A Review of the Recent Eco-design Education Initiative for Industrial Design and Technology Undergraduates at Loughborough University

Abstract

During the last decade one of the authors has worked on numerous industrial design projects. During this time eco-design strategies were not implemented or were only used if they complimented what were perceived as traditional design activities. Recently, due to a number of internal and external stimuli, eco-design strategies are becoming core drivers in industrial design activities. This paper examines some of the drivers and barriers behind a number of British companies and why they are changing to encompass good eco-design strategies. To aid this change, companies and design consultancies are looking for industrial design graduates who have a sound knowledge of sustainable design strategies. Recently, an eco-design education initiative for industrial design and technology undergraduates at Loughborough University was undertaken to try to address this issue. This paper includes extracts from an undergraduate dissertation that reviewed this initiative. Some conclusions of the initiative from both a student's and from a professional designer's point of view are suggested and the current and future developments of the module are outlined.

Introduction

In 1994 one of the authors (KSB) designed a gravity-fed water filter for a domestic appliance manufacturer (Fig.1). Closely following the design specification, the water filter was designed using minimal wall thickness and a single polymer and all the parts were simply clipped together. The whole product was then distributed in a simple cardboard package. Many of the design decisions, particularly in the context of this paper, may appear to be driven by eco-design strategies, however, in 1994 there were no eco-design drivers. The wall thickness, as with all good product design strategies was designed to be minimal to reduce manufacturing and shipping costs. The single polymer decision was not due to concerns about the ease of recycling but to the availability of a low-cost food-grade polymer. The simple clip design was not introduced for ease of disassembly, but for ease of assembly. The parts were not load bearing so simple one-way clips could be used to hold all the parts together, aiding in quick assembly times. Using cardboard for packaging, rather than expanded polystyrene foam, was due to the fact that if expanded polystyrene foam had been used, it would take up considerably more valuable warehouse space when compared to fold flat cardboard boxes.

In the same period the author (KSB) also designed products using the same drivers as the water filter but this time the products were rather more complicated and designed to reduce assembly times and component count, which on first inspection may again appear to be a good eco-design strategy. However, eliminating screws and ultrasonically welding disparate materials may have reduced component count and improved assembly times but the manufacturing and assembly process would have had a severely detrimental effect on end-of-life disassembly and material sorting.

> '...until now, many designers may have felt that, if they wished to use their skills, they had no alternative but to participate in the misuse of design. Now, however, as individual values and business priorities are beginning to change, they have the opportunity to demonstrate that environmental considerations, along with social and ethical concerns occupy a central position within mainstream design thinking.' (Mackenzie, 1991)

Many of the strategies that eco-design thinking promotes have distinct parallels with good design practices. Reducing the wall

Kevin Badni
(Lecturer) **and
Rhoda Coles**
(Research Student)
Department of Design and Technology, Loughborough University

Figure 1: Gravity-fed water filter and simple clip assembly detail.

Fourth step: functionality concepts completely fitting into the sustainable society.

Third step: alternative fulfillment of functionality, new concepts

Second step: (complete) re-design of existing product concepts

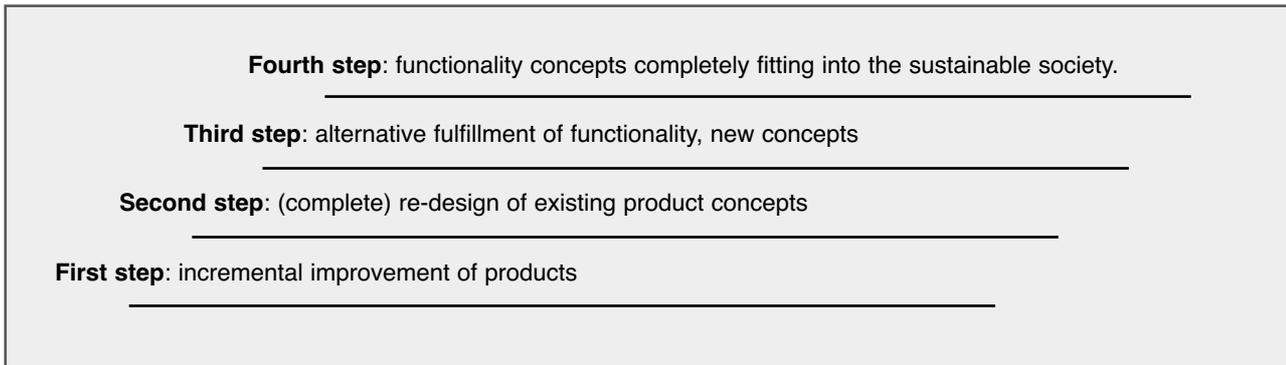**First step**: incremental improvement of products

