock was imported. The use of recycled materials in products may thus be associated with positive trade effects. This is an area that deserves further investigation.

### 5.3 Indirect Impacts of the ‘Green’ Product Development Projects

The questionnaire was designed to evaluate not only commercial performance at a narrow product level, but also to examine the wider commercial impacts of environmental improvements. As SC Johnson Wax indicated, these included strategic aspects, such as the effect upon company image and attitudes of staff towards environmental matters. The consequences of the ‘green’ product have been divided into two groups; product-level impacts and company-wide impacts. These are summarised in Table 9.
Table 9  Indirect Impacts of 'Green' Product Development Projects

<table>
<thead>
<tr>
<th></th>
<th>Indirect Impact</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product-level</strong></td>
<td>Stimulated/influenced development of other products</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Influenced materials selection/manufacturing process for other products</td>
<td>5</td>
</tr>
<tr>
<td><strong>Company-level</strong></td>
<td>Influenced attitudes towards environmental issues</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Produced changes in product/marketing strategy</td>
<td>8</td>
</tr>
</tbody>
</table>

Sample n= 16  Note: Firms may have recorded responses in more than one category.

The nature of these impacts are explored in the following sections, which will examine product development, production processes, and general company strategies in turn.

5.3.1 Further Product Development
In nearly two-thirds of cases, some 63% of the firms interviewed, the ‘green’ product stimulated development of further projects. These arose from adapting the initial, ‘green’ product into other applications, or diversifying into related markets. For example, SC Johnson Wax used the Shake n’Vac container to test the feasibility of introducing of recycled plastic into the rest of the product range. Several firms diversified through increasing their product ranges. Nitech gradually built up a range of torches and other products to exploit its battery innovation, concentrating on the demand for reliable, high-performance portable lighting for professional users. Trannon designed a new ‘Coppice’ range, including a stool, dining and low table and a futon settee and several other products have followed. At the time of the interview Environmental Paints planned to introduce a gloss paint based on the Ecos formulation for matt emulsion paint.

Once Gestetner’s management accepted the commercial potential for recycling cartridges, the firm considered expanding into refurbishing photocopiers (a much larger market) and paper recycling. Two lighting firms, Starlowe and GE, both developed fittings (luminaires) to complement their low energy lamps. Starlowe originally manufactured external light fittings and they also incorporated CFL technology in the design of interior fittings. GE moved in the opposite direction expanding into exterior fittings from interior lighting.

5.3.2 Production Processes and Materials Selection
Five firms reported that they modified their production processes as a result of their ‘green’ product development project, many through the introduction of cheaper materials and alternative production techniques. GTE responded to health and safety legislation by modifying the method of applying triphosphor coatings on the interior of the glass tubes without the use of organic solvents. The solution adopted involved a switch to using water as a medium for the triphosphor coatings. The firm also reported that the low operating temperature of CFLs enabled them to achieve reduced material costs through increased use of plastics and reduced reliance on metals in their fittings.
Atmosol are the only firm in this sample to have encountered supply chain pressure, although this related to their other products, rather than the ‘green’ aerosol design they had developed. The Body Shop insisted on the incorporation of recycled material in plastic containers that the company makes.

5.3.3 Attitudes, Product and Marketing strategy

All 16 firms in this survey revealed positive changes in management attitudes towards environmental issues. For example, the success of the Boomerang project was crucial to the acceptance by Gestetner Australasia that such a product could compete in terms of quality, and the concept of refurbishment could be applied to other office equipment. The project’s manager commented ‘Some managers initially saw Boomerang as a joke. But now realise it is a successful product and a serious business.’

The effect on marketing strategies in this sample of firms was more diverse. Nitech became aware of the potential to promote the environmental credentials of their batteries, when they realised they had developed a ‘green’ product and now stress the environmental benefits of the X-Cell battery in their advertising: ‘Environmental awareness has developed as they discovered they had got a green product....They now push the green factor in marketing.’ Similarly, GE Lighting realised that in the case of energy-efficient products, environmental benefits are commensurate with commercial benefits. Environmental Paints found that environmental issues were a new concept in marketing, and had to learn how to exploit such features themselves, while Osram have dedicated more resources for producing environmental information in response to consumer demand. Osram have changed the emphasis of their marketing strategy. Initially they concentrated on the financial benefits of CFLs, but now highlight the environmental benefits accrued from reduced power station emissions. Stelrad’s sales force use the fuel efficient ‘Turbo’ condensing boiler as a lure, on the strength that they are the UK’s major producer of this type of boiler, but then proceed to sell other types of appliances.

