'End of Life Decisions – A Design Guide'

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Abstract

The European Waste Electrical and Electronic Equipment (WEEE) directive is due to impact companies in the United Kingdom from January 2006 (Tollady, 2005). A key aim of this legislation is to reduce the environmental impact of electrical and electronic products by making producers responsible for recovering, reusing and recycling large percentages of the equipment they manufacture and import, once it reaches the end of its life. Despite this approaching deadline, the authors have found that many companies are still unclear about the implications this legislation will have on the design of their products. A key problem for companies is ensuring that design teams are aware of the requirements and feel empowered to develop products which are compliant. However, there are currently no practical tools to guide the design decision making process and support the development of financially viable, compliant electrical and electronic products.

This paper reports on the SortED project which aims to develop an end of life decision making design guide to help companies quickly identify the implications of the WEEE directive on the products they design, manufacture and import, by guiding them towards appropriate design solutions that will help them get maximum revenue out of their products by using the restrictions of the Directive as an opportunity for innovation.

Keywords

Legislation, Extended producer responsibility, WEEE directive, Design, Ecodesign, Communication to designers

1 Introduction

This paper reports on an eight month development project called SortED, which is being carried out in the Department of Design and Technology at Loughborough University with funding from a HEROBC Innovation Fellowship. A key aim of this project is to develop an end-of-life decision making design guide to help companies quickly identify the implications of the Waste Electrical and Electronic Equipment (WEEE) directive on the products they design, manufacture and import, so that they can tackle the requirements in an informed way.

The WEEE directive is piece of European legislation which aims to dramatically reduce the amount of toxic waste electrical and electronic products (e-waste) being sent to landfill by requiring producers to take financial responsibility for the products that they manufacture and import, once they reach the end of their life. The WEEE directive is due to be transposed into UK law in the summer of 2005 and the UK government intends to *"implement the Directive's producer responsibility obligations for household and non-household WEEE and its take-back obligations on retailers/ distributors from January 2006"* (Tollady, 2005). Any company which does not meet the specified recycling and recovery targets by early 2006 will not be able to sell their products in the

European Union (European Parliament and the Council of the European Union, 2003). Despite this approaching deadline, the authors have found that many companies (including large multinationals) are still unclear about the implications this legislation will have on the design of their products and a study referred to by Holdway and Walker (2004) suggests that *"89 per cent of companies (SMEs) were unaware of what the legislation means for them, and therefore had not taken any implementation steps"*.

2 Early stage integration

It is widely recognised that ecodesign principles (which includes the new requirements being set by the WEEE directive) should be implemented at the 'early stages' of the product development process where the design brief is most flexible and the most critical decisions with respect to; cost, appearance, materials selection, innovation, performance, environmental impact, and perceptions of quality (longevity, durability, reparability), are made (Bakker, 1995, Bhamra et al., 1999). It follows therefore that the WEEE directive will have a considerable influence on the types of issues that industrial designers and design engineers need to address early in the design process. To ensure that this happens, it is important that design teams understand the requirements of the Directive and feel empowered to take practical steps to ensure that the products they design are compliant.

In order to tackle this problem a number of influential bodies in the UK are involved in a range of awareness raising campaigns. A particularly public campaign was the RSA WEEE man which aimed to communicate the issues associated with e-waste to a three broad audiences; industry, the general public and school children (RSA, 2005). Other approaches more specifically aimed at industry include the publishing of articles and guide books (Envirowise, 2001a, Envirowise, 2001b, Envirowise, 2004), WEEE focused seminars and company focused workshops such as the DesignTrack workshop offered through the Envirowise programme. The DesignTrack workshop, involves a *"one-day visit from an Envirowise Design Track advisor,* [who] *assists companies in making cost savings and helps to reduce negative impacts on the environment through design improvements."* (Holdway and Walker, 2004) However, although workshops are a highly effective way of communicating information to designers and the hands on approach is usually well received by designers (Dewberry, 1996, Lofthouse, 2001a), approaches of this nature are time consuming, relatively expensive to run and can not be easily integrated into daily practice. These types of workshops also mean that designers need to rely on the outside expertise of consultants, which can be inconvenient and may mean that companies do not develop these skills internally. Designers need practical tools which compliment this approach, recognise the culture of designers and provide a real alternative to external consultants. This is what the SortED project set out to do.

