Zero emissions from office, contract and kitchen furniture

The findings of a 2 year research project

The British Furniture Manufacturers trade association

Project partners

Technology Strategy Board

Kingston University London

GREEN WORKS

morgan

University of Brighton CENTRIM

keepmoat plc delivering community regeneration

Contents

Further information and downloadable documents can be obtained at www.bfmenvironment.co.uk

The project was undertaken between June 2006 and December 2008 by a project consortium led by BFM Ltd – the trade association of British Furniture Manufacturers. The project was co-funded by the Technology Strategy Board's Collaborative Research and Development programme, following an open competition. The Technology Strategy Board[1] is an executive body established by the Government to drive innovation. It promotes and invests in research, development and the exploitation of science, technology and new ideas for the benefit of business - increasing sustainable economic growth in the UK and improving quality of life.

[1] For more information visit www.innovateuk.org

Executive summary

The furniture supply chain involves raw material suppliers, the furniture manufacturer and the customer, either with or without retailer involvement. Historically, the UK has largely had an “open system” with regard to furniture, where virgin raw materials are required at the front end of the process and the end-of-life product is sent to landfill. The resulting system is not sustainable on a planet with finite resources and in the case of the UK, a dwindling number of holes in the ground for land-filling.

This project considered the scope to change to a closed system and to implement a range of changes in the furniture supply chain to bring about step-changes in sustainability. Particular emphasis was placed on four areas:

- **Product service systems:** reconsideration of the way in which furniture manufacturers sell their product offers the potential to decouple producers’ business success from the amount of products sold. This project has shown that there is the potential to create value from the provision of additional service rather than additional product, meaning that manufacturers no longer have to sell twice as much product (consuming twice as much resource) to double their profits. The retention of ownership of the goods by the manufacturer, leads to added incentive to invest in cleaner design to ensure that maximum benefit will be derived from the materials contained within the end-of-life products
- **Cleaner design:** the consideration of environmental issues during the design of the product is essential to reduce the impact of the product during its first life-cycle as well as ensuring that the embodied materials and resources are available at the end of the first life to become the raw materials for subsequent products. The project has demonstrated that the consideration of environmental issues during the initial design of the product is essential to reduce the impact of the product during its first life-cycle as well as ensuring that the embodied materials and resources are available at the end of the first life to become the raw materials for subsequent products. The case study regarding Morgan Contract Furniture shows that environmental improvement can go hand in hand with economic benefits associated with leaner manufacturing and increased marketability of the product
- **Sustainable procurement:** furniture purchasers have the potential to influence the supply chain by demanding environmentally sound products and services. Furthermore, such purchasers can also specify a constructive end-of-life outlet for their used furniture. This project has sought to provide the tools for contract and office furniture purchasers to enable them to take an informed view regarding the environmental credentials of furniture and the potential options at its end-of-life
- **Remanufacture**: the use of end-of-life furniture to create new products, offers an attractive route for furniture which is surplus to reuse requirements. However, a wide range of logistical, operational and marketing barriers must be addressed for the process to function in an economically viable manner. The concept has been embraced by a number of commercial organisations in the US and Green-Works proved that the process can potentially work in the UK.

1 Introduction

A range of documented research projects have been undertaken previously to reduce environmental impact within the furniture sector. These have typically concentrated on the manufacturing phase rather than the whole of the supply chain with an emphasis on specific production issues such as solvent reduction, packaging optimization and wood waste resource efficiency (BFM 2001, 2002, 2004 & 2005). The result has been the identification of best practices which offer good scope for improvement, but the change has been incremental rather than providing step changes towards sustainable production.

For example, wastage rates for board material typically average around 20%. The potential for excellent economic and environmental savings has been demonstrated. However, the bulk of material (80%) ends up as finished product, becoming waste at the end of its useful life. By definition, much greater environmental improvements can be achieved by concentrating on the 80% rather than the 20%.

Therefore, this project has focussed on the wider supply chain and ways to preserve the value of the materials embodied within furniture. The process of furniture manufacture starts with the concept of the need and the subsequent design. The manufacturing process requires a range of physical inputs which lead to the generation of the product and associated waste materials. The finished good is placed on the market, used and eventually comes to the end of its first useful life at which point it is typically disposed of. This results in an open system, which constantly requires new raw materials and the availability of further landfill capacity. Consequently, the system is not sustainable.

A feasibility study was completed in early 2006 to identify whether there was scope for significant environmental improvement in the furniture supply chain. The study concluded that good potential existed, especially with regard to 4 key areas:

- **Product service systems:** reconsideration of the way in which furniture manufacturers sell their product offers the potential to decouple producers' business success from the amount of products sold. By creating value from the provision of additional service rather than additional product, manufacturers no longer have to sell twice as much product (consuming twice as much resource) to double their profits.
- **Cleaner design:** the consideration of environmental issues during the design of the product is essential to reduce the impact of the product during its first life-cycle as well as ensuring that the embodied materials and resources are available at the end of the first life to become the raw materials for subsequent products
- **Sustainable procurement:** furniture purchasers have the potential to influence the supply chain by demanding environmentally sound products and services. Furthermore, such purchasers can also specify a constructive end-of-life outlet for their used furniture. In order to influence customer demand and disposal, consumers need to be educated regarding the environmental implications of material selection, methods of construction, product lifespan and dismantleability.
- **Remanufacture:** this option offers an attractive route for material which is surplus to reuse requirements. In order to develop an economically viable model which can be replicated on a national scale, it is necessary to address the design of

remanufactured product ranges, marketing, branding and the practicalities of moving from prototype to full production. In addition, if a remanufacturing industry is to be established with long term viability, it will be necessary to map out the expected flow of end-of-life materials over the next 25 years and consequently, a section of the project was also devoted to **material evaluation**.

Integrating these elements within a supply chain based initiative allows real progress to be made with regard to the reduction of environmental impact throughout the product life cycle. An improved life cycle model embraces a closed loop, whereby end-of-life products become raw materials for similar or other products. This means that the consumption of virgin resources is minimised, as is the requirement for landfill and other forms of disposal. The improvements are brought about through the integration of cleaner design which influences all stages of the product life cycle and ensures that the maximum value can be derived from the end-of-life product.

Some manufacturers may see this as highly theoretical thinking. However, the process has been in use for many years in other sectors and has already been employed by some of the most successful furniture manufacturers around the world such as Herman Miller, Kinnarps, Vitra and Wilkhahn. One of the challenges for this project has been to develop and adapt best practice to make it suitable for all furniture manufacturers.

1.2 The sector

The UK furniture manufacturing sector remains a significant contributor to the economy. It employs around 120,000 in an estimated 7,700 companies (CSIL, 2003). The value of UK furniture production is around £5 billion, with total consumption of £7 billion once imports and exports have been accounted for.

It is estimated that domestic furniture manufacturers annually consume 2.3 million tonnes of wood material such as solid timber and board (BFM, 2005), of which around 525,000 tonnes becomes waste. A further 2 million tonnes of wood waste is estimated to arise from the sector in the end-of-life furniture waste stream (BFM, 2004). Other important raw material and waste streams include foam, fabric, packaging and wood coatings.

This project has concentrated upon contract, office and kitchen furniture, which together account for around 45% of UK production. These sub-sectors account for the bulk of the furniture waste arising in the commercial and industrial waste streams – the areas which fell within the scope of the TSB funding call. In addition, these appeared to be the sub-sectors with the greatest potential for the adoption of innovation for reasons such as the pressure from corporate consumers and the practical issues such as the movement of large batches of similar products / materials offering scope for economies of scale.

2 Product Service Systems

2.1 Introduction

Most furniture manufacturers will not be familiar with the term “product service systems” – but it simply refers to the various ways of doing business. Products and services together meet customer needs, yet they are often delivered separately. Most furniture manufacturers have traditionally used the most basic product service system (PSS), simply selling the furniture and to a large degree, washing their hands of it.

Alternative PSS’s can be used to reconfigure the relationship between products and services so that they are delivered jointly via a single offering. Viewing the product-service mix more holistically in terms of PSS could potentially result in customer needs being met more effectively, more economically and with reduced environmental impact.

The traditional furniture business model involves selling furniture to make a profit. If a company wants to double its profits, twice as much furniture will need to be sold. This will consume twice as much raw material, meaning that increased profit essentially leads to increased environmental impact.

Alternative product service systems look to add value through service rather than material consumption. If successful, they will decouple profit from resource consumption, a vital element of sustainable production.

Three categories of PSS can be identified (Verkuijl et al, 2004).