Figure 2: Eco-design process staircase.

thickness of parts is due to financial savings, not only in terms of reducing the amount of material used and the reduction in manufacturing cycle time (the thinner the wall thickness, the quicker the cooling and ejection time), but also in the reduction in the time and cost of producing the mould tool. Eco-design strategies promote the reduction in the use of different materials for easier disassembly and material sorting at the end-of-life of the product. If the same polymer can be specified for a large number of parts of the product, then this is also seen as good design practice as it allows for multiple impression tooling containing a number of parts. It also allows the manufacturer to bulk buy the raw material and manufacturing set-up times are also reduced.

The eco-design process has been described by Brezet, Cramer and Stevels (1995) as a staircase with four steps. (Fig. 2)

Stevels (1997: 49) concludes that activities on the first and second steps are well within the span of control of individual companies. For success at steps 3 and 4, consumer life style and infrastructure changes in society play a major role. Stevels (1997: 49-50) continues his assessment of the step one activities as follows.

Eco-design activities, incremental improvement
All companies launching products into the market can carry out step one eco-design actions and every employee can contribute to it. Common sense plays an important part in these types of activities. Essentially, it is

bringing together the following type of information (Table 1):

However, these step one strategies are usually weighed up against other requirements in the product's design. If, for example, it was decided that a transparent window was required in a more rugged product, the designer could specify a polycarbonate window as it is simple to mould, clear and relatively impact resistant. However, if the rest of the product requires a more impact resistant material, such as ABS, the polycarbonate window would need to be connected to the ABS polymer and this is likely to be undertaken using ultrasonic welding techniques (Fig. 3). Environmentally, welding of the disparate polymers is not recommended. To concur with eco-design strategies the designer would have to create an ABS casing that mechanically holds the polycarbonate window, this would be dimensionally larger and thus will be aesthetically different from an ultrasonically-welded polycarbonate window (Fig. 3a). The two-piece product would also require some extra assembly time to fix the two parts together. However, at the end-of-life of the product the mechanically fixed product could be disassembled for material sorting and recycled, whereas the welded unit could not.

The same is true for welding or multi-shot moulding any dissimilar materials together. From the viewpoint of a product design strategy, this can dramatically reduce any assembly overheads and eliminate any unsightly screws as well as ensuring an

Table 1: Some examples of step one incremental improvement.

By counting, e.g.	How many parts are in the products?
	How many types of material have been used?
	How many screws or other fixtures are in place?
By measuring, e.g.	Energy consumption.
	Weight.
	Presence of environmentally relevant substances.
	Disassembly time of the main parts?
By calculating, e.g.	What is the cost of environmental improvements?
	What are the yields of environmental improvements?

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uncompromised joint line. Permanently welding disparate materials together obviously makes recycling extremely difficult. To create the same product without welding, either screws, deep push fit bosses or clips are required. This could have a severe impact on the aesthetic and assembly route, so choice of material and fixing strategies would need to be considered very early on in the design process.