3 Communicating to designers

Since the 1990s there has been a large amount of research which has focused on; design for disassembly (DFD), recovery times, strategies to ease disassembly and end of life strategies for different product categories (Simon, 1994, Das and Naik, 2002, Dowie, 1994, Dowie-Bhamra, 1996, Dowie, 1995). However, this data has tended to be technical in nature and has only been reported in academic papers and reports. If this wealth of information could be translated into a palatable format for design teams, it would an excellent basis for the development of an end-of-life focused tool.

In the past ecodesign tools have often been developed for engineering disciplines, which has lead to problems for designers, who work in very different ways to engineers (Lofthouse and Bhamra, 2000). Previous research has identified that tools which are developed for design teams need to take into account the culture of design and the fact that industrial designers may have 'their own way' of carrying out ecodesign (Sherwin, 2000). Making sure that designers can effectively access information on the WEEE directive is not only critical to ensuring that companies have the ability to

meet the requirements of the WEEE directive, but also ensures that they can make the most of the skills of their design teams and capitalise on the fact that industrial designers have the potential to add scope to the solution, because they draw from a wide range of fields such as mechanical design, marketing, psychology and artistry (Bates and Pedgley, 1998, Lofthouse and Bhamra, 2000).

3.1 Presenting information in the right way – problems with the WEEE directive

The official WEEE directive is a dry and wordy legal document. An extract which demonstrates how the recovery and recycling targets for white goods are communicated, is presented below:

"2 - Regarding WEEE sent for treatment in accordance with Article 6, Member States shall ensure that, by 31 December 2006, producers meet the following targets:

(a) for WEEE falling under categories 1 and 10 of Annex IA,
— the rate of recovery shall be increased to a minimum of 80 % by an average weight per appliance, and
— component, material and substance reuse and recycling shall be increased to a minimum of 75 % by an average weight per appliance" (European Parliament and the Council of the European Union, 2003)

Although this approach is appropriate for legal communications, the combination of a non visual approach and scientific language is totally incongruous with the way that designers work (Lofthouse, 2001a). Lofthouse (2001a) goes on to say that it is important to recognise that information which is intended for designers needs to presented to in a creative way, with maximum use of graphics (pictures and colour) and minimal text, using non technical language. It should not however be dumbed down and must still convey all the facts.

Another problem with the WEEE directive (European Parliament and the Council of the European Union, 2003) is the way in which the information is laid out within the documentation. To ensure that designers fully understand the implications, they have to read through the whole document, identify the areas which effect them, find and look through Appendix IB to identify the category that their product falls into, and then find and look through Appendix IA to identify the specific targets for their category. This is not a user friendly approach and may mean that it takes designers a great deal of time to extract the right information from the documentation.

The combination of the issues outlined above may mean that in more extreme cases, designers abandon the process altogether and/ or pass the task on to someone more 'technically' minded. Based on this presumption it follows that the information in the WEEE directive needs to be translated into a format which is appropriate for designers to understand.

3.2 Ecodesign tools for industrial designers

In a study entitled 'Information/Inspiration' which set out to identify the types of tools that designers need to support their involvement in ecodesign Lofthouse (2001) identified that design teams are looking for a combination of guidance, education and draws on information and inspiration.

3.2.1 Providing appropriate content

Findings from 'Information/Inspiration' illustrated that case studies have a valuable role to play in supporting designers involved in ecodesign as they allow them to build up a bank of tacit knowledge around the subject that they can draw on at a later date. In addition to this relevant information which has a similar focus to that which they would use in regular design projects (i.e. materials information, details on fixings) helps designers 'get on' with the task of tackling ecodesign requirements. As separate entities inspirational case studies and appropriate information have an educational role for designers. Combining information and inspiration helps to make the

information more interesting and relevant, whilst bringing the examples alive and making them 'real'.

It is also important that designers are provided with the right level of information. For example the case study in Figure 1 tends to only whet the appetite of the reader, rather than provide substantial, useful information.

Varian Medical Systems opted for sustainable redesign of its radiotherapy simulator collimator unit and is now achieving:

- £162 000 / year in components and materials cost savings;
- A 65% reduction in the number of components used per collimator;
- A reduction of 29% in the number of fasteners and a 27% reduction in assembly time;
- Easier equipment disassembly for recovery and recycling.