- Product oriented PSS: traditional situation where the product is owned by the user / consumer. The provider offers *additional services*, mainly for the product sold, e.g. maintenance, guarantee, and take-back at end-of-life.
- Use oriented PSS: the product is owned by the service provider who sells *functions* instead of products, by means of modified distribution and payment systems, e.g. sharing, pooling and leasing. The provider no longer sells the product, but only its usage.
- Result oriented PSS / system optimisation: here the provider sells a *benefit.* The product is owned and run by the supplier, who has an incentive to intensify and optimise the product's operation and increase its service life. E.g. Product Substitution Service - products are substituted by new services or Facility Management – where the supplier gives the customer incentives to consume more efficiently, optimising the system, e.g. by using modified payment systems such as contracting

2.2 The benefits of alternative PSS’s for the furniture sector

The adoption of alternative PSS’s could have a number of potential benefits for the furniture supply chain:

- Development of an ongoing relationship between the manufacturer and user, encouraging product and manufacturer loyalty, thereby increasing the likelihood of future purchases
- Generating ongoing revenues through the provision of services, rather than a one-off sale price from the simple selling of the product
- Maintenance of the product in optimal condition – helping to improve the client's perception of the product and by association, the manufacturer
- If the product incorporates the principles of cleaner design, there may be scope to harvest valuable resources from the end-of-life product, if it is traded-in by the customer or if ownership is retained by the manufacturer
- Equipping the manufacturer to deal with future producer responsibility legislation. Producer responsibility is the concept of making producers responsible for meeting the end-of-life costs associated with the recycling of product after a customer has finished with it. Such regimes already exist in the UK with regard to packaging[2], electronics[3] and end-of-life vehicles[4]. It is widely predicted that requirements will spread to other areas such as furniture in the future.
- Customer pressure: an increasing number of UK & EU public procurement initiatives are encouraging the move towards sustainable products, with end-of-life product management being an important consideration
- Creating additional market opportunities through a more sustainable business model which decouples profit from resource consumption

2.3 How could alternative PSS's work for the furniture sector?

Alternative PSS's could potentially be adopted by the sector in a number of ways. At their simplest level, product oriented PSS's would involve the manufacturer continuing to sell its product as normal, with the addition of services such as:

- Refurbishment: occasional cleaning and repair of products either in-situ or when returned to base. This refurbishment might extend to changing the upholstered sections of chairs to remove stains &/or update product colours.
- Extended warranty: an extended period of providing repair in the case of breakage or damage
- Take-back: the provision of a trade-in value for old furniture when the customer purchases new product from the same supplier

The next level of complexity would involve "use oriented PSS's" where the provider no longer sells the product, but only its usage. Typically through an arrangement with a finance house, the customer will effectively buy a service such as the provision of office desking and seating for a set number of people. The furniture will remain the

---

[2] Producer Responsibility Obligations (Packaging Waste) Regulations 2007

[3] Waste Electrical and Electronic Equipment Regulations 2006

[4] End-of-Life Vehicle (Producer Responsibility) Regulations 2005

property of the manufacturer &/or the associated finance house. By retaining ownership of the product, the manufacturer has a vested interest in designing, manufacturing and servicing the product in a manner which preserves the value of the embodied resources and energy within the product.

The preservation of the embodied resources can only be fully exploited if a company embraces cleaner design principles. If a product integrates good quality components, it potentially becomes worthwhile to use them not just for the first life, but also for subsequent products. This process only becomes viable if the product has been designed for disassembly, otherwise the labour cost associated with disassembling the product will outweigh the economic benefit of reusing the components.

Discussions with a range of players from all parts of the furniture supply chain were held in a number of workshops. The potential of leasing, particularly as a driver of effective product take-back and remanufacture, was acknowledged, but a number of challenges were identified. Some of these were thought surmountable (initiating new partnerships and developing new capabilities; promoting and marketing leasing); some less so (the relatively low initial and residual value of furniture). Yet precedents do exist, particularly in the US, and in the words of one manufacturer; “I just think it may be the way that you might have to win orders in the future.” This will certainly be the case if producer responsibility obligations extend to products such as furniture &/or if the EU Green Public Procurement requirements become widely adopted (see section 6.1)..

2.4 Conclusions

The use of alternative product service systems has the potential to contribute to step changes in the sustainability of the furniture supply chain, through:

- Development of alternative service packages to add value to the basic product including take-back, leasing, contracting
- Increasing the reuse, refurbishment and remanufacturing potential of furniture. This would include the optimisation of furniture design, component fixing and labelling systems
- Decoupling profit from resource consumption

However, there are barriers, not least of which will be the challenge of convincing both manufacturers and consumers of furniture that there are significant benefits of shifting away from traditional product purchasing.

2.5 Project reports

For more detail on the project results regarding PSS’s, please see the following publications:

- Identification of current product service systems employed by UK furniture manufacturers
  http://www.bfmenvironment.co.uk/images/DTI/Task%201.1.pdf
- Identification of alternative product service systems
  http://www.bfmenvironment.co.uk/images/DTI/Task%201.2.pdf

- Feasibility evaluation for the furniture manufacturing sector http://www.bfmenvironment.co.uk/images/DTI/Task%201.3%20-%20final.pdf

Figure 1: End-of-life contract seating with the potential for remanufacture

3 Cleaner design

3.1 Introduction

It is only possible to minimise the environmental impact associated with the manufacture of a piece of furniture if cleaner design principles have been embraced. Similarly, the end-of-life impacts can only be minimised if the embodied energy and resources within the product can be preserved – again a function of cleaner design.

For the purposes of this project, five items of office, contract and kitchen furniture were selected:

- Stacking chair
- Office desk
- Tub Chair
- Public seating
- Kitchen unit

Work was undertaken with a manufacturer of each product to quantify the environmental impact of an existing typical model. The measuring technique followed the principles of the Life Cycle Analysis methodology in accordance with ISO 14040. The process enabled the identification and quantification of key factors from the cradle to the grave of a product, which have an environmental impact. A team with environmental management and furniture design expertise subsequently worked with each manufacturer. Their remit was to redesign the product to provide similar or improved functionality whilst significantly reducing environmental impact. New product concepts, prototypes and in one case a full product line, were generated and the effects on the environmental impact of the new product were quantified.

The successful elements of re-design varied according to the product. A summary is provided below and full details for individual products can be accessed through the references in section 3.5.

3.2 Waste management hierarchy

When considering such design, it is worth noting the waste management hierarchy - a series of options for managing a waste (and also a raw material) in order of decreasing environmental and economic preference:

- Eliminate: try not to use the material &/or produce the waste in the first place – challenge the assumption that it is unavoidable
- Minimise at source: reduce as far as possible
- Reuse: is it possible to reuse the material? A classic example of reuse is the traditional milk bottle. It takes less energy and significantly less material to collect, wash and refill a bottle than it does to make a new one. The technique preserves the embodied materials and energy of the original product
- Recycle: reprocessing for reuse will typically require more energy than the previous options, but it does capture materials for further use and in the case of

substances such as aluminium, it takes significantly less energy to recycle than it does to process the virgin materials

- Recover: recovering value in some other means such as incineration with heat recovery or composting. This will typically provide less value and in the case of incineration, will destroy the raw material leading to the release of carbon
- Disposal: the least favoured option is disposal to landfill or incineration without heat recovery. Such processes destroy the value of the embodied raw material and energy. Both techniques will also lead to the release of carbon.

3.3 Cleaner design considerations for furniture

A wide range of considerations can be relevant with regard to the cleaner design of furniture. These include:

- Material intensity
- Material selection
- Longevity
- Disassembly
- Reduce releases

3.3.1 Material intensity

It is often environmentally beneficial to minimise the amount of resources needed for a given product. For example, kitchen base units traditionally consist of a series of boxes placed side by side. The material intensity can be greatly reduced by avoiding the duplication of the side panels and reconsidering the amount of material that actually needs to be included in the top, base and back of the unit – i.e. the bits that will not be seen. The structural function of such elements can be achieved through the use of a limited number of supporting rails &/or through alternative methods such as the greater use of walls to support the unit.

Typical issues to consider with regard to material reduction are the specification of the correct gauge of material and avoidance of duplication. The process is often known as “light-weighting” and results in a requirement for less material per product. As well as the direct benefits of lower material consumption, the reduction can lead to lower transport costs and impacts as well as a need for less packaging as the amount of drop protection will be lowered.