Moreover, ‘The Turbo gets Stelrad articles in magazines on energy savings. It is an important attraction at exhibitions. Publicity effects have been very important for the company.’

An interesting example is provided by SC Johnson’s approach to the Shake n’Vac packaging problem. It was initially a feasibility study of the use of recycled plastics to identify the practicalities of contributing to the company’s emerging environmental policy. The UK Marketing Director did not consider ‘green’ aspects should be part of the brand image, as consumers did not consider the environment to be important and this was not a feature which could be uniquely identified with the company. Moreover, environmental friendliness was also identified by consumers with poor product performance, which discouraged the company from promoting a ‘green’ image. They recognised the need for more environmental information on the product labels which the company decided to provide in response to consumer suspicion of unlabelled packaging. However, they insisted on presenting information in a scientifically accepted form, for example; ‘this material is 90% degradable within one week’, which potentially puts them at a disadvantage compared to vague labelling such as ‘100% biodegradable’. (Although their packaging will eventually entirely degrade, the test stipulates a minimum of 90% biodegradation.)

In addition to the recycled packaging exercise, a manager persuaded the company to pilot a ‘green’ multi-surface cleaner. The Technical Manager, however, was concerned that presenting the consumer
with one ‘green’ product would imply all others are ‘non-green’. But as recently as 1995 SC Johnson Wax shifted its emphasis, as the company appears to have recognised a market demand for ‘green’ products, but consider that consumers are unwilling to sacrifice price and performance. Their intention is to develop ‘eco-efficient’ products, which they define those which achieve environmental benefits simultaneously with performance and competitive pricing. An example of an product launched since our survey illustrating this approach is the compressed air aerosol. The reformulated furniture polish ‘Pledge’ using the new aerosol was launched in Europe in 1994. Their rationale for ‘greening’ a high profile market leader was that it would have a significant impact on a dynamic mass market.

An illustration of the diverse direct and indirect effects of ‘green’ products are shown diagramatically in Figure 4.

**Figure 4  Summary of Indirect Impacts of ‘Green’ Products**

This diagram shows an analysis of impacts from the narrowly defined product level through to the company strategy level. We have seen that ‘green’ products have a range of direct and indirect effects. Building on their general commercial success, the firms studied in this survey have been able to expand their product ranges through the application of the technology pioneered in the ‘green’ product development project. This has sometimes influenced production processes and material selection. In an iterative process, management attitudes have also changed, and these changes have informed marketing strategies. More advanced management would consider these impacts at all levels and it seems that this is particularly relevant with ‘green’ products. So, although the green products were generally commercially successful, their further positive indirect impacts are of particular importance.

**5.4 Project Outcomes – Summary**

Some general observations concerning the commercial outcomes and indirect impacts of the ‘green’ product development projects include the following:

- For the medium and large firms, the ‘green’ product may be a relatively minor part of their business, whereas in the small firms the green product or range may be the only or main source of revenue.
• The sales growth of ‘green’ products can be very spectacular, especially in dynamic and expanding markets, often outperforming conventional non-green products.

• Profit margins are broadly similar to conventional products, which suggests that there is little scope for ‘pricing-up’ green products.

• Due to higher development costs, there is a slightly longer payback period for ‘green’ products than for comparable non-green projects.

• It is significant that many redesigned ‘green’ products were more successful than their predecessors and that the ‘green’ products generally exceeded original expectations of commercial performance.

• Some ‘green’ products can perform well in certain environmentally-aware export markets, where such products are already well accepted.

• Environmental performance alone is insufficient to ensure the commercial success of a product. As noted earlier, it must offer a high standard of performance, quality and value for money.

• Green product development projects have influenced the development of other products, materials choice, manufacturing processes, marketing strategies and general management attitudes towards environmental issues.