Transport packaging is another issue where, at first inspection, eco-design strategies have some initial parallels with good product design strategies but, if examined more closely, there are some distinct conflicts. To protect a product during transportation, many manufacturers use what appears to be an eco-friendly material, cardboard. The manufacturers use this material as it is cheap, easy to store and requires minimal tooling to cut into shape and produce cut-outs and folds. For many products, however, expanded polystyrene foam is used as it has superior impact-absorbing characteristics compared to cardboard. Expanded polystyrene foam is not as easily recycled as cardboard so is not recommended by eco-design strategies. Lewis and Gertsakis (2001) state there is no material currently in use that is ideal from an environmental perspective because each material has advantages and disadvantages. Boyden et al (1991) found that it is not possible to rank one container system ahead of another on environmental grounds. This is because each system (e.g. glass, liquid paperboard, high-density polyethylene) performs differently depending on which environmental indicator is used (i.e. energy, mineral use, greenhouse gas production, generation of air or water pollutants or the production of solid wastes).

An alternative to thinking about which packaging material is least environmentally damaging, is to rethink the whole packaging strategy. The Xerox Corporation in the USA has switched from disposable to re-usable boxes. Xerox has replaced thousands of different-sized one-way shipping containers with a system that relies on nine standard re-usable corrugated boxes. The new system saves Xerox around US$2-5 million annually (Saphire 1994: 12-13). This change in approach to packaging is not only eco-friendly but satisfies the fiscal demands of manufacturers.

Eco-design not only requires a rethink of packaging, material usage, manufacturing routes and thoughts on disassembly, it also requires a complete change in our consumer attitudes. It is almost impossible to buy a kettle today that is designed so a broken

element can be replaced, even though the vast majority of the elements used in kettles are supplied by the same two companies. Not only is it difficult and relatively expensive to buy a replacement element, it is also difficult and expensive to find someone to fit it. The marketing companies have also managed to convince the public that boiling water requires a transparent kettle which glows and can be rotated through 360 degrees so you can watch the water boil from any angle (Fig. 4). So the thought of replacing a burnt out element seems quite unreasonable.

'Many products have reached a dead end by now in terms of further development. This has led to 'additive' design: more and more features or extra gadgets are added instead of reanalysing the basic problems and evolving new and innovative answers' (Papanek, 1984: 246).

Through the study by the Eco-redesign (TM) programme in Australia, the Axis Kettle embodied a range of environmental features that are difficult to find in any other similar water-boiling appliance (Fig. 5). From a consumer perspective, these 'green' features translate directly into user-benefits that make the Axis easier to use, fill and clean, safer to operate and more energy-efficient. The Axis Kettle's high level of environmental performance is in its energy saving design and its potential for easier end-of-life disassembly

Above: Figure 3: Polycarbonate screen ultrasonically welded to ABS frame.

Figure 3a: Polycarbonate screen mechanically joined to product. Fixing rivets have been disguised as a feature.

Figure 4: 360 degree rotating transparent kettle.

Figure 5: Axis Kettle

and recycling. Design of the Axis Kettle was significantly influenced by research which showed that most people re-boil electric kettles even when there is no need to. The solution was relatively obvious – keep the water hotter longer. The Axis Kettle's double-wall design acts like a hi-tech tea cosy to reduce heat loss. In order to fully exploit the increased heat retention, a water temperature indicator signals whether re-boiling is required.

The kettle has also been designed for easy disassembly to facilitate, encourage and increase the possibility of recycling. This is further assisted by specifying minimal but similar materials and using fewer components, many of which are stamped with plastics identification codes to help make recycling more efficient (Bielby, 2003).

Educating industrial design graduates with knowledge of eco-design strategies is becoming more important. Without a strong foundation in eco-design knowledge, the design process, which is a holistic process, is not complete. Brezet, Cramer and Stevels' (1995) design process steps show that step

Figure 6: Large enterprise questionnaire.

External Stimuli	Government legislation (i.e. Waste from Electrical and Electronic Equipment). Pressure from environmental action groups. Pressure from competitors. Shareholders and investors. End-users of the products.
Internal stimuli	An environmental benefit. Manufacturing cost reduction. An increase in market opportunities. Synergy with the company's brand values. Improvement in the company's brand image.
Barriers	No clear environmental benefit. No alternative available. Not yet required by legislation. Conflicting functional requirements. Investment not justified. Insufficient capacity. With too radical an approach it may not fit with the brand image.