Figure 1 Varian Case Study (Envirowise, 2004)

This can lead to frustration. Feedback from designers in the 'Information/Inspiration' (2001) project indicated that they are ideally looking for examples which they can learn from. The data suggests that the Varian case study would be more useful for design teams if it provided information on:

- The way in which the number of components were reduced (was it as a result of consolidation, reduction of functions or reorganisation of internal components),
- how the number of fasteners was reduced,
- which fasteners were used, and
- whether any other approaches were used to reduce the disassembly time.

It would be better still if it was illustrated with images of the product before and after the transformation.

3.2.2 Linking guidance and information

Though the publications generated by Envirowise to help companies meet the requirements of the WEEE Directive provide useful guidance for designers (Envirowise, 2001a, Envirowise, 2001b, Envirowise, 2004) it has been seen that providing this guidance in isolation can be misread as a list of constraints (Lofthouse, 2001a. Lofthouse (2003) identified that linking guidance of this nature to practical information sources that provided potential solutions, meant that the designers no longer see checklists as challenging requirements but, *"…more as opportunities, even potential sources of inspiration."* In 'Information/Inspiration' (Lofthouse, 2001b) rather than simply being told to 'consider disassembly', 'use recycled materials where possible' and 'reduce energy consumption', teams are provided with links to websites that provided useful information for solving the particular problem. Linking together information and guidance ensures neither is provided in isolation and that when users identify important issues they can easily follow them up by following links to practical design focused information (Lofthouse, 2003).

3.2.3 Delivery

As was outlined in section 2 interactive hands-on workshops which allow participants to learn by doing are a very effective way of teaching designers (Dewberry, 1996, Lofthouse, 2001a). However the heavy time commitments that they require mean that they are not always the best mode of delivery, and actually something which takes up as little time as possible, is preferable (Lofthouse, 2001a). In recognition of this the ideal would be to deliver the information in a way which enables teams to run internal activities if they have the time and resources but also have a design friendly method of accessing the required information as and when it is needed.

4 Methodology

The SortED project has been divided into 5 phases. To date, Phases 1-3 have been completed, Phase 4 is under way and Phase 5 is yet to start.

Phase 1 - Establishment

Phase 1 of the project focused on establishing the theoretical context. It involved:

- reviewing the wide range of literature written on end-of-life issues,
- reviewing the progress of the legislation and understanding the legislative requirements, and
- drawing together understanding regarding how to deliver complex information to designers in a way which they will respond positively to.

From this background work a number of key requirements for the design brief were established:

- To develop a tool which will appeal to design teams and help them to understand the requirements of the WEEE directive in terms of the products they develop.
- To present the targets set by the WEEE directive in a way which is easily understood by designers.
- To ensure that designers understand how best to develop products so that they meet the specific requirements of the WEEE directive (which only endorses the use of certain end of life strategies).
- To enable design teams to achieve the above as quickly and easily as possible.

Phase 2 - Design

During the Phase 2, the web development package FrontPage was used to mock up the prototype tool based on the brief which emerged from Phase 1. Findings from the literature and previous experience in communicating to designers was drawn upon. In order to develop the content for the tool, the project team put themselves in the position of the designers and carried out a range of disassembly activities on different products, to better understand the types of issues that they would face when looking at their products from the perspective of WEEE for the first time. These activities helped with the development of the downloadable worksheets (described later) and also highlighted a range of interesting findings which could be fed back in to the tool, to benefit the end user. Other appropriate content was compiled with the help of a wide range of stakeholders from the supply chain (including dismantlers, recyclers, logistics suppliers and manufacturers), who provided information via semi structured interviews and design reviews. It is interesting to note that the process of sourcing the content for SortED has further illustrated the need for a tool such as this. Despite the fact that there is a great deal of information available, it has been a time consuming process to identify the requisite questions and gather the required answers, as it is widely dispersed and often difficult to access.

To ensure that the material was presented in an appropriate format for design teams, the SortED tool drew from the theoretical holistic framework developed during an earlier doctoral study (Lofthouse, 2001a) which aimed to identify a better understanding of the types of support mechanisms that industrial designers require for ecodesign.