6 ENVIRONMENTAL POLICY AND MANAGEMENT

As discussed in the previous section, the firms in this survey had incorporated some aspects of environmental performance within product design and, when combined with product performance, quality and value, such environmental considerations often rewarded the companies with commercial success. This resulted in a range of other impacts, including on the strategy of the companies more generally. Although environmental performance has yet to permeate completely into corporate thinking, this study sought to explore the place of environmental issues within wider management strategies.

This section will present the results of the survey concerning the extent to which environmental policies and management systems had been introduced by the sample firms, the level of resources which had been dedicated to ‘green’ issues, and if long term changes in resources resulted from the green product development project. It will also indicate how the implementation of standards and product labelling systems had been employed as marketing tools.

6.1 Company Environmental Policies

Environmental reviews and audits and the development of company environmental policies are becoming commonplace business activities, especially among large firms (Vaughan and Mickle 1993; Green, McMeekein and Irwin 1994). It is instructive to examine how many firms in this sample have undertaken environmental audits, produced guidelines or company policy documents.
Over half (56%) of the companies had formal, written environmental policies, including all the medium and large firms, and one small firm, Environmental Paints. The quality and contents of such policies was very varied; some firms have produced comprehensive environmental policies, while others are concerned with limited aspects, such as industrial discharges. For example, SC Johnson Wax’s environmental policy has been established for some years, and is continually revised to produce ‘realistic goals’. Osram’s was very thorough, typical of a firm with headquarters in Germany, where environmental responsibility is well documented. Hoover had developed a comprehensive Environmental Mission based on a life cycle approach to product design, manufacture, use and disposal and which includes ten objectives covering environmental management, compliance with legislation, workforce awareness and training, consumer information, supplier performance and environmental auditing. In contrast, Stelrad were concerned specifically with foundry waste and compliance with environmental regulations, while Grace Dearborn’s environmental policy addresses their own industrial discharges.

A further five firms (31% of the sample), all small enterprises, had an informal unwritten policy, generally incorporating the proprietor’s or director’s personal philosophy (‘It’s all in David’s head’ said one interviewee). Only two firms (13%), both small, had no environmental policy.

6.2 Responsibility for Environmental Policy

One measure of how seriously companies regard environmental issues is reflected in the responsibility for such matters. We therefore enquired who was responsible within the company for developing and implementing environmental policy decisions. The results are shown in Figure 5.

Figure 5. Responsibility for Environmental Policy

![Pie chart showing responsibility for environmental policy]

Sample n = 16

In this survey, environmental issues are managed by company directors in half of the firms: only two medium and large firms (Osram and GTE) compared to six of the small enterprises. This is because the informal structure of the small firms ensures that they do not have much need for intermediate
management levels. Two firms, Hoover and SC Johnson Wax, had convened environmental committees to organise and implement environmental policies. Environmental affairs are dealt with by an Environmental Officer at Grace Dearborn, Stelrad and GE. In this sample, it appears environmental issues are well integrated into senior management practices with only two firms having no-one responsible. But it is instructive to examine how far these have been delegated through the company hierarchy. In fact, five firms had appointed an Environmental Product Manager, all with one exception are large firms. This in itself is an interesting development, and demonstrates that ‘green’ issues beyond compliance and process modification are being more closely scrutinised. However, such positions within companies are a relatively recent development, and could either reflect a growing concern for environmental issues, or merely a short-lived response to public demand. These possibilities were pursued to gauge how management interest in the environment had changed, and if environmental issues were still high on their agenda.

6.3 Resources for Green Product Development

The importance a firm attaches to environmental matters will be reflected in the resources dedicated to environmental issues in general, although not necessarily to green product development. Considerable effort may have been expended in process compliance, but in this context we were interested in exploring the change in resources allocated to developing environmentally friendly products. Table 10 shows how much resource allocation had changed over the three year period before the company was interviewed.

