

Today's Moves Towards Eco-innovation in the Medical Electronics Sector

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Abstract

This paper presents a detailed analysis of the drivers for eco-design within the specific industry of medical electronics. It is suggested that the three most significant issues can be grouped under the headings 'regulation', 'sustainable procurement', and 'competition-driven innovation'. This paper discusses these pressures and their effects including:

- a review of the relevant current and future legislation,
- examples of how sustainable procurement principles are currently being applied within the medical electronics market, including interview evidence from procurement practitioners, and,
- examples of how product design and business model innovation are being used by leading companies to deal with these pressures.

This paper concludes that, because of the particularly strong drivers for improvements in environmental performance of products, other industries are likely to be able to learn from successful companies in the medical electronics sector and that medical electronics manufacturers are more likely to be willing to engage in more radical 'eco-innovation' approaches.

Medical Electronics : Early signs of tomorrow's trends in sustainability

It has been suggested that one of the reasons for the disappointing growth in eco-design has been the lack of a suitably convincing business case (McAloone et al., 2002; Charter, 2005). Previous research has highlighted a number of factors which potentially favour the adoption of eco-design within the medical sector (Farish et al., 2005). This paper presents a detailed analysis of the drivers for eco-design within the specific industry of medical electronics. It is suggested that of the many diverse pressures felt by manufacturers of medical electronics to improve the environmental performance of their products, the three most significant issues can be grouped under the headings 'regulation', 'sustainable procurement', and 'competition-driven innovation'. This paper discusses these pressures and their effects including:

- a review of the relevant current and future legislation,
- examples of how sustainable procurement principles are currently being applied within the medical electronics market, including interview evidence from procurement practitioners, and,
- examples of how product design and business model innovation are being used by leading companies to deal with these pressures.

This paper concludes with preliminary suggestions as to how the eco-design community could exploit these pressures as an opportunity to test more radical eco-innovative methods and why other industries should be taking note of the activities within the medical electronics sector.

New approaches to Regulation

Medical waste poses a significant risk to the environment for two main reasons: first, the volume in which it is produced; and secondly, due to the environmental impacts associated with waste incineration (currently the most prevalent method for dealing with this type of 'hazardous' waste in the UK¹). For these reasons, medical equipment is being subjected to increasing scrutiny from both healthcare trusts - who must finance the increasing costs of waste management (Farish et al., 2005) - and environmental legislators.

Two recent pieces of environmental product related legislation to enter into force are the Waste Electrical and Electronic Equipment (WEEE) (European Commission, 2003) and Restriction of Hazardous Substances (RoHS) Directives (European Commission, 2003). 'Medical Devices' including, for example, radiotherapy equipment, analyzers, and dialysis equipment are captured under Category 8 of the WEEE Directive. Such equipment is currently exempt from the RoHS Directive although this is currently under review. 'Producers' of equipment covered by the WEEE Directive within the EU are required to arrange and provide finance for the collection and recycling of their equipment, if and when the end-user requests this service. Current recycling costs for medical electronics are around €200-300 per tonne within the UK, which, combined with the cost of reverse logistics and data reporting, can leave the manufacturer with substantial costs to pay for dealing with their EoL products².

However, there is often scope for reducing recycling costs if the product is designed with the recycling process in mind. Academic and industrial research has been undertaken to develop product design approaches to ensure that recycling is completed with minimal time and effort and that maximum value can be obtained for the materials and components extracted from the product, often referred to as Design

¹ Barrett *et al.* (2004) cited in Farish *et al.* (2005) report that of the estimated 142,440 tonnes of 'clinical' and 'special' waste generated by the UK NHS in 2004, a recycling rate of 0.002% was achieved.

² The UK government estimates the annual cost to industry of complying with the WEEE Directive within the UK lies in the region of £86m - £123m in 2007, rising to £276m - £425m in 2017 (Department of Trade and Industry, 2006).

for Recycling (DFR) (see for example Ishii (1994), Kriwet (1995)). With specific regard to the WEEE Directive, DFR will also involve ensuring that items listed in Annex II of the Directive, such as batteries and large capacitors, can be quickly located and removed for separate treatment (Stutz et al., 2002; Brandstotter et al., 2004). The WEEE Directive is therefore encouraging manufacturers to consider design for recycling during the development of their products.