Phase 3 - Pilot

During the pilot phase the key requirements within the brief were evaluated and developed, and different elements of the tool were tested with ‘typical’ users. For example, the downloadable worksheets were tested on a group of Industrial Design students at Loughborough who were redesigning a razor, electric toothbrush and hairdryer for the Boots Company as part of their second year Sustainable Design module. The way in which the targets for each category were communicated was tested on a range of trained industrial designers. During the testing semi structured interviews and observation were used to collect qualitative data from the participants. It was felt that qualitative data had the best potential for generating the ‘rich’ data required. Strauss and Corbin (Strauss and Corbin, 1990) note that not only is qualitative research synonymous with researchers who concern themselves with *“issues related to human behaviour and functioning”* but

that these *"…methods can be used to uncover and understand what lies behind phenomenon about which little is yet known"* (p.19).

Phase 4 - Review

The review stage, which is currently under way, involves drawing together all the findings from the pilot and feeding them back into the design.

Phase 5 - Test

During this phase the SortED prototype will be used to test both the quality and nature of the content, and the appropriateness of the delivery mechanism. The tool will be presented to a number of design teams as a working prototype, in order to encourage discussion and enhance the development process. The teams will be observed using SortED to tackle a number of exercises and then interviewed afterwards to encourage them to reflect on their experiences. It is anticipated that this type of mechanism would produce a mixture of positive and negative feedback that would provide a rich insight into the designers' needs and benefit further development. In the past this approach has proved to be a very effective way of generating useful feedback and intuitive design changes (Lofthouse, 2001a).

5 SortED: a strategic tool for design teams

SortED is a web based tool with a visual graphic interface which has been developed to appeal to design teams. It has been designed to be used at the development stage of a project to identify what the specific WEEE requirements are for a given project.

Two routes of access have been created. Users can follow the structured approach which guides the team through the different questions that they need to ask to ensure that electrical and electronic equipment is WEEE compliant. Alternatively, if users are searching for more specific information they can dip into the relevant section using the side navigation bars, site map or search facility.

Following the structured route, users are encouraged to ask three key questions:

1. Which category of WEEE does your product fall into and what are the targets?
2. What's going to happen at the end of the product's life?
3. How are you going to get the product back?

It was felt that this simplistic approach would help to make the content of the WEEE directive more accessible. Users can follow hyperlinks within each section to access more guidance and information. This is explained in more detail in the sections below.

5.1 Identifying WEEE targets for a given product category

Within 'Which category of WEEE does your product fall into and what are the targets?' users choose a specific route to follow based on their product category. If for example they select Category 1 - Large Household appliance they only have access to information which is relevant to that category. The aim of this approach is to minimise confusion regarding category targets and make the information as specific as possible to the design teams. Selecting their appropriate category directs the user to a page which visually presents the recovery, reuse and recycling targets for their product. One of the key aims of the SortED project is to present these targets in a way which is accessible to designers. As was outlined in section 4, a range of designers were consulted to identify which approach most effectively communicated the correct information to them. The description of the targets laid out in the WEEE directive were rewritten so that they were clearer for the designers and also represented in an image format (see Figure 2). The various options available for meeting each of the targets are listed and more detailed information on the advantages and

disadvantages of each approach, design implications and business implications can be accessed by following the hyperlinks.