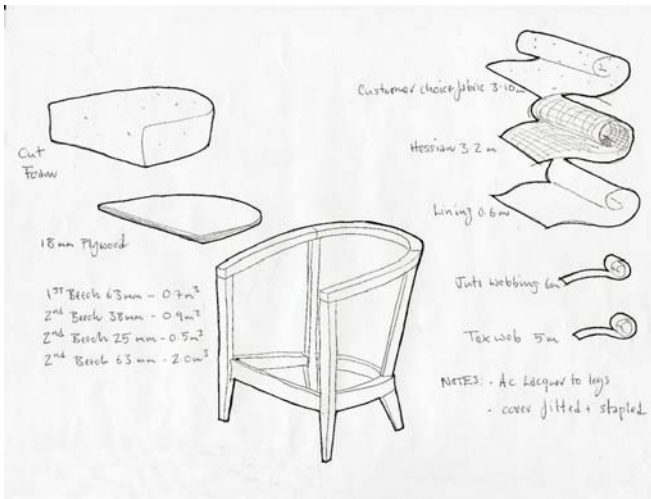


Figure 2: tub chair construction before cleaner design enabled a 51% reduction in chair weight (see section 3.4)

This will normally be a good thing in a world of finite resources. However, there will also be occasions where the benefit of using more material will outweigh the environmental impact of the consumption. For example, increasing the amount of material used in a product and components may lead to increased lifespan, improved potential for subsequent reuse and less likelihood of failure in use, with the avoidance of the environmental costs of premature repair or disposal.

3.3.2 Optimise material selection

Raw material selection has a range of environmental implications. Materials vary greatly in terms of issues such as:

- Are they renewable or based on fossil fuels? Wood based products are typically good things to use from an environmental perspective
- Are the materials good carbon performers or do they contribute greatly to the carbon footprint of a product? Replacing metal with wood is environmentally sound because of the relative carbon neutrality of wood, with knock-on benefits such as the fact that waste wood can be used for heat generation in furniture factories, thereby displacing fossil fuel use
- Are the materials from sustainable &/or certified sources? Plenty of information is available regarding timber certification. The objective of the various certification schemes such as that operated by the Forest Stewardship Council (FSC), is to create an auditable trail between a sustainable forest and an end product
- Do products contain a good recycled content where applicable? The UK puts a significant amount of effort into encouraging businesses and domestic individuals to undertake recycling. However, this is pointless if there is no outlet for the recyclate. Those who specify products and packaging have an important role to play in using recycled content where this is available at the same or lower cost with the same or better performance.
- Are they reusable or recyclable at the end of their life?

- Are appropriate labels used to identify material types? This is especially important for plastics that are often difficult to identify and which need to be segregated for recycling.
- Are products joined in a manner that makes it easy to dismantle, refurbish and upgrade?

3.3.3 Increase the useful lifetime of embodied resources

Resources are finite so there is a need to reduce the amount we require. Ways of achieving this goal include designing for long life, refurbishment, reuse and then recycling, i.e. in a way that "borrows" resources from the environment and returns them to the economy as a usable resource.

In addition to physical durability, consideration should also be given to *aesthetic* or *emotional* durability. Too often, pieces of office and contract furniture are deemed to be obsolete simply because the customer has tired of the design. The incorporation of timeless designs will help to ensure that the useful lifetime of embodied resources is not shortened simply by the producing becoming "uglied out". Similarly, the design of items to enable a swift makeover will prolong its life by ensuring "emotional durability". An example is provided by Morgan Contract Furniture Plc, which has designed a range of tub chairs with the outer fabric being kept in place using Velcro. Thus, it is a simple task to replace the covers if they are dirty or if a different colour scheme is required.

3.3.4 Disassembly

Once a product has reached the end of its first useful life, disassembly allows the resources incorporated within it to be released for further use. In accordance with the waste management hierarchy, this would ideally be through reuse followed by recycling. Labour costs will quickly outweigh the value of furniture components unless products have been designed so as to facilitate disassembly.

3.3.5 Reduce releases

Consideration should be given to minimising the quantity and environmental impact of any production residues and by-products or any releases from the product when in use. Examples issues for furniture include:

- Wood waste: optimisation of product design, raw material purchasing and production to minimise the amount of waste arising and ensure that it is reused, recycled or recovered where unavoidable
- Formaldehyde: typically used in the manufacture of board material such as chipboard, as part of the resin that binds the wood particles together. There are health concerns with regard to exposure to formaldehyde. In reality, any board bought from UK based manufacturers supplied by UK based board mills, will be specified as "E1 – low formaldehyde"
- Volatile organic compounds (VOCs): solvent borne wood coatings (stains and lacquers) will contain a range of VOCs such as xylene and toluene. These are designed to transport solid particles onto the furniture during spraying and then evaporate off to leave the desired finish. VOCs are of environmental concern due to their contribution to photochemical smog. Alternatives to solvent borne coatings include water borne (which will still contain some solvent) and ultra-violet cured coatings. Although these alternatives lead to reduced solvent

emissions, there will typically be side effects such as a requirement for the forced drying of water borne coatings which consumes energy.

3.4 Morgan Contract Furniture: tub chair redesign case study

Figure 3: tub chairs before and after redesign - showing that the process had no impact on product appearance

Morgan Contract Furniture is a company which designs, makes and delivers timber based seating and tables for the contract market, mostly in leisure areas such as cruise ships, hotels, clubs and restaurants.

Among the company's product range is a low backed tub chair sold widely to clubs and hotels for use in bedrooms and reception areas.

It has a solid beech frame, joined with dowels and reinforced with glued and screwed glue blocks. The cut foam back is supported on a webbing and hessian platform. The cut foam seat is supported on 18mm birch plywood. The upholstery cover of 50:50 cotton and polyethylene is sewn and then stapled directly to the beech frame. The finish is a solvent-based stain (when colour is specified) and an acid catalysed high build lacquer to show wood parts. The existing product is approximately 69% wood, 24% fabric, 6% foam, and 1% other plastic.

The company wanted to redesign chair the chair to give similar appearance and functionality whilst reducing environmental impact. The redesigned product uses less material, reducing the weight of a chair from 52kg to 25 kg (a 51% reduction).

Figure 4: Environmental impact of tub chair redesign

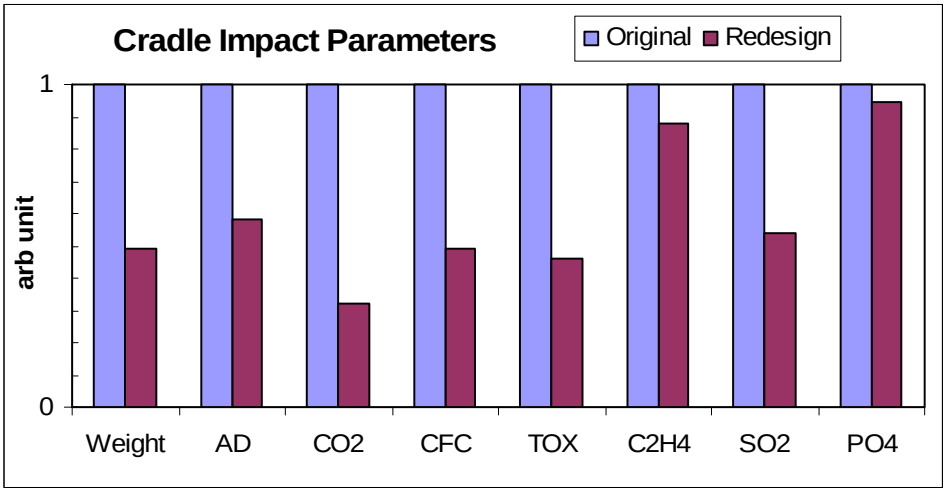
Original Tub Chair	Weight (kg)	Redesign Tub Chair	Weight (kg)
Beech	28.700	Beech plywood	4.900
Birch	6.754	Pressed timber	8.400
Foam	3.240	Beech wood	2.38
Upholstery	6.076	Foam	3.240
Jute	6.214	Fixings	0.080
Polyethylene	0.113	Upholstery	6.076
Polypropylene	0.103	PE	0.105
Rubber	0.313	Other	0.119
Other	0.087		
ORIGINAL	**51.6**	**REDESIGN**	**25.3**

The reduction in weight in the redesign concept comes from less wood product and natural lining used. The board has been replaced by plywood and particleboard. Plywood is a material consisting of veneers (thin wood layers or plies) bonded with an adhesive. For the chair, beech plywood is used.