Table 2: Some examples of internal and external stimuli and barriers to eco-design.

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one designs can relatively easily absorb eco-design strategies to run in parallel with good product design practices. Step two designs require a different approach; eco-design is core to the process and cannot be simply used as a seasoning to the design process.

'One might be able to argue that up until now designing with environmental impact in mind was a matter of personal taste or individual moral responsibility. Now it is clear that it will become a commercial imperative. The value and role of designers will be substantially reduced if they cannot incorporate new concepts and new criteria into their work.' (Mackenzie, 1991)

Large enterprise involvement
In 1994 the Dutch Government focused on a key question 'How do we implement environmental product development or eco-design amongst SMEs?' (small and medium-sized companies). This question led to the creation of the IC Eco-design project with the aim to make SMEs conscious of the opportunities arising from eco-design (Hartman and Bottcher, 1997). A number of questions were asked of the SMEs as to their perceptions of internal and external influences that either stimulated or created barriers to the implementation of eco-design strategies.

Through the Loughborough University eco-design initiative, a small number of British LEs (large enterprises with 250 or more staff and a turnover of GBP5.6million plus) (DTI, 2003) were invited to take part in providing live eco-redesign projects for the students to work on. With the impending introduction of government WEEE (Waste Electrical and Electronic Equipment) legislation, it was interesting to see if in 2003 the British LEs had the same perceptions as the Dutch SMEs

in 1997 with regards to eco-design implementations. A questionnaire based on the format used for the IC Eco-design project was sent out to six managers of British LEs.

Analysis of the questionnaire produced the following results. The reasons these companies are now placing eco-design as an important driver for their design is due to a number of external and internal stimuli. Along with these positive stimuli there are also a number of negative obstacles that the companies perceived as barriers to implementing eco-design. Table 2 outlines some examples:

The commercial results expected from using eco-design are mixed. In some cases the market share is hoped to be increased but accompanying this there is an acknowledged fact that the end-users are now expecting environmentally designed products. The actual profit based on eco-design strategies could not be predicted, eco-design strategies are seen as drivers to increase the final product's selling price, rather than to implement the introduction of earlier cost cuts.

Within each LE there is no single person responsible for keeping up-to-date with eco-design issues, it is seen as integral to a number of people's 'day jobs', using publications and workshops to disseminate information throughout the companies.

The LEs were motivated to participate in the Loughborough University initiative as they wished to increase the quality of specific products seeing idea generation as an important part of product innovation. There was also a strong feeling that they wished to support students and British universities and at the same time they wished to learn more about eco-design issues.

The need to integrate sustainable issues into higher education design courses

Eco-design is not seen as the most important driver but during designing, as with manufacturing methods, material selection, ergonomics or any of the other myriad of drivers that designers have to consider, businesses that strive to remain competitive have started to recognise the opportunities to maintain a commercial lead inherent in the new demands for environmental quality.

'The traditional definition of a well-designed product is one that performs its function successfully; is manufactured efficiently, using appropriate materials and techniques; is easy to use; is safe; offers good value for money, and looks attractive. The relative importance of these factors will vary from product to product. New definitions of good product design will include an environmental consideration: is the product designed to minimise the impact it has on the environment, during the whole of its life cycle.' (Mackenzie, 1991)

Not only are LEs and SMEs being self-driven by internal stimuli, the external stimuli, particularly government legislation are also putting increased impetus for the application of sustainable design strategies throughout the design activity. The need to integrate sustainable design into design practices is becoming increasingly more apparent. However, the implementation of sustainable issues can be difficult. Each shift towards sustainability, however small, requires innovation, creativity and support. Few companies have either the knowledge or the expertise to implement issues regarding sustainability throughout the product development process. Another problem encountered by many companies has been finding a suitable and easily understood method of documenting their environmental activities and outcomes to their stakeholders in a clear and comprehensive manner. It is also suggested that without efficient environmental management systems, the impact of initiatives becomes diluted over time.