The next piece of product related environmental legislation to emerge from the European Union's 'Integrated Product Policy' will be the 'Energy Using Products' (EuP) Directive (European Commission, 2005). Due to come into force in August 2007, this framework Directive will streamline the adoption of new standards for minimum energy efficiency and other environmental considerations. The products which have been highlighted as priority targets for the Directive are given below:

- Heating and water heating equipment
- Electric motor systems
- Lighting
- Domestic appliances
- Office equipment
- Consumer electronics
- Air conditioning systems

However the scope of the Directive is not limited and virtually any energy using products could eventually be covered provided they meet the following basic criteria:

- i. Sales volume into the EU greater than 200,000 units per annum,
- ii. Significant environmental impact within the EU, and,
- iii. Significant potential for improvement of the environmental impacts.

The Directive will require manufacturers to perform an environmental assessment of their products and then use this assessment to inform design decisions with the aim of reducing the overall environmental impact. These activities will have to be documented in an 'Ecological profile' and compliance with the Directive will be a prerequisite for the CE certification process.

Whilst medical electronics do not feature on the list of priority products there are some indications that such products are being considered for inclusion within the scope of the EuP Directive. In 2003, the European Commission commissioned the standards body CENELEC to produce a list of relevant standards, either current or in development, which were consistent with the aims of the Directive. A consultation document produced by CENELEC as part of this work listed a wide range of standards relevant to the priority target groups, *but also* the International Electrotechnical Commission's (IEC) collateral standard for medical electrical equipment entitled 'Requirements for the reduction of environmental impacts'. In this draft standard, the introduction states that:

The objective of this collateral standard is to improve the environmental compatibility for the entire range of medical electrical equipment, taking into account all stages of the product life-cycle: product specification, design, manufacturing, sales, logistics, installation, use, end of life management. (International Electrotechnical Commission, 2005).

This medical standard is clearly closely aligned to eco-design principles and, if incorporated into the EuP Directive, would be the first piece of product-related environmental legislation to tackle the entire life cycle as opposed to considering single issues or single life-cycle phases in isolation. Furthermore, this particular standard will be part of the wider harmonised IEC (IEC60601-1) which will be required for Food

and Drug Administration approval in the USA, and for similar medical approval processes in Canada, Japan and Australia by 2010 (Eisner et al., 2004).

Considering the WEEE, RoHS and EuP Directives it seems clear that in order to continue selling into the world's major markets, and to avoid incurring excessive costs in complying with such legislation, manufacturers of medical electronics must begin to consider and reduce the lifecycle impacts of their products through eco-design effort.

Sustainable Public Procurement

Sustainable procurement is the pursuit of sustainable development objectives through the procurement process (Walker, 2006). In recent years the UK government has begun to recognise the role of public procurement in developing markets for sustainable products and services³. It has stated an objective of becoming a leader in sustainable procurement in the EU by 2009 (HM Government, March 2005). In April 2006, the Sustainable Procurement Taskforce issued the report 'Procuring the Future' which outlines the range of policies and initiatives which are developing in order to meet this objective (Sustainable Procurement Taskforce, 2006). An example of the specific targets set out in this report is for all public sector organisations to work with business to identify and set future minimum requirements in order to encourage investment in R&D by suppliers. Furthermore, organisations must ensure that by April 2009 their national and regional contracts do not offer any products/services that fall below these minimum standards.

The UK public healthcare system, including the National Health Service (NHS), will be required to play an important role if the government is to succeed in meeting its sustainable procurement objective. Changes in procurement policy within public healthcare could have significant implications for manufacturers of medical electronics due to the large proportion of the market that they represent. For example, in 2003 the UK government spend on healthcare was over £30 billion of which around £1.5 billion was spent on medical equipment and supplies (Sustainable Procurement Taskforce, 2006).

In order to better understand the possible implications for medical electronics manufacturers of current and future sustainable procurement policies within the NHS, interviews were undertaken with a procurement manager from an NHS trust and with the Sustainability Manager for NHS Purchasing and Supply Agency (PASA).

NHS PASA was formed in April 2000 to act as 'a centre of expertise, knowledge and excellence in purchasing and supply matters for the health service' (NHS PASA, 2005). NHS PASA has been praised for their role in promoting sustainable procurement (Sustainable Procurement Taskforce, 2006). Recent NHS environmental procurement initiatives have included developing a 'Green Risk' methodology which uses risk assessment principles to help procurement practitioners to decide the level of checks and controls which should be applied to a contract according to the possible environmental implications. Other projects have included incorporating 'Green Flags' into product catalogues to indicate products which comply with relevant eco-labelling schemes.