Life cycle analysis was conducted on the original and redesigned products. The life cycle is split into various sections (for a full explanation see reports referenced in section 3.6). The first is the "Cradle" which considers impacts associated with the raw material processing and furniture manufacturing process. This shows that the redesigned chair performs better in all categories:

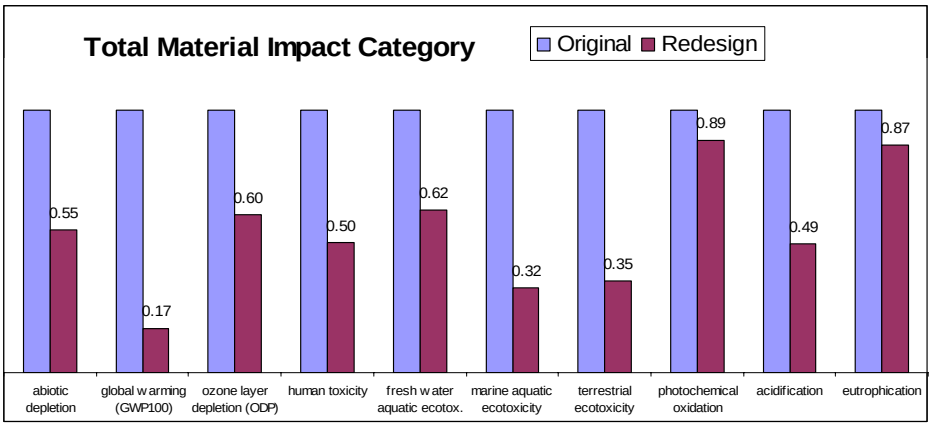
- Abiotic depletion (AD): related to the extraction and use of non-renewable resources such as minerals and fossil fuels
- Carbon dioxide release (CO2): contribution to global warming
- Ozone layer depletion (CFC): the impact on upper atmosphere ozone levels leading to increased ultra violet radiation penetration at the Earth's surface
- Human toxicity (TOX) concerns effects of toxic substances on the human environment
- Acidification (SO2): contribution to pH reduction in the environment
- Photochemical oxidation (C2H4): contribution to photochemical smog formation
- Eutrophication (PO4): also known as nitrification, this is the impact associated with the over-enrichment of the environment with resulting in excessive growth of organisms and depletion of oxygen concentration

Figure 5: Cradle impact parameters



The Total material (=cradle + disposal) impact categories are compared for both chairs. The data is relative to the original with categories normalized to unity as above. The allocations for disposal at the end-of-life for both chairs are similar. The pattern for the Total is similar to that for the Cradle.

Figure 6: Total material impact category

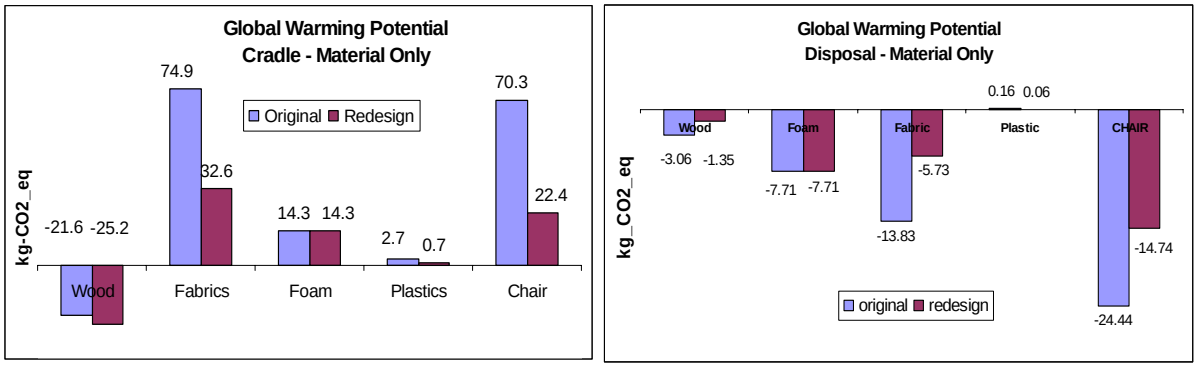


Carbon footprint

The Cradle GWP or material input carbon footprint is 70 kg CO2 _eq in the original chair. The redesigned chair has a cradle GWP of 22 kg CO2 _eq which represents an 80% reduction and meets the emission target reduction in line with the UK's 80% reduction in CO2 emissions by 2050.

The LCA with disposal consideration is 46 kg CO2 _eq in the original and 8 kg CO2 _eq in the redesign. The negative contribution to global warming is due to the use of neutral carbon wood and its caloric value. The reduction in fabric in the redesign is reflected in the GWP.

Figure 7: Global warming potential



3.5 Conclusions

Environmental design is integral to the minimisation of the production impacts for a piece of furniture as well as being essential to achieving the economic release of resources at the end-of-life phase. Work with the participant companies showed that significant environmental improvement can be achieved and this will often be accompanied by economic benefits.

3.6 Project reports

For more detail on the project results regarding environmental design, please see the following publications:

- Product market analysis of the UK wooden furniture market http://www.bfmenvironment.co.uk/images/DTI/Work%20package%202.1%20Final.pdf
- Examples of good environmental practice in furniture design, manufacture and supply http://www.bfmenvironment.co.uk/images/DTI/Work%20package%202.3%20Final.pdf
- Lessons in the environmentally sensitive redesign of office, contract and kitchen furniture http://www.bfmenvironment.co.uk/images/DTI/Task%202.6%20-%20final%20report.pdf

Figure 8: An end-of-life divan being sent to landfill in a skip of mixed material

4 Material evaluation

4.1 Introduction

A large amount of material contained within furniture arrives at the end of its useful life each year in the UK. It is estimated that around 2 million tonnes of wood waste arises in this manner each year (BFM, 2004), in addition to the weight of other important constituents such as foam, fabric, packaging and wood coatings.

The materials available for remanufacturing in future years are determined by those which have been integrated into furniture products in the preceeding years. Expected lifetimes of furniture vary greatly depending upon the type and the application. For example, office seating will typically have a lifespan of 5-10 years whereas office desks might be expected to last for 15 years.

This work package focussed on the main types of office and contract furniture:

- Office chairs
- Office desking and pedestals
- Contract kitchens
- Contract seating
- Contract bedding

4.2 Scale of consumption

- Office chairs are defined as task chairs with a 5 star base which can swivel. PRODCOM (2005a) figures suggest 1.52 million UK manufacturer swivel office chairs sold annually in the UK with UK manufacturer sales worth £159 million p.a. One of the project participants, Orangebox Ltd, accounts for around 200,000 of these chairs each year. A great variety of office chairs are available on the market with retail prices ranging from under £30 to over £1000 each.
- Around £325 million worth of office desking and pedestals are sold each year. The vast majority of products are based on melamine faced chipboard. According to PRODCOM (2005e), UK manufacturer sales were around 2.9 million desks and pedestals in 2005, with imports accounting for a further 0.3 million.
- UK sales of kitchens are estimated at 1.05 million p.a. PRODCOM (2005b) figures suggest UK manufacturer sales of 17 million wooden units with a further 6 million wooden non fitted units. Melamine faced chipboard is the main constituent, most of which is thought to end up in the commercial waste stream with professional installers being responsible for removing the majority of existing kitchens.
- Contract seating includes seats for hotels, cruise ships, leisure facilities and stadia. The size of the contract seating market is very difficult to estimate. However, it is likely to account for at least one quarter of the total contract market, i.e. around £360 million.

- According to PRODCOM (2005c) annual sales of mattresses run at around 5 million units p.a. UK net supply at manufacturer selling prices were estimated at £579 million in 2005. A proportion of this production will be for the domestic environment, with the remainder for contract markets. On the basis of sub-sectoral turnover, it is assumed that around one third of the total is destined for the contract market to be used in facilities such as hotels, education facilities and prisons.