Acknowledging these difficulties was the first step towards a realisation of the need for developed strategies if sustainable design was to be effective throughout the design process. Many initiatives were developed. These are some of the more significant initiatives in the context of this paper:

- the *EcoIndicator 95 and 99 Manuals for Designers* developed by the Pré Consultancy (http://www.pre.nl)

- the UNEP manual *Eco-design: a promising approach to sustainable design and production* (1999, http://www.unepie.org)

- the work done at Royal Melbourne Institute of Higher Technology (http://www.cfd.rmit.edu.au) and published as *A Guide to Eco-redesign: improving the environmental performance of manufactured products* (1997)

- the work of Edwin Datschefski (2001, http://www.biothinking.com)

- publications of *The Journal of Sustainable Product Design* (http://cfsd.org.uk)

- the publication from Martin Charter and Ursula Ticshner *Sustainable Solutions* (2001).

But it is becoming a growing concern that this integration of sustainability is arriving too late and, although the numbers are increasing, only a select few 'forward-thinking' businesses are concentrating on sustainable solutions. A clear solution to this problem is to establish the knowledge and ability required to create sustainable products (and stress their importance) before designers enter the industrial design industry. It is also clear that the best place to establish this knowledge base is within higher education, as Orr states:

'It is worth noting that [the destruction of the world] is not the work of ignorant people. Rather it is largely the results of work by people with BAs, BSs, LLBs, MBAs and PhDs.' (Orr, 1994: 7-8).

What is not clear is how to establish this knowledge base. Given the breadth of the sustainability agenda, translating the concepts into effective higher education curricula is a formidable challenge.

With the emerging need to introduce students to sustainable design strategies, a recent initiative for industrial design and technology undergraduates at Loughborough University was undertaken. The original paper can be found in *The Journal of Design and Technology Education* Volume 7, Number 2 'Eco-design Strategies: A Recent Initiative for Industrial Design and Technology Undergraduates at Loughborough University' (Bhamra, Lofthouse and Norman, 2002).

The Loughborough initiative

Loughborough University has always included sustainable design within its industrial design and technology courses. However, in 2000, staff departures and keen internal interest led to the creation of an education for sustainability programme to further engage second year students with the sustainable

design agenda. With the help of the International Ecotechnology Centre (IERC) at Cranfield University and the resources mentioned earlier, two new modules were developed.

The first module 'Issues in Sustainable Development' enabled students to become aware of the range of issues concerning sustainability related to design activities. This was done by five two-hour lecture-led sessions and five one-hour student-led seminars. The lecture-led sessions were a combination of lectures from Dr Vicky Lofthouse and Dr Tracy Bhamra, both from Cranfield University, which included social, economic and environmental issues, responsibilities of the industrial designer, the effects of emerging legislation, manufacturer's attitudes and practices and the impact of industry on the world and its environment. They also introduced many of the available tools to aid the implementation of sustainable solutions. The student-led seminars required students to read a selection of papers from *The Journal of Sustainable Product Design* and the new text *Sustainable Solutions* (Charter and Tishner, 2002) and present one each to the rest of the group.

The second module 'Design for Sustainable Development' enabled students to develop an eco-design strategy through the study of the eco-design manual developed by Tu Delft (Brezet *et al*, 1997, see also www.unepie.org). Students were required to apply the eco-design method by selecting a product, creating an environmental product profile utilising eco-design tools, establishing the eco-design strategy, generating improvement options and communicating the final outcome. The teaching of this module was done via six two-hour workshops and two progress tutorials.

Students were also encouraged to look at and utilise the Design for the Environment Multimedia Implementation (DEMI) project website (www.demi.org). Set up as a learning resource specific to higher education, it is still in its developmental stages but contains many of the key principles, case studies and information sources relevant to the sustainable agenda.

Student review for the course 2001-2002
Outline of the study
Key questions that were asked into the eco-design initiative were:

• Do recent developments in thinking regarding sustainable design provide a sufficient basis for this change?

• Has the outcome of this change (the development of the Loughborough initiative) been successful?

• Have sustainable issues been well integrated into the whole course?

• Has the initiative developed positively over the two years it has been running?