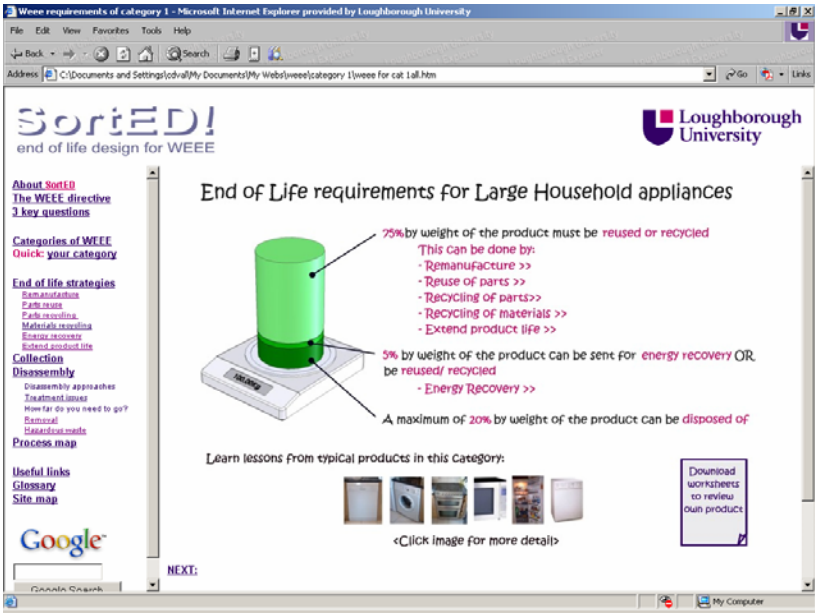

Figure 2 Illustration of the graphic communication used to communicate the WEEE directive targets for Category 1 products within the SortED tool

5.1.1 Hands on workshop

Within this section of the website users can also download a series of worksheets which form a 'Disassembly and Analysis workshop' and guide them through an end of life focused analysis of their own product. The workshop aims to give users the opportunity to:

- experience taking products apart,
- learn what makes things easy to disassemble,
- identify whether their product currently has the potential to meet the requirements of the WEEE directive, and
- identify where improvements need to be made to promote disassembly / where design changes are needed to meet the requirements of the WEEE directive.

During the disassembly procedure they are encouraged to:

- note any difficulties that they have,
- record the combined weight of the all components made of the same material,
- identify which components would need to be taken apart to meet the WEEE directive targets,
- record any obvious ways in which disassembly could be improved, and
- identify (if necessary) how the product can be redesigned to ensure that it does comply with WEEE.

5.1.2 Case studies

Within the section, links are also provided to detailed product case studies. These case studies are presented in the format of the worksheets and therefore provide the dual function of demonstrating how they should be filled in and providing detailed analysis information of other similar products. Users have access to detailed images of disassembled products, suggested design improvements identified from practical activities, any specific problem areas which the team identified with the case study product, information on product composition, and the typical end of life scenarios that are appropriate to these compositions.

5.2 What's going to happen at the end of the product's life?

The 'What's going to happen at the end of the product's life?' section introduces the different end of life options that designers have and explains how the options that they will select will be influenced by the type of product they are dealing with. It encourages designers to ask questions such as:

- Can you remanufacture your product?
- Can you or anyone else reuse any of your parts?
- Which components could be easily recycled?
- Which materials can you recycle?

Each of these questions links to further information on the selected topic, as well as more detail on the related design and business implications of a selected approach. Users can also access links to suppliers who for example, provide a remanufacturing service and links to illustrative case studies which outline how other companies have successfully used selected approaches. The intention here is to demystify the process and demonstrate the types of business models that others have used to make end of life responsibly economically viable.

Throughout this section links are made to the Disassembly area, which provides information on the different types of disassembly (e.g. manual, brute force and active disassembly) and the design techniques which can be used make the process more economically viable.

5.3 How are you going to get the product back?

The final section 'How are you going to get the product back?' what is known about the collection procedure, and provides examples of how others currently handle business to business, and business to consumer collection. However, the WEEE legislation which was originally expected to become British law in August 2005 and been pushed back to early 2006, this lag has also delayed the release of information regarding the types of collection mechanisms which will be used to make the WEEE directive operational. When decisions regarding collection have been finalised by government, more information will be added to this section.

6 Conclusions

In recognition of the fact that *"at least 80% of the quantities and costs of materials and utilities required to manufacture electrical and electronic products are locked in at the design stage"* (p.2)(Envirowise, 2004) and that it is widely recognised that to be most effective ecodesign principles should be implemented at these early stages, it is clear that industrial designers have an important role to play in ensuring that electrical and electronic products are compliant with the WEEE directive.

With this in mind, it is important to ensure that industrial designers can easily access information on the WEEE directive in a way which empowers and engages them. Though this may be something which has been recognised by others it has not been addressed in a way which directly takes into consideration the culture of Industrial Design. It is in recognition of this that the prototype tool – SortED has been developed. It aims to draw on existing theory about how to develop ecodesign tools design teams and 'translate' some of the key end of life data which has been generated by the sciences into a format which is accessible for design teams.

The SortED project will continue to develop, test and refine the prototype tool with the aim of providing a design friendly solution to the WEEE legislation.

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