<table>
<thead>
<tr>
<th>Change in Resources</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 25% increase in past 3 years</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Up to 25% increase in past 3 years</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>About the same</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Decrease in past 3 years</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>No answer</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>100</td>
</tr>
</tbody>
</table>

Frigidaire and Osram were the two firms which have shown the greatest (25% plus) increase in resources devoted to developing greener products. GE Lighting were the only firm in this sample which had reduced resources. Most of the firms (63%) in our survey have invested more resources in the pursuit of environmentally friendly product development. This result is comparable to that from a larger survey conducted in 1993 of 169 firms which had expressed an interest in a government scheme to support innovation that might lead to environmentally improved products or processes. In that survey 34% responded that they had made a large change in the past five years towards
developing environmentally friendly products, and 72% reported an increase in resources devoted to making environmental improvements to products or processes (Green, McMeekin and Irwin, 1994). In our study, efforts had been directed towards compliance, with some firms also engaged in achieving a variety of quality and product labelling standards. These standards were developed as indicators of management competence and an independent endorsement of a product’s environmental performance.
6.4 Environmental Management Standards and Product Labelling Schemes.

Product differentiation can be achieved through a variety of techniques, including good design and the promotion of a quality image. Consumer behaviour may also be influenced by products bearing evidence of standards or labels denoting particular qualities. We wanted to explore how the evolution of industry standards and environmental labelling which serve to display to consumers aspects of quality had been employed to create competitive advantages, or how much government intervention had been available for industrial support.

This section examines how many of the firms in this survey had registered for such labelling and standards schemes, which at present are largely voluntary, and include quality management and environmental management. Environmental management has now become a subject in its own right, and many industry standards have evolved from quality assurance programmes which proliferated in the 1980s. Many firms have already registered for the Total Quality Management British Standard (BS5750) on which an environmental standard, the Eco-management Standard (BS7750), has been based. BS7750 has much in common with BS5750, and is intended to encourage an integrated approach to environmental management. The system demands that an environmental review or audit of a company has been undertaken. More recently, product specific awards, such as the EU Eco-label, have evolved as a system of providing consumers with independently verified product performance claims, free from the misleading hyperbole which dogged so many products that emerged in the ‘green consumer’ boom of the late 1980s. The Eco-label currently applies to a varied, but limited range of goods, and is awarded on the basis of a LCA which demonstrates that the product exceeds minimum environmental criteria.

Only four (25%) of the firms had conducted environmental audits, and three have proceeded to register for an appropriate standard. Just one firm, Environmental Paints, has registered for BS7750, although Gestetner have obtained the Australian Standard 3901 for quality, which was exploited in marketing the ‘Boomerang’ remanufactured toner cartridge. Osram operate to ISO 9000 and at the time of the interview were making progress towards both BS5750 and BS7750. This relative lack of formal environmental auditing and management, especially in small firms, is in broad agreement with the findings of other surveys (e.g. Barrow and Burnett, 1990). However, it contrasts with the results of the product and company LCA analysis (see Section 3), which shows that all the firms in this survey were reasonably well informed and motivated to improve environmental standards. However, it is difficult to understand how a company can produce a meaningful environmental policy without having undertaken some form of review and thus establish effective benchmark data against which progress can be monitored.

Turning to the Eco-label scheme, SC Johnson Wax were in favour of an appropriate label. It is the intention of the EU to introduce a label for hair sprays which will include aerosols and pump action sprays, and thus include their range of products. The three CFL manufacturers represented in this survey have all been actively involved in the Eco-labelling process as members of the European Lighting Companies Federation (ELC). Environmental Paints were also involved in the EU Ecolabel scheme for the paint industry, but withdrew in protest. In their opinion the minimum standard has been manipulated to accommodate the dominant companies in the sector. In their opinion, the
proposed standard did not reflect the best available technologies, and consequently they were very sceptical of the effectiveness of such a label.

The EU Eco-label for lighting is still being negotiated, and the ELC has effectively stalled the labelling process. It appears that the lighting industry prefers a comprehensive energy label applicable to all lighting rather than the CFL-only Eco-label. An energy label, they argue, could be a standardised part of product information.

Hoover was involved in formulating the EU Eco-label criteria for washing machines and aimed to attain the Eco-label for its ‘New Wave’ range of washing machines then under development. Hoover were granted the first Eco-label from the European Commission in November 1993 for the ‘New Wave’ range of washing machines, which exceeded the required levels of electricity and water consumption and detergent loss during use. (As shown by the LCA of other energy-consuming products such as lamps, the environmental impacts which arise from the production and disposal phases of a washing machine are negligible compared to the impacts arising in use.)