4.3 Material contents

Work was undertaken to analyse the type and weight of materials contained within a selection of typical items from each of the product categories. For example, office chairs have a number of components:

- Base: the five star base will typically be made of plastic (polypropylene) for budget chairs, painted metal or aluminium (premium chairs) and plastic castors
- Mechanism: made from steel, the mechanism will join the base to the seat and will hold the controls for seat adjustment. It will also have the back support brace fixed to it. Control levers may be steel or nylon reinforced polypropylene. Some are now given a coating with a different type of plastic compound to provide better tactile qualities such as a rubberised surface.
- Seat: this will have an outer covering of fabric overlying foam which is placed on or moulded over a solid plastic inner. Fabric may have a drawstring as well as being glued to the foam (to preserve the required contours).
- Back: similar to the seat in terms of construction, this will have fabric and foam supported by a plastic inner. The back will typically have an outer plastic shell at the rear. Alternatively, certain chairs have a mesh back with an outer support

Analysis of a standard swivel chair showed the following breakdown of materials:

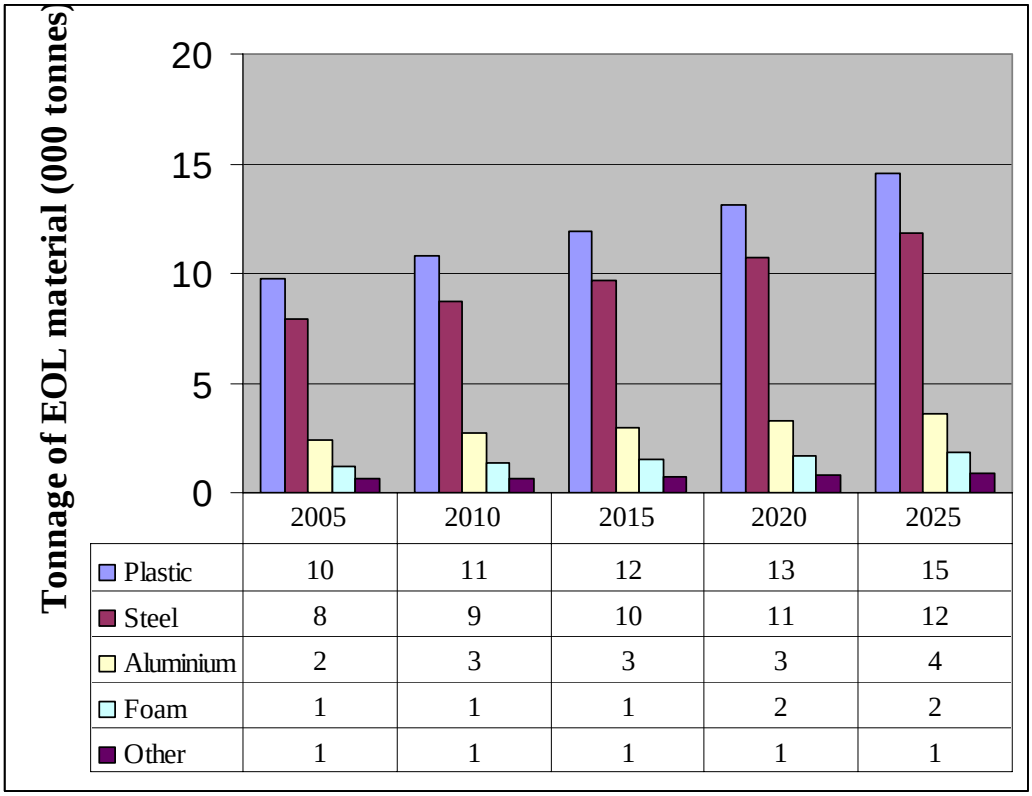
- Plastic 8 kg (polypropylene, nylon and polyester)
- Steel 6.5 kg
- Aluminium 2 kg
- Foam 1 kg
- Other 0.5 kg
- Total 18 kg

This standard form of chair represents the bulk of the market, with a life expectancy of perhaps 5-10 years. Higher value chairs will typically have less plastic and more aluminium &/or steel. They will also have a greater life expectancy

If this breakdown is taken as representative of the sub-sector, a 10 year lifespan is assumed and a 2% p.a. growth rate is projected[5], it is possible to estimate the amount and type of material which could be expected from EOL office chairs between 2005 and 2025.

[5] Based on suggestion of BRA, 2006

Figure 9: Estimated end-of-life material arising from office chairs 2005-2025



	2005	2010	2015	2020	2025
Plastic	10	11	12	13	15
Steel	8	9	10	11	12
Aluminium	2	3	3	3	4
Foam	1	1	1	2	2
Other	1	1	1	1	1

4.4 Available materials

The fact that products and materials are expected to reach the end of their first useful life at a specific time, does not necessarily mean that the materials will be harvestable for further use. A range of barriers can potentially hinder productive end-of-life material utilisation for example in the case of office chairs:

- Fabric: will become faded and stained over time.
- Foam: may loose its shape and develop compressions from frequent use
- Castors: will quickly have a worn appearance if used on hard or rough surfaces
- Mechanism: will develop looseness or “play” over time, e.g. in the back fixing

Therefore, for many items the reuse potential will be limited – and this will continue to be the case until new products, designed for disassembly, have worked their way through the supply chain and start to arise as end-of-life furniture. Therefore, recycling will often be the best option for such items. Other barriers include:

- Logistics: who will undertake the reuse, refurbishment, remanufacturing, recycling and recovery? Manufacturers have shown a reluctance to handle such items on the basis that they are furniture makers not waste managers
- Hygiene concerns: potential for contamination of new products
- Logistics: transport, labour and space costs associated with the collection of materials

- Uncertainty of supply: variable sized batches, in different states of disrepair will arise in various locations. These will typically include items made by a range of manufacturers
- Identification of materials: this can be a problem with regard to unmarked plastics
- Value / use of materials: concerns about a lack of reliable outlets for harvested materials
- New product displacement: manufacturers of new furniture naturally fear the erosion of their traditional markets by an increased supply of reused and remanufactured product.

4.5 Conclusions

The project considered the EOL material arising from five categories of contract and office furniture. The combined sales value (2005 manufacturer selling prices) of these items was £1,146 million, which represented around 53% of the estimated £2,149 total value of office and contract sales.

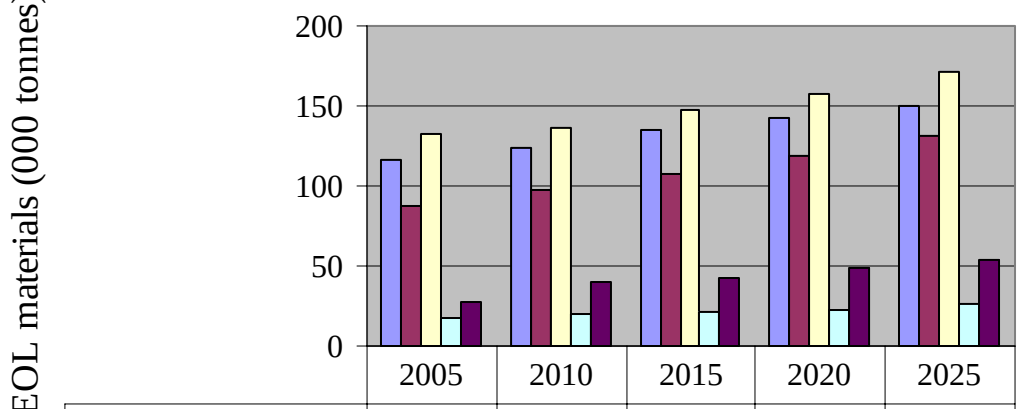
The analysis showed that a range of materials were important in the construction – and hence EOL material arisings – from contract furniture. This reflects the wide range of furniture types which are included within the "contract" market. The findings contrast those of a previous study by BFM (2004) which concentrated on domestic furniture and concluded that wood based materials dominated EOL arisings.

Figure 10: Summary of new supply and end-of-life material arisings in 2005 for 5 categories of furniture

Sector	New sales		EOL material arisings in 2005 (000 tonnes)					
	Value (£000)	No. of items (000)	MFC	Solid wood	Metal	Plastic	Foam, fabric & filling	Total
Office chairs	£159,000	1,520	0	0	10	10	1	**21**
Office desking & pedestals	£325,000	2,900	65	0	42	2	0	**109**
Contract kitchens	£111,000	4,400	51	0	0	0	0	**51**
Contract seating	£360,000	5,000	0	88	59	6	12	**165**
Contract bedding	£191,000	1,650	0	0	22	0	15	**37**
Total	**£1,146**	**15,470**	**116**	**88**	**133**	**18**	**28**	**383**

If such a breakdown of materials is taken as being representative of the office and contract market, the total amount of EOL material arising from these sub-sectors can be extrapolated on the basis of turnover, as demonstrated in the graph below.

Figure 11: Estimated end-of-life material arising from office and contract furniture 2005-2025



	2005	2010	2015	2020	2025
MFC	116	124	135	142	150
Solid wood	88	98	108	119	131
Metal	133	136	147	158	171
Plastic	18	20	21	23	26
Foam, fabric & filling	28	40	43	49	54

EOL material arisings of 383,000 tonnes are predicted to have arisen in 2005, a figure which will rise to 532,000 tonnes by 2025 if business as normal is pursued. The lifespan of the office and contract products considered in this report ranged from 5 to 15 years. Consequently, the majority of EOL arisings until 2015 are already in the system. This means that action on environmental design taken today could start to produce benefits in 2015 to 2020, leading to a reduced tonnage of material destined for landfill and an increase in refurbishment and remanufacturing. The latter two options are currently insignificant in the market place.