During the interviews, both procurement practitioners expressed the opinion that the NHS had made significant improvements in terms of sustainable procurement in recent years. Both interviewees cited the

³ For further discussion on sustainable procurement policies within the UK and the European Union see Walker (2006)

example of local food sourcing as evidence of this⁴. When asked how electronic products are managed throughout their life cycle, it was noted by one interviewee that until recently the NHS policies on this topic were insufficient. The example was given of EoL pacemakers which the procurement manager had had great difficulty in disposing of as no contractor was able to deal with this particular type of hazardous electronic waste. He had contacted other NHS trusts who reported having similar difficulties in finding a contractor to safely dispose of EoL pacemakers. It was suggested by the interviewee that cases such as this have led to a tightening up on policy and tender documents in terms of responsibility for disposal of EoL medical electronics. This trend could result in manufacturers being required to take responsibility for their EoL products even when they are not covered by formal legislation such as the WEEE Directive.

One procurement manager stated that whilst they would like to increase the amount of 'environmentally friendly' products that they purchase, their primary task was to deliver value for money and cost-savings. Hence in some cases they were unable to justify the additional capital cost of an eco-friendly alternative. The interviewee went on to add that in some cases the application of Whole-Life Costing had provided of means of justifying higher capital costs. He suggested that making Whole-Life Costing mandatory on large contracts would help to embed such costing approaches and a sustainability focus in procurement practises throughout the NHS.

From this evidence it would seem that moves towards sustainable public procurement within the UK are already taking place. Manufacturers should be aware that in the future pressures from the central government to meet the 2009 sustainable procurement targets will mean that the NHS and other large public sector customers will be placing increasing stringent environmental demands on their suppliers.

At this point it should be noted that academic researchers have also highlighted the role that procurement can make in stimulating innovation as well as the environmental improvements previously discussed. Phillips *et al.*(2006) examined the constraints and enablers to the process of innovation within the context of UK health care supply networks. They found that manufacturers in this sector looked almost exclusively to the large public sector customer i.e the NHS, as their main source of innovation and have largely ignored their own supply base. Phillips suggests that manufacturers wishing to stimulate innovation should develop a better understanding of their supply network and consider ways to develop innovative linkages with their suppliers. Such supply chain initiatives are likely to be vital for manufacturers within the context of NHS objectives to improve innovation in healthcare delivery, which are discussed in the following section.

Competition-driven Innovation

Innovation is cited by many sources as being critical to moving closer towards the objectives of sustainable production and consumption (see for example, Brezet, 1997). In 2003 the Department of Trade and Industry (DTI) undertook a review of the UK's innovation competencies and provided recommendations as to how these could be maintained and developed in order for the UK to remain a competitive exporter of innovative goods and services (Department of Trade and Industry, 2003).

⁴ Several NHS Trusts have now moved to sourcing local fresh produce. This has brought benefits such as better food quality and nutritional value, support for the local economy, and of course the environmental benefit of reduced 'food-miles' in transportation (NHS PASA, 2006).

The NHS has been criticised for being a 'slow and late'⁵ adopter of new technologies (Wanless, 2004). The Health Industries Task Force (HITF) (2004) produced a report which considered ways to encourage innovation within the medical sector with a focus on turning round the NHS into an 'early and fast adopter' of innovations . Some of the recommendations of this report have already been implemented. For example, it recommended further developments in the role of the nine existing regional 'Innovation Hubs' set-up between 2002 and April 2005 with the primary task of improving the management of intellectual property within the NHS (Department of Health, 2002). Their role has now been extended to encourage NHS workers and local companies to bring ideas for innovative new products to the hubs whose task it is to evaluate the ideas, ensure that good ideas receive the resources necessary to be taken into production, protect the intellectual property associated with innovations, and help the resultant product gain acceptance throughout the NHS .

With initiatives to encourage innovation in place, and with increasing pressures from legislation and procurement requiring manufacturers to improve the environmental performance of their products, there are a number of opportunities emerging for proactive manufacturers with competencies in these two aspects of design. Manufacturers of medical products have begun to respond with a range of innovative approaches. The following short case studies provide examples of a range of approaches from medical electronics manufacturers who are seizing these opportunities:

Collaborative Eco-design at the Smiths Group

Smiths Medical is one of the five diverse engineering companies which form the UK based Smiths Group. In 2004, Smiths Medical began an eco-design pilot project organised on behalf of the Smiths Group by the environmental science consultancy ENVIRON. The project brought together small groups of designers, engineers, sales and marketing staff representing the five Smiths Group companies for a series of one day workshops over a period of six months. Each company proposed an existing product to be evaluated and redesigned using eco-design principles and methods. For Smiths Medical one of the most successful outcomes from the project was the redesigned Pneupac VR1 automatic ventilator. Improvements from the old design included:

- Weight reduction by 70% and volume reduced by 10%,
- ergonomic and recyclable plastic casing,
- increased efficiency of oxygen use,
- more robust design combined with easier maintenance to extend product life (Smiths Group, 2005).