Students were also asked questions regarding the success of the programme in more simplistic terms. They were asked for their opinion of each of the teaching methods used within the programme. They were also asked to suggest ways in which the education for sustainability programme could be improved. The responses to these questions were then used in informal discussions with Eddie Norman. A final questionnaire was then given to Eddie Norman.

Have recent developments in thinking concerning sustainable design provided a sufficient basis for changes in the industrial design and technology course at Loughborough University?

In order to answer this question it is necessary to assess what developments would provide this 'significant basis'. Firstly, there has to be a required level of 'need' to implement a new topic or course. Furthermore, this need must be great enough to justify the changes made to the industrial design and technology course.

As Cavanagh-Downs explains: 'In the future all companies will need to implement strategies to reduce the environmental impact of products' (1997: 2). It is also becoming clear that industry will benefit if knowledge of good eco-design practice is established in its workforce before they enter the industrial design profession. There is also growing consumer and government awareness and concern and this has led to new legislations. This will soon mean that companies will have to account for their environmental performance and 'once it is a market requirement' states Eddie Norman 'designers with 'eco-design know-how' will be in demand' (Coles 2002: 25).

It has already been concluded within the design industry that developed strategies are required if sustainable design is to be effective throughout the designing. It is clear that these developed strategies are also required within higher education. As Suurland clearly stated, '...this is a steadily growing process that needs to be fostered by sufficient incentives...' (1999: Preface). Industry has also shown that these strategies are best implemented with the support of professionals such as RMIT (www.cfd.rmit.au) or the Dutch consultants at Pré (www.pre.nl). In order to assess whether

these strategies and support were present within the Department of Design and Technology, questions were asked about what resources and support were available during the creation of the Loughborough initiative and whether these were deemed sufficient.

Loughborough University's use of the developed initiatives mentioned earlier, along with the professional advice, support and supplementary lecture series offered by Dr Vicky Lofthouse and Dr Tracey Brahma from Cranfield University, show conclusively that sufficient support was available for the creation of the Loughborough initiative.

Can the initiative be considered a success?

To elicit information on the success (or failure) of the 'education for sustainability' programme or Loughborough initiative that was developed, a decision had to be made concerning ways to measure this success. Walker and Nielson state:

> 'It becomes evident that in order to incorporate the principles of sustainability, the focus has to change from being 'product orientated' to being 'issues orientated'...' (1998: 7)

Academically, students must show a sound knowledge of many of the issues surrounding sustainability on passing the second year for the course to be considered 'successful'. Questions were asked on a variety of subjects to discover whether this was the case.

When Dr Eddie Norman developed the Loughborough initiative his aim was 'to allow students a good insight into current practice' (Coles, 2002: 26). He then wanted to give 'interested students the chance to increase their knowledge by learning about 'best practice' from worldwide sources and allowing them the opportunity to attempt an eco-redesign project' (*ibid*).

The programme has been very successful in installing a basis of knowledge for further sustainable activity to be taken. All second year students have been introduced to the principles of sustainability and have been made aware of their relevance, especially within the industrial design industry. This opinion is reflected in the words of a third year student who states:

> 'I believe it to be important because as designers we have the ability to shape the future to some degree...it should be on every designer's conscience and in the future it will be evident in practice more and more.' (Coles, 2002: 27)

Students who involved themselves in the two optional modules showed high levels of

understanding regarding the issues of sustainability. They showed the ability to evaluate the environmental performance of products and services and document their findings using clear and unambiguous methods. They showed the required skills to assess the environmental acceptability of materials and processes and to determine whether suppliers were socially acceptable. They also showed an understanding of the ability to implement environmental consideration at every stage of the design process. As another third year student points out '...sustainability is a subject that can be woven into most aspects...' (Coles, 2002: 27). This provided students with a 'cradle to grave' attitude towards products and services in keeping with the principles of sustainability.

Although the background reading was described as 'a bit dry', most students agreed that reading around the subject was essential as it '...gives up-to-date information about sustainable design...', '...highlights good and bad cases, current and past practice..' and '...is needed so that pupils learn from past mistakes and successes...' (Coles, 2002: 27). Students found the opportunity to look at previous case studies invaluable when it came to producing their own eco-redesign solutions as it provided a wealth of ideas and examples.