4.6 Project reports

For more detail on the project results regarding environmental design, please see the following publications:

- Calculation of material availability in end-of-life furniture within the UK over the next 25 years http://www.bfmenvironment.co.uk/images/Task%20%203.1a%20-%20summary.pdf
- Standard procedure for site operatives to enable efficient identification, removal and storage of re-workable product from a 'batch' http://www.bfmenvironment.co.uk/images/Task%203.2a.pdf
- Matrix of 'reworkability' to enable remanufacturing organisations to evaluate batches scientifically http://www.bfmenvironment.co.uk/images/DTI/Task%203%203a.pdf

5 Remanufacturing

5.1 Introduction

Remanufacturing can be defined in a number of ways. For the purpose of this project, the objective was to understand the process of disassembling furniture products with the intention of utilising the materials for the manufacture of alternative furniture products. Green-Works undertook the work package for this project. Alternative models of remanufacturing exist, e.g. where components are reformed back into the original product and also where a closed loop is formed because the work is undertaken by the original product manufacturer.

As per the waste management hierarchy (section 3.2), the reutilisation of component parts in their original form will be the preferred technique as it preserves the value of the embodied materials and energy. However, in the case of the material being handled by Green-Works, this was not a viable option. Reprocessing remanufacturing techniques were applied to products which could not be reused (the traditional Green-Works activity) due to an over-supply relative to demand. Therefore, the utilisation of the component parts to form new products, potentially represented the best practical environmental option for the material.

5.2 Prototype design

No past examples of commercial furniture reprocessing remanufacturing were known to exist in the UK. Therefore, the starting point for Green-Works was the development of a range of potential furniture designs. The five products designed were:

1. Cube storage system
2. Home study desk
3. Kiddi Furniture
4. BekCase (modular bookcase)
5. Flying Carpet

A number of common design criteria were incorporated within the prototypes:

- Small panel sizes: this made it easier to derive the required panels from end-of-life material. A particular problem with the latter was its variability in terms of panel size, defects and the presence of holes from previous fixtures and fittings
- Simple construction enabling flat pack distribution. Consequently, the products could be shipped around the UK rather than catering for Green-Works more traditional markets within the local catchment area served by the company’s own vehicles
- Derived from panel thicknesses and materials most commonly associated with office desking – i.e. 18 & 25 mm

- Value added products – to offer innovative design or to open up new market niches. There was little point in trying to compete with commonly available and mass produced items dominated by extremely cheap imports.

5.2.1 Cube storage system

The Cube storage system comprised simple cubes of melamine faced chipboard which form a modular storage system with the potential to be extended as required. The attractions of the product were:

- The potential to produce a value added product with an innovative design
- Simplicity: the product simply required 4 square panels
- Utilisation of relatively small panel sizes

Four different sized cubes were produced with a maximum panel size of 500 x 350mm. The product subsequently proved popular both in store and also when sold over the Internet.

5.2.2 Home study desk

This was a simple slab sided desk, it used MFC for the sides / feet rather than a metal structure. The desk was of modest dimensions 1000 x 600 mm which reflected the needs of the domestic market and again, made it suitable for manufacture from standard end-of-life office desk top sizes (for which 1600 x 800 mm is an industry standard). A desk of such size was principally designed for use with a flat panel monitor or laptop, which increasingly dominate the home office screen market. The design enabled the desk to be dispatched in a flat pack manner – thereby facilitating national distribution.

5.2.3 Kiddi Furniture

Furniture aimed at children naturally uses smaller panel sizes and if the design is innovative, it opens up higher value markets. In addition, children will want colourful furniture (e.g. red, blue or yellow) which enables paint to be applied to any colour of incoming panel to disguise the original colour of the end-of-life material. The range potentially has the additional benefit of enabling coloured surfaces to be offered. Three types of products were prototyped: a chair, a stool and a desk. These were made from reclaimed MDF, which has the benefit of allowing curved profiles to be offered, creating a softer feel to the product and potentially reducing the scope for injury.

5.2.4 BekCase

This was a modular book case with a base consisting of a 1200mm wide unit with a height of 875mm. Onto this base unit could be added additional 1 or 2 shelf units. The led to the ability to create a large unit from relatively small panel sizes.

5.2.5 Flying Carpet

This was a very different type of product intended to be derived from heat treated carpet, with Green-Works receiving a potentially large supply of carpet tiles which could be used to form the raw material. In reality, this product failed to make it past the prototype stage.

Figure 12: The Bekcase (left) and a set of 6 cubes

5.3 Prototype manufacture

The first four product ranges made it through the prototype design and onto the manufacturing stage. A range of alterations were made to the initial designs in order to facilitate progress from prototype production to items which could potentially be made on a larger scale. One problem identified at this stage was the tendency of the product range to balloon, with many variations of a given item coupled with a tendency to produce bespoke items for individual customers. For example, even for the simple home study desk, over 30 specifications were designed (with variations in colour, size, style and the presence of cable management options etc). With hindsight, product ranges would have been greatly limited and bespoke items would not have been offered.

Once the design and production teams were happy with the specification, the items were sent for testing at the furniture laboratory of Mamas and Papas. This was an extremely useful process which identified a number of problems associated with methods of construction and the durability of the finishes applied to the kiddie furniture.

5.4 Cost benefit analysis

An investigation was made into the economic merits of producing batches of furniture using reclaimed materials compared to virgin materials. This was based on the manufacture of 50 cubes and 40 desks by each method with the intention of allowing the comparison of raw material costs, labour and machine time. The study also enabled an assessment to be made of any limitations associated with the use of reclaimed material, along with any reduction in the selling price of the finished product.

After producing identical runs of furniture with reclaimed MFC and bought in MFC, it was established that at the existing price points of £35 retail per desk and £20 retail per cube:

- Reclaimed cubes would generate a profit margin of 32.25%.
- New MFC cubes would not generate a profit.
- Reclaimed desks would generate a profit of 47.48%
- New MFC desks would generate a profit of 10.61%

5.5 Upscaling production

Particular problems were experienced by Green-Works regarding the upscaling of production and the associated shift from prototype production to mainstream production. Not surprisingly, many of the issues stemmed from the variability of the incoming raw material streams in terms of the size, thickness, colour, damage, previous fixing marks and the quantity of desktops.

Problems were experienced when trying to produce customer orders from material which had been recently received, with mismatches in material supply and demand. Therefore, an initiative was undertaken to cut down incoming desktops into stock panels of specified dimensions. This enabled better control of stock levels and the generation of a stock inventory. Housekeeping improved as a result of stock racking and palletisation – leading to increased productivity. In addition, the sorting of material enabled sales staff to quickly identify wood available to complete orders leaving them less reliant on the joinery staff to close a sale.

5.6 Company branding

A company's "brand" is its identity and personality. A brand is made up of everything which expresses a company's values. This goes beyond product and service quality. A customer buying a product is also investing in the values and principles of the company *behind* the product. (Olins 2003; Charter et al 2002).

A four step strategy was employed with Green-Works to address the issue of branding:

- An analysis of the existing brand, seen internally and externally
- A restatement of the company's core values, strategic priorities and the identification of the "brand story"
- Targeting of product types and sectors
- Development of a brand identity and communication design route which captures the brand story, is appropriate for the identified target markets and moves away from the traditional visual and verbal language of "green" communications.

Green-Works had a "brand", in terms of its reputation and the values attached to the company by its clients (furniture donors) and customers (furniture buyers). It was clear that the brand was centred on the collection of "waste" furniture and its redistribution to good causes at low cost (logo strapline: *"Making waste work for the community"*). This identity failed to capture other important aspects of what Green-

Works does and stands for. The new product design and remanufacture venture provided an opportunity for an updated branding effort.

The Green-Works approach to communicating its existing brand had also not been very sophisticated and embodied the conventional verbal and visual languages of green communications. There was also inconsistency in applying this identity across different media and platforms (web, print, electronic presentations etc.).

Green-Works management restated the company's core values and strategic priorities. This highlighted an inconsistency between (1) how it perceived itself and wanted to be perceived, and (2) how it actually *was* perceived externally. The Green-Works brand needed to better express the company's actual capabilities and aspirations.

"Green-Works is an award winning social enterprise which is radically changing the way society thinks about waste. We ensure that redundant office furniture from the commercial world can be made readily available for re-use and remanufacture. By preserving valuable resources, we protect the environment, create real jobs and help regenerate communities across the UK." (http://www.green-works.co.uk)

The challenge was to move Green-Works from a company providing basic services, to a credible, professional, corporate and consumer brand with a great story to tell. After mapping-out of the Green-Works values, activities and aspirations, the next stage was to combine all these elements in a single, coherent visual identity and design route, to be delivered via Green-Works' website and marketing materials.