Environmental case studies for each of the redesigned products were compiled and included in the Smiths Group Environmental, Health and Safety Report 2005. These case studies and the environmental credentials of the new VR1 have been exploited in their marketing strategy. Furthermore, the lessons learnt from the pilot project are now being used to formulate a systematic eco-design strategy for the company.

Remanufacturing at Siemens Medical

Since 1993 Siemens Medical have been operating to an in-house environmentally compatible product design standard which relates to the entire life cycle of the product (Siemens AG, 2005). Building on their expertise in design for disassembly, reuse and recycling, Siemens now offer a range of 'Refurbished Systems' including X-ray, angiography and magnetic resonance imaging equipment. Products taken back from their original owners are sent to a refurbishing centre in Germany where they undergo the Siemens

⁵ This comment refers to the length of time required to have a new product approved for clinical use – seven years is common – and also the slow spread in the use of new products, even after they have successfully completed medical approval and have proven benefits over existing technology.

'Proven Excellence' quality guaranteed refurbishment process. The five step refurbishment process involves: selection, de-installation, refurbishing, re-installation and warranty and service. The products are re-sold for around 30% less than the cost of a new system but with a warranty 'typically equivalent to a new system'. To facilitate the reuse and acquisition of used parts, Siemens have submitted a proposal for standardizing ratings of degrees of newness.

Although no research has been undertaken to assess the possible environmental benefits which are achieved due to the Siemens refurbishment process, business benefits include: expertise in take-back systems which has made compliance with the WEEE Directive much simpler; environmental marketing benefits; access to new low-cost market segments; and environmental marketing benefits.

Sustainable 'Design Entrepreneurs' – Lightweight Medical

Lightweight Medical was founded in 2003 with the aim of developing sustainable medical devices. They describe themselves as operating a 'speculative' business model in that they licence the intellectual property of their designs to manufacturing partners in return for a royalty of the product sales (Farish et al., 2005). The companies mission statement is as follows:

To consult patients and medical staff to understand problems which could be solved with well designed medical devices or technology. To carefully research, conceptualise, prototype and subsequently license the resulting intellectual property. To ensure our designs are environmentally and socially responsible. Our bottom line is to help save lives and become a market success. (Lightweight Medical, 2006)

This clear focus on user requirements combined with a strong interest in sustainability have generated ideas for products such as the LINT transport incubator. Currently in development, this type of transport incubator are used to transfer critically ill babies between hospitals. The use of carbon-fibre has made the new incubator more than 50% lighter than existing models. This lightweight design will lead to functionality improvements such as improved manoeuvrability, but should also lead to environmental benefits associated with the reduced mass for transport.

The three cases given here demonstrate how proactive medical electronics manufacturers are using innovation to turn business pressures in to drivers for new design approaches, services and business models. These approaches are delivering business benefits such as tangible results of Corporate Social Responsibility policies (Smiths Group, 2006), access to new markets (Siemens AG, 2006), and improved partnerships with stakeholders (Farish et al., 2005). Maximising the potential of sustainability-driven opportunities looks set to play an increasing important role within the business strategy of these proactive manufacturers.

Implications for stakeholders

This paper has focused on the particular drivers for environmental improvement within the medical electronics sector. Product-related environmental legislation, sustainable public procurement practises and competition-driven innovation have been highlighted as being particularly strong drivers within this sector. However, similar pressures are being felt throughout the entire range of engineering industries. In 2004 Arthur D Little consulting conducted a survey of 40 technology companies across Europe, the US and Japan, on the topic of 'Sustainability-Driven' innovation (Arthur D. Little, 2005 cited in Arthur D. Little, 2006). It was found that of the companies who are already embedding sustainability into their business, 60% reported improvements to their revenues and 43% enjoyed cost reduction benefits. Furthermore, 95% of companies believe that Sustainability-Driven Innovation has the potential to deliver business value. These results confirm that leading companies outside of the medical electronics sector are already deriving business benefits from Sustainability-Driven Innovation and view it as a key trend for the future.

The two main conclusions from this paper are firstly, that other industries are likely to be able to learn from successful companies in the medical electronics sector because of the particularly strong drivers for improvements in environmental performance of products. Also, in all of the case studies presented, the companies involved have sister-organisations operating in other industries. The dissemination and implementation of the expertise, skills and business models into other sectors is likely to occur rapidly due to this type of intra-company knowledge transfer.

Secondly, this paper has provided a sample of how medical electronics manufacturers are applying eco-design principles to adapt to their business environment. It is suggested that as the pressures on companies within this sector continue to grow, they are likely to be willing to engage in more radical 'eco-innovation' approaches. Medical electronics manufacturers will be approached as potential industrial research partners to test more radical eco-innovative methods.

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