The reason for enthusiasm for the Eco-label at Hoover reflects its recent marketing strategy. The company were determined to move up-market with the New Wave and challenge the dominant continental European manufacturers. For Hoover the Eco-label met a particular marketing need, but for other washing machine manufacturers this is not the case and by mid 1996 none had applied, although it is estimated that many of the machines currently available would also qualify. Other manufacturers, including Hotpoint and Zanussi, were waiting for more convincing evidence of the success of the scheme and will only respond to consumer pressure, claiming that customers are unaware of the Eco-label (Smith and Potter, 1996). Moreover, a compulsory and free EU Energy Labelling scheme for many white goods was introduced in 1996, and so most manufacturers considered the marketing advantages of the Eco-label not worth its registration and annual licensing costs.

6.5 Environmental Policy and Management – Summary

In summary, some broad observations regarding environmental reporting, environmental management standards and product labelling, with respect to our sample firms, include the following:

• All of the larger firms had produced written environmental policy documents, which tended to focus on compliance issues. Most small firms relied on informal, unwritten environmental policies.

• Environmental concern and commitment is generalised but varied, but formally adopted mainly in the larger firms. Small firms tend to base their environmental approach on the philosophy of individual ‘environmental champions’, typically the owner/managing director.

• Environmental management was well established; only a minority of larger firms had failed to delegate responsibility, while the small firms general allocated responsibility to top management. However, only a few, mainly large, firms had formally adopted environmental management standards.

• Resources dedicated to environmental issues, including green product development, was increasing in the majority of firms.
• Large firms can dedicate more resources, and are more exposed to adverse publicity concerning environmental performance than small enterprises. Any manufacturer could potentially exploit some aspect of environmental performance in product promotion.
7 GENERAL CONCLUSIONS

Most studies of business and the environment have focused on company environmental policies and responses to regulation and other environmental pressures. Few studies exist of design for the environment at the product level and those which do tend on focus on case studies of ‘green’ design projects in large companies with established environmental policies. This study is therefore one of very few to examine green product development projects in small as well as in medium and large firms. However, the study was exploratory and the sample size small. The following conclusions should therefore be regarded as indicative rather than firm.

7.1 The ‘Green’ Product Development Projects

• With a few exceptions, the firms in this study did not set out to produce a ‘greener’ product. Rather most firms aimed to develop a new or improved product that would perform better, create a new market, enable them to increase or maintain their market share against the competition, or respond to market demands or regulatory pressures. Often it was only subsequently that the firms recognised the environmental advantages of their new or improved product, and used this in marketing. Environmental factors were thus taken into account in pursuit of commercial and market aims. This is in agreement with other studies which point to the importance of commercial and market pressures as one of the two main stimuli for the development of greener products. However, probably because of the nature and size of the sample, this survey shows less emphasis on existing or anticipated environmental regulation as the other main stimulus to green product development and more on the pursuit of technical or design excellence.

• In the light of the commercial aims of these projects, it is not surprising that most of the companies adopted an incremental or ad hoc ‘green design’ approach to the incorporation of environmental factors in product development. This focused on one or two environmental issues of particular concern to the firm. The firms were most often concerned with materials choice and reducing the environmental impacts of production – with the aim of conserving raw materials, limiting manufacturing waste and, for reasons of legal compliance, avoiding pollution. This was followed by concern for reducing the energy and pollution impacts of the product in use and with recycling materials at the end of product life.

• None of the firms in this study routinely adopted a systematic ‘ecodesign’ approach to product development in an attempt to reduce/balance environmental impacts over the whole life cycle of the product from ‘cradle to grave’, including both product and process impacts. However, some of the firms had broadened from exclusively considering environmental impacts of the product during either the production or the use phase to considering the environmental impacts of its materials, distribution and disposal, indicating a learning process involving a shift from ‘green’ design towards ‘ecodesign’. None of the firms, however, had considered sustainable product design. This examines the basic function or human need served by the product and alternative means of meeting it to minimise environmental damage long-term. This lack of interest in sustainable design is not surprising given the radical changes that might be involved in such an approach, including the substitution of products by services.
• This study confirms that of other work in showing that it is not necessary to have a different product
development process, nor essential to employ environmental specialists, in order to incorporate
environmental factors into product design. It is, however, important to adopt best practice in the
management of product development, in particular the establishment of team-based, integrated
approaches and good links with and involvement of suppliers.