The final identity and design route departs from the old in a number of ways:

- The company name is presented quite differently, both textually and visually, in the new logo.
- The strapline has been removed and not replaced.
- Colour is used much more dynamically, suggesting transformative change while using a "natural" green-blue colour palette.
- The three-dimensional effect, with an element of optical illusion, suggests the company's focus on physical products.
- The simplicity and robustness of the logo design lends itself to considerable adaptation, eg. via alternative colourways.
- The overall effect of the new logo is much cleaner than the old logo, and conveys a much greater degree of professionalism.

Figure 13: The Green-Works logo before (left) and after (right) the redesign process

GREEN-WORKS	GREEN WORKS

The immediate goals of this project were to clarify the Green-Works brand; to understand the market opportunity for the company's new remade furniture; and to consider how to give all its audiences a clear, recognisable, and consistent vision of

Green-Works, as both a remanufacturer and a business. In addressing these goals the project has sought to present a model for other branding efforts in the area of product remanufacture.

5.7 Conclusions

Green-Works has undertaken a major transformation of its business activities and brand in a short space of time. It has sought to both establish a viable remanufacturing business model. Many lessons have been learnt and these have been summarised in the project documentation to provide a blueprint for others to follow without reinventing the wheel.

5.8 Project reports

For more detail on the project results regarding environmental design, please see the following publications:

- Design of 5 prototypes from end-of-life materials
  http://www.bfmenvironment.co.uk/images/Task%204-1.pdf
- Manufacture of prototypes
  http://www.bfmenvironment.co.uk/images/DTI/dti%20ZEE%20Task%204-2%20report.pdf
- Cost benefit analysis of manufacture from reclaimed or virgin material
  http://www.bfmenvironment.co.uk/images/DTI/dti%20ZEE%20Task%204-3%20report%20(2).pdf
- Remanufacturing product branding
  http://www.bfmenvironment.co.uk/images/DTI/Task%204.5%20-%20final.pdf
- Development of a blue print for social remanufacture
  http://www.bfmenvironment.co.uk/images/DTI/Task%204.6%20-%20final.pdf

6 Sustainable procurement

6.1 Introduction

Contract and office furniture purchasers form a crucial link in the supply chain. They have the potential to buy goods on the basis of their environmental credentials, rejecting offers from manufacturers that do not incorporate cleaner design issues in their products. Purchasers also control the end-of-life destiny of any furniture that is being replaced.

The concept of sustainable procurement involves the meeting of the needs of the consumer in a way that achieves value for money on a whole life basis. As well as generating benefits for the user, there should also be benefits for society and the economy at the same time as the minimisation of damage to the environment, or even better, the generation of environmental improvements.

The UK Government is the country's largest purchaser of goods and services, with an annual budget of £150 billion. Through the Sustainable Procurement National Action Plan it is seeking to transform the way in which this money is spent. One example is a pilot project as part of the Forward Commitment Procurement initiative. Work was undertaken with HM Prison Service (HMPS). A call was placed in late 2006 for expressions of interest by potential suppliers of environmentally sustainable solutions to the provision and disposal of around 60,000 mattresses, to help HMPS achieve its sustainability goals.

At a European level, each year European public authorities spend the equivalent of 16% of the EU Gross Domestic Product on the purchase of goods and services. The EU has launched a Green Public Procurement strategy which outlines the environmental criteria which certain product groups should meet when being purchased. One set of criteria applies to furniture[6] and it is envisaged that public authorities within each Member State will be given a target for the percentage of product which must meet the relevant GPP criteria.

6.2 Sustainable procurement regarding furniture

There appears to be a progression of stages through which environmental criteria must pass before they become key purchasing criteria:

- Stage 1: Organisations firstly recognise that environmental issues are important and start discussing these internally
- Stage 2: Environmental criteria are included in tender documents and supplier evaluation exercises – albeit with a limited amount of action on the basis of results
- Stage 3: Questions are asked and actions are taken on the basis of the answers.

The vast majority of specifiers for office and contract furniture appear to be at Stage 1 or lower and environmental considerations are not significant purchasing criteria for

[6] http://ec.europa.eu/environment/gpp/pdf/toolkit/furniture_gpp_product_sheet.pdf

them. Purchasing decisions are much more likely to be based upon cost, specification and delivery time.

Some of the more proactive purchasing companies have reached Stage 2 and are taking an interest in the issue – albeit with an apparently patchy amount of action taken on the basis of the feedback received from environmental questionnaires. Some of these organisations also demonstrate that a small amount of knowledge can be a dangerous thing, with ill-informed questions being common place. Typical examples include blanket statements such as:

- *"We will not purchase hardwoods"*: European and North American beech, oak and ash are commonly used hardwoods which are unlikely to be grown in an unsustainable manner. Specifiers can of course state that certified timber must be used if they have concerns with regard to the origin of the material
- *"Products must contain no formaldehyde or volatile organic compounds (VOCs)"*: office desking will typically be made of melamine faced chipboard and all chipboard produced within Europe contains formaldehyde (as do all humans and trees as it is a naturally occurring substance). If board material is to be avoided, solid timber will typically be used and this will require coating to be applied to protect the finish. Most coatings contain solvents (VOCs) even water borne coatings (typically 5 to 10% VOC content).
- *"Preservatives should not be used"*: no need for this requirement as preservatives will never be incorporated into furniture for internal use

Such questions and requirements contribute to the disillusionment of the manufacturer. They encourage the view that questions are being asked simply so that the purchaser can be seen to be taking an interest in environmental issues even though they have limited comprehension of the issues. In addition, there is plenty of anecdotal evidence suggesting that little or no action seems to be taken by specifiers on the basis of the environmental information received.

Further disillusionment was found among some of the most environmentally proactive furniture manufacturers in the country. Despite their efforts, they had been rejected from tenders even when environmental issues were stated as a key consideration of the contract – e.g. when tendering for work with environmental pressure groups. However, caution must be exercised with regard to such tales – as a range of criteria must always form part of the purchasing decision, with environmental criteria only ever being one of these.

Not all of the fault can be attributed to the specifiers. Some manufacturers were guilty of contributing to the confusion of customers through incorrect claims such as one manufacturer which designated its chipboard as being "formaldehyde free" on the basis that it only contained a small amount of formaldehyde and another which claimed to use chrome plating due to it being an environmentally sound process (which it is not due to the chemicals and energy consumption involved).

Key barriers preventing companies moving onto Stage 3, include a lack of product specific environmental knowledge upon which to base decisions along with a range of competing issues which are central to the purchasing decision.

There was agreement among such purchasers that help could potentially be provided through the publication of guidance regarding key environmental issues relevant to

furniture manufacture as well as through third party product specific environmental evaluation and certification initiatives.

6.3 Factors affecting environmental performance of furniture

A wide range of factors can potentially affect the environmental performance of furniture. Full details are given in the project reports referenced in section 6.5, but essentially these reflect considerations mentioned earlier in this report with regard to cleaner design. Key criteria include:

- Packaging: often the last criteria considered when developing products, but it is the first item that the customer will typically see. Ideally, the packaging of a product will be thought about at an early stage of product development with a view to eliminating unnecessary packaging use.
- Product material selection: the choice of materials can greatly influence the environmental properties of the product. Issues include sustainable sourcing, consideration of the recycled content and the potential for end-of-life recycling
- Product material usage: reduced raw material consumption results in lower harvesting impacts and fewer requirements for processing and transport emissions. Consumption can be addressed through the design of products to reduce the amount of material required and also through process optimisation to reduce the amount of waste that is generated when processing the raw materials.
- Product assembly and end-of-life management: a common barrier to the reuse, remanufacture and recycling of materials is the cost of labour required to identify, separate and dismantle. In order to maximise the value of resources in a product, it is necessary to ensure that materials are economically harvestable / disjointable. Therefore, consideration should be given to joints – rationalising the number and designing them for dismantling as well as assembly.

  The value of the embodied resources and energy can be preserved to the greatest degree through reuse, which is typically facilitated through the provision of repair and refurbishment options. Again, the labour requirement is typically a barrier to refurbishment

As well as considering issues associated with the product, specifiers will also want to ensure that the potential supplier is acting in an environmentally sound manner and so will want to ask some questions about company environmental performance.

The guidance document associated with this work package provides two sample questionnaires (one brief and one detailed), which specifiers might like to consider when assessing the environmental credentials of both furniture products and suppliers.