Nevertheless, moving from an ad hoc ‘green design’ to a more systematic ‘ecodesign’ approach
involves assessing the ‘cradle to grave’ environmental impacts of the product over its total life cycle.
This may require the participation of environmental specialists in the project team from the beginning
of product development.

7.2 Commercial Outcomes

• With one exception, the firms in this sample did not attempt to sell their ‘green’ products mainly on
their ‘environmental friendliness’. Environmental performance of a product is not usually the highest
priority in terms of competitive advantage and other attributes are more crucial to commercial
success. In common with other studies of green products, this sample indicated that to be
commercially successful the products had to be competitive in terms of specification, performance and
quality. For many products value for money and/or reduced operating costs are also important factors
in customer choice. Improvements in environmental performance only become a significant
competitive factor once such levels of product performance, quality and value are attained. Products
need to work well, be of high quality and offer economic value before environmental factors enter the
list of customer requirements.

• The financial data in this study needs to treated with caution, given that detailed data was only
obtained from six of the small companies, together with sales and export data from three of the large
companies. Nevertheless some interesting tentative conclusions can be drawn.
  – The sales growth of innovative ‘green’ products can be very rapid.

  The ‘green’ products developed by small firms, achieved very high annual and total sales growth
rates, with a mean sales growth rate of nearly 200% per year. However, these small firms tended to
begin from a low or zero sales base. Spectacular overall and annual sales growth rates therefore tend
to be combined with a small market share. By comparison, where data were available for the medium
and large enterprises, sales grew by an average of 28% to 73% per year. These firms were generally
well established, with significant market share.

  – Profit margins for the ‘green’ products are broadly similar to comparable non-green products.

  The average gross profit margin of the green products developed by the small enterprises in this
survey (at 44%) is similar to the average for similar types of products from the previous Commercial
Impacts of Design (CID) survey (37% before the subsidised design project and 46% after it) and is
within the margin of error for such a small sample. This suggests that environmental features do not
add much value to a product and hence there is limited scope for firms to ‘price up’ green products.
This is consistent with the earlier conclusion that environmental factors only start to convey a
competitive advantage to a product after performance, quality and value for money are equal or
superior to other products.
Due to higher development costs, there is a somewhat longer payback period for ‘green’ products than for comparable ‘non-green’ projects.

The cost of developing the green products was higher than for comparable non-green products. Because both types of product had similar profit margins, the green products therefore experienced a longer payback period. Repayment on total investment was on average a little more than 2 years for the green products developed by the small enterprises in this survey, compared to 15.5 months for similar projects in the CID non-green sample of product and engineering/industrial design projects.

Green products do not necessarily lead to higher exports, although particular products can perform well in certain environmentally-aware export markets, where such products are already well accepted. The benchmark CID study (in which 60% of firms had <100 and most of the remainder <500 employees) showed average exports were 19% of sales, with product design projects leading to 10% exports and engineering/industrial design projects exporting over 40% of sales. The latter is the most appropriate category to compare with most of the ‘green’ products in this survey. For the ‘green’ products made by small firms, exports averaged less than 15% of sales, but there was a large range, from no exports through to a proportion in excess of 65%. Exports for the large firms also covered a large range from zero to 90%.

This result is partly because small firms tend not to be major exporters, while for the large firms exports depended on the acceptability of their product in overseas markets. But for those firms, large or small, that were operating in certain environmentally-sensitive export markets, the environmental performance of the product was often crucial and enabled them to succeed in exporting a significant proportion of their output.

It is significant that many redesigned ‘green’ products were more successful than their predecessors and that the products generally exceeded original expectations of commercial performance. Half the medium and large firms reported that the ‘green’ product was commercially more successful than the product it replaced. This is a strong result, in spite of the small numbers involved. The small enterprises were almost all founded on a single product, thus no comparison could be made. Only one firm considered that its ‘green’ product was less commercially successful than its predecessor, as the cost of the recycled polymer used for packaging was higher than virgin plastic. In this case the real benefits were viewed not at the product level, but as an investment in the company’s image and as a commitment to environmental standards, that is indirect benefits.

7.3 Indirect Benefits and Impacts

- These ‘green’ product development projects had a number of important indirect effects including the following:
  - Two-thirds of firms increased their range of products through the application of the technology or design pioneered in the green product development project.
  - Some of these firms also benefited from the substitution and application of alternative (and sometimes lower-cost) materials.
  - All 16 firms in this survey revealed positive changes in management attitudes towards environmental issues as a result of the green product development project.
– Several firms came to recognise the commercial value of the environmental advantages of their product, and this encouraged new approaches for marketing. Some green products also generated valuable free publicity.

– Some firms experienced general business expansion, requiring restructuring, following the market success of the green product.

7.4 Differences between Small and Larger Firms

• Green product development fits into the general pattern of design and innovation in industry as a whole, including the role of small and large firms, for example:

– The innovative role of small enterprises seems to apply to ‘green’ products as well as to other products. This survey indicates that the small firms were more ‘pro-active’ and generally developed more innovative ‘green’ products than the larger firms. These products were typically based on the innovative ideas of one or two individuals. Indeed some of the small firms were founded by individuals who left large corporations because of lack of interest in their product idea.

– Small firms are able to design innovative ‘green’ products for niche markets requiring relatively low levels of R & D. Larger firms tend to adapt existing products or innovations to satisfy volume markets, sometimes requiring major investments in R&D and manufacturing. However, a green product or innovative green idea developed by a small firm, if successful (or required by legislation) may be taken up and developed for volume production and marketing by larger companies.

– Green product development projects in the small firms were affected by prevalent small business problems of raising finance and developing markets. Several of the small firms experienced difficulties in raising finance to develop their green product. Two of the small businesses failed due to financial problems or difficulties in establishing a viable market for their product, although similar products were taken up for manufacture by other firms. A partnership with larger companies might be a key to overcoming such problems.

7.5 Environmental Policy and Company Strategy

• Only one of the ‘green’ products in the survey was developed directly as a part of a company environmental strategy. Most were developed in response to commercial, market or regulatory pressures, or as a result of personal ideas or technical opportunities. If there was a company environmental policy this was usually developed separately from the green product development project.

• All of the larger firms had produced written environmental policy documents, which tended to focus on compliance issues. Most small firms relied on informal, unwritten environmental policies, typically based on the philosophy of the owner/managing director. The small firms also had more difficulties than large firms in implementing a comprehensive environmental approach across all their company operations.

• Resources dedicated to environmental issues, including green product development, was increasing in the majority of firms.
• At company level, a focus on materials choice and on energy and pollution from the production and use phases was apparent. In addition, there was a concern with waste management and recycling. Although relatively few considered the environmental consequences of transport and distribution, several firms appreciated the commercial advantages of reduced packaging.

• Small companies are typically examples of ‘bottom up’ learning about the environment – from ‘green’ project to environmentally-oriented product and marketing strategies. The development of greener products, and cleaner production processes, in the larger companies was more likely to develop as a part of a ‘top down’ company or marketing strategy. In some of these larger firms, this is part of an entire strategic change, in others it is a refocusing of an existing culture.

7.6 The Future for ‘Green’ Products

Several other studies have shown that action on environmental issues in manufacturing industry has tended to focus on reducing pollution from production processes and on waste management, and has been driven by legislation. The development of ‘green’ products that have a reduced environmental impact arising from their materials, manufacture, distribution, use or disposal is still relatively rare, especially in the UK and among small companies. This study has shown that the development of green products can be a very worthwhile activity, for both small and large companies. The majority of green product development projects were commercially profitable, as well as enabling the companies to create or enter new markets. Small firms succeeded in creating new industrial/commercial niche markets with innovative ‘green’ products, while larger firms tended to develop their higher volume consumer or commercial markets with environmentally improved products. However, the study also makes clear that the environmental performance of a ‘green’ product is not usually the primary factor in its success. To succeed in the market the products had to be competitive in terms of performance, quality and economic value.

For well-designed products, good environmental performance can provide an additional attraction to customers, especially in certain export markets. This provides a commercial incentive for companies to develop green products. But for more widespread development and market acceptance of green products, and for the application of more comprehensive ‘ecodesign’ approaches, some form of regulation is likely to be needed.
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