6.4 Conclusions

Contract and office furniture purchasers form a crucial link in the supply chain. They have the potential to buy goods on the basis of their environmental credentials, rejecting offers from manufacturers that do not incorporate cleaner design issues in their products. Purchasers also control the end-of-life destiny of any furniture that is

being replaced. When asking informed questions on environmental performance and acting on the basis of the responses from manufacturers, purchasers can play a key role in encouraging the move towards more sustainable products and procurement systems.

6.5 Project reports

For more detail on the project results regarding environmental design, please see the following publications:

- User needs analysis: http://www.bfmenvironment.co.uk/BFM/Research/DTI/Work%20packages/WP5/Task%20%205.1.pdf
- Guidance document on the sustainable specification, purchasing and disposal of furniture. http://www.bfmenvironment.co.uk/images/Task%20%205.3c%20-%20Report.pdf

Figure 14: End-of-life office furniture awaiting reuse or remanufacture at one of the Green-Works warehouses

6 Conclusions

This project concentrated upon the materials and energy embodied within furniture products, with a view to reducing the environmental impact of the whole product life cycle. The focus has been on office, contract and kitchen furniture, i.e. furniture products most likely to end up in the commercial and industrial waste stream. Such sub-sectors were also chosen as they were believed to be the most likely to provide furniture products with the best chance of improvement from a sustainability perspective. Key benefits included the potential for large batch production to integrate the principles of cleaner design, encouragement for furniture manufacturers through supply chain pressure exerted by corporate consumers and the practical issues such as the movement of large batches of similar products / materials offering scope for economies of scale.

The project has demonstrated the potential that exists to significantly improve the environmental performance of furniture products at the same time as generating economic benefits. However, in order to achieve maximum impact, it is necessary to consider the four interrelated areas addressed by the project:

- Product service systems: the reconsideration of the way in which furniture manufacturers sell their product offers the potential to decouple producers' business success from the resource consumption. The retention of ownership of the goods by the manufacturer, leads to added incentive to invest in cleaner design to ensure that maximum benefit will be derived from the materials contained within the end-of-life products. Such an example of proactive producer responsibility offers the potential for UK manufacturers to gain a competitive edge over their competitors who will struggle to address such issues from overseas.
- Cleaner design: the project has demonstrated that considerable scope exists to reduce the whole-life environmental impact of a product through the consideration of cleaner design. The consideration of environmental issues during the initial design of the product is essential to reduce the impact of the product during its first life-cycle as well as ensuring that the embodied materials and resources are available at the end of the first life to become the raw materials for subsequent products. The process of improvement becomes particularly effective when using a "fresh pair of eyes" to challenge traditional methods of construction and to make environmentally beneficial suggestions. Again, case studies such as that regarding Morgan Contract Furniture show that environmental improvement can go hand in hand with economic benefits associated with leaner manufacturing and increased marketability of the product.
- Sustainable procurement: furniture purchasers have the potential to influence the supply chain by demanding environmentally sound products and services. Furthermore, such purchasers can also specify the use of alternative product service systems as well as a requirement for a constructive end-of-life outlet for their used furniture. Some contract and office furniture purchasers already take an interest in sustainable procurement. However, this interest can be counter-productive where ill-informed questions are being asked of potential suppliers and where little if any action appears to be taken on the basis of the responses. Consequently, this project has sought to provide the tools for contract and office

furniture purchasers to enable them to take an informed view regarding the environmental credentials of furniture and the potential options at its end-of-life

- Remanufacture: the use of end-of-life products to create new products, offers an attractive route for furniture which is surplus to reuse requirements. However, a wide range of logistical, operational and marketing barriers must be addressed for the process to function in an economically viable manner. The concept has been embraced by a number of commercial organisations in the US and Green-Works proved that the process can potentially work in the UK.

Future work

As this project considered innovative areas for step changes in UK furniture manufacturing, it is not surprising that many new questions and challenges were identified which will be worthy of consideration in future initiatives:

- Product service systems: at present there is only limited UK activity involving alternative product service systems for furniture, partly as a function of a number of barriers identified in the project. Problems included the fact that the leasing of furniture is an alien concept to most businesses and facilities providers. There were concerns with regard to how product financing might operate and whether the residual value of typical furniture would be too low to justify any deviation from the standard business model. It would be particularly beneficial to use a supply chain partnership to work through the implementation of alternative product service systems
- Cleaner design: excellent progress was achieved with most of the 5 products considered by this project. It would be beneficial to develop this body of knowledge and best practice further with the consideration of additional products and also work with the other major sub-sector not addressed to date, that of domestic furniture
- Sustainable procurement: further work could usefully be conducted with furniture purchasers and specifiers as part of a supply chain initiative, with a view to optimising the selection of furniture and the identification of the best practical end-of-life environmental options for used products
- Remanufacturing: much scope exists to further optimise furniture remanufacturing at levels ranging from the internal operation of the remanufacturer through to the involvement of a range of supply chain partners to pilot commercial remanufacture conducted by, or on behalf of, the original product manufacturer.

Appendix 1: Definitions

- Board material: particleboard such as medium density fibreboard, chipboard and melamine faced chipboard which comprises wood fibres bound with a resin matrix
- Carbon footprint: a measure of the impact our activities have on the environment. It relates to the amount of greenhouse gases produced during the manufacture of a specific product or the provision of a service etc.
- Cleaner design: the design of product in a manner which reduces the whole life cost, thereby improving sustainability. Also referred to as greener design, environmental design or sustainable design
- Coated wood: timber to which stains, sealers or lacquers have been applied. This category does not included wood which has been impregnated with preservative (treated wood)
- End-of-life furniture: furniture that has come to the end of a particular cycle in its life. For example, an office table that is discarded by its first owner and passed to a charity based organisation for reuse. “End-of-cycle” furniture is a more correct term as the life of the item continues until it has been remanufactured or recycled. However, EOL is the term in most common use
- Hardwood: wood derived from deciduous species such as oak, beech and ash
- Producer responsibility: a term used to describe a policy approach that requires producers who place products on the market to take greater responsibility for those products when they become waste. For example, the Producer Responsibility Obligations (Packaging Waste) Regulations 2007 require those who own packaging and supply it down the packaging chain to contribute to the cost of its recovery and recycling
- Recycling: reprocessing of material into a new product. For example, a table which is chipped-up and sent to a board material manufacturer for conversion into chipboard
- Remanufacturing: the process of disassembly of end-of-life products, with the utilisation of some or all of the component parts to make new products.
- Reuse: the continued use of an item for its original purpose. For example, a table that is discarded by the first owner and passed onto a subsequent owner for use as a table. A small amount of work may be required to make an item suitable for reuse, e.g. the cleaning of the table surface
- Softwood: wood derived from evergreen species such as spruce
- Waste management hierarchy: a series of options in decreasing order of environmental and economic desirability ranging from elimination at source through to disposal via landfill

References

BFM (2001) Benchmarking solvent use in the UK furniture manufacturing sector. *BFM Ltd, London*

BFM (2002) Implications of sustainable development for UK reproduction furniture manufacturers. BFM Ltd, London

BFM (2004) Evaluation of the market development potential of the waste wood and wood products reclamation and reuse sector. WRAP, Banbury

BFM (2005) Benchmarking wood waste combustion. BFM Ltd, London

Bromhead, A (2003) Reducing wood waste in furniture manufacturing. Fauna & Flora International, Cambridge.

Charter, M., Peattie, K., Ottman, J. & Polonsky, M. J. (2002) Marketing and Sustainability. BRASS / Centre for Sustainable Design.

CSIL (2003) The furniture industry in the European Union. CSIL Italy

Olins, W. (2003) On Brand. Thames & Hudson.

PRODCOM (2005a) Product sales and trade – 36110 Chairs and seats

PRODCOM (2005b) Product sales and trade – 36130 Other kitchen furniture

PRODCOM (2005c) Product sales and trade – 36150 Mattresses

PRODCOM (2005d) Product sales and trade – 36140 Other furniture

PRODCOM (2005e) Product sales and trade – 36120 Other office and shop furniture

Verkuijl, M., Tischner, U. & Nickel, R. (2004) Product Service Systems To Offices: State Of The Art Study. http://www.suspronet.org/fs_reports.htm

Wackernagel, M. (1999). "An evaluation of the ecological footprint." Ecological Economics 31: 317-318.

WRAP (2003) Wood waste recycling in furniture manufacturing. WRAP, Banbury. www.wrap.org.uk

WRAP (2004) Evaluation of the market development potential of the waste wood and wood products reclamation and reuse sector