The lecture series by Cranfield University was regarded highly by students. Receiving information from professionals acted to further endorse the information given. Students were unanimously very pleased with the eco-design 'tools' and found them 'easy to use, clear and simplistic. They gave effective results and show you a clear path for improvement' (Coles 2002: 28). Indeed these tools were of more use to the students during the eco-redesign project in semester two than any other resource.

The Tu Delft manual was largely forgotten by third year students who had taken the 2000-2001 course. They did, however, comment on their enjoyment of the practical side of the course and the pleasure in seeing the knowledge they had acquired in the first semester being transferred into sustainable solutions of their own. This begged the question of the need for the Tu Delft manual. However, second year students who were in the process of following the manual mentioned that, although it was not the most informative part of the course, the manual gave 'structure and guidance to the use of the tools and knowledge learnt during the first semester' (Coles, 2002: 28).

Success was measured not only by a student's ability to remember text but also by their

ability to use this knowledge within the field of their expertise, in this case by designing products or systems. As aptly stated by Juck, 'solutions then become focused on the specific locality and function, rather than abstract 'knowledge' (2002: 16). A topic for discussion now arises as to how to determine whether a product or system designed in response to the initiative is to be viewed as positive or negative within the context of sustainability; how sustainable does the outcome have to be? Walker and Nielson also state:

> '...It is being widely recognised that a more fundamental, systemic shift in our approaches to product design, manufacturing and our material expectations will be required if sustainability is to be fully embraced.' (1998: 7)

So is the success of the course to be measured by the ability of its students to consider a product in greater depth as to its relationship with the ways in which people live, work and view that product, in the students' ability to create fully sustainable products and/or systems, in the students' ability to create products that have a level of 'environmental friendliness' that is similar to the level expected in industry on their entry into the workforce, or by a combination of all these factors?

One noticeable element within the 'education for sustainability' module at Loughborough University's Department of Design and Technology is that high marks can be readily gained with limited environmental advancement as long as the project is seen to be encased in sustainable references, the use of 'eco-design tools' and environmental 'jargon'. This problem has been embedded within the struggle towards sustainability throughout its history. Rather than take a more urgent approach to the need for sustainable solutions, leaders give the notion of 'a little goes a long way'. These approaches, although encouraging and self-satisfying, only act to ensure a very slow approach to a sustainable society. Mcdonagh and Braungart comment:

> 'Eco(efficiency might be seen as bailing out the Titanic with teaspoons (yes, it slows down the disaster, but the sinking ship still sinks.' (cited in Charter et al, 2001: 141)

This leads the author to ask whether the Loughborough initiative's approach to 'education for sustainability' is a success within the wider agenda of continuing the advancement of sustainability at a brisk enough pace. As one second year student

states, 'we must all consider the issues in order to make progress and challenge convention' (Coles 2002: 34). Is teaching a corrective method of redesign sufficient? Eagan suggests not, stating:

> 'Universities play a role not only in educating our future leaders to deal with the legacy of contaminated and damaged planetary life support systems but also in experimenting with models that can lead society to operate in more environmentally conscious ways.' (2002: 48)

Should the Loughborough initiative be concentrating on developing new, highly sustainable products that consider the problems of an unsustainable society from its source? Many practitioners believe this to be the solution and state the current feasibility of these solutions. Allenby (1995) states:

> 'The main barriers to such a new cyclic approach are problems of culture, psychology and embedded ways of thinking rather then problems of information and technological capabilities.' (cited in Eagan *et al*, 2002: 50)

Although this approach to sustainability is more complicated and, to some extent, uncharted, as Cavanagh-Downs points out '...we have to radically rethink how products are conceived, produced and consumed with a view to using products and materials more efficiently...' (1997: 4), it is certainly viable and seemingly the most current approach to take. What is debatable, however, is whether universities, and particularly the Loughborough initiative, should be employing this revolutionary approach or whether the approach outlined by the Pré Consultancy as the 'systematic drive for the continuous improvement of the life cycle environmental performance of products' (www.pre.nl) is still acceptable. When Norman was asked to comment on the effectiveness of the Department's eco-redesign approach to education for sustainability his response read:

> 'It is not more effective, but it is currently where society is. New sustainable products require movement in the way people design, make, buy, use and dispose of products (or their dematerialised equivalent). Changing society is a tough agenda. Designing products in a more eco-efficient way is at least something that designers can do now and, perhaps, should be expected to do.' (Coles, 2002: 35)

But is this acceptable to a university programme? This is more a question of where universities lie within current industrial practice, as Norman states '...whether design education should be leading or lagging current

design practice is always up for debate' (Coles, 2002: 35).

Nevertheless, the commercial imperatives within industry act to diminish the importance of sustainability and, although legislation is pushing its integration forward, these movements are slow and in many cases unwelcome. The solutions lie in empowering students with the ability to produce radically sustainable solutions as *well* as effective eco-redesign outcomes and in installing within them a heightened sense of the importance of sustainability. This can then act as a catalyst for increased sustainable action upon entry into the industrial design industry.

Integration
The importance of 'integration' with regard to the success of an education for sustainability programme was also discussed. Students were asked about the qualities they considered as being essential to design, what skills they hoped to gain from the entire degree and what their employment interests were (to understand where sustainability fitted into their wider agenda). Current second year students were asked whether they planned to integrate the principles of sustainability into their third year major project. Third year students were asked if their major projects contained any sustainable elements. Lecturers who were not involved in the creation of the initiative were asked for their views on sustainability, their knowledge of the subject and to what extent it affected their judgement and marking of students' work throughout the industrial design course.

An issue that has arisen during the course of the inquiry is that, although the sustainability teaching appears to be effective, it is unlikely that students will take this information any further than in achieving a project that gains them marks within the 'education for sustainability' subjects. As Juck points out 'raised awareness and increased knowledge do not automatically lead to more sustainable behaviour' (2002: 15). He then goes on to suggest that this is due to the far more inviting principles surrounding industrial design that he entitles the 'shadow curriculum'. This shadow curriculum counteracts any ideas of sustainability and includes the economic structure that is currently 'based on the exploitation of people and nature and aiming for growth within a closed system' (2002: 15). In essence, he is stating the fact that the ideas of sustainability are in direct contradiction with the ideas of good design that are drilled in: development, progress and growth, all entrenching unsustainable behaviour based on the ideals of money, power and prestige and, more specifically, the need to increase one's share in it.

It is a difficult job to convince design students of the benefits and, more so, the importance of sustainability. We must first break through their inherent values as people and consumers. Students are used to seeing products in the market place doing well and winning awards that have no environmental considerations at all (for example, mobile phones). They are used to items being made in a certain way, by a certain process and from a particular material. They will therefore consider these options more readily.

Norman suggests that one reason third year students are not using the principles of sustainability in their projects is due to 'current industrial practice not deeming it essential' (Coles, 2002: 30-31). He then goes on to theorise that once legislation comes in the students' knowledge will re-emerge within industry.

Another reason for students not including environmental considerations in projects outside the modules could be due to Loughborough University's Department of Design and Technology undermining the importance of sustainability by making it an optional matter. For teaching sustainability to be effective, there is a need to integrate teaching, research, personal behaviour and the marking structure of other elements of the course within a framework of sustainability. This need is backed up by Hesselink (2000: 41) and Juck who expresses the need for 'redefining the notion of excellence within a sustainable context' (2002: 15).

The judgement of a product with regard to its long-term impact needs to become an integral part of industrial design courses. It has also been suggested that the integration of sustainability with other elements of design enables solutions to be more effective. Students also take this view on the integration of sustainability with all other elements of design, one explains, 'when subjects are integrated together then the application of those subjects becomes much easier to understand' (Coles, 2002: 32).

When asked what improvements could be made to the 'education for sustainability' programme, nearly all students expressed a desire for the programme to become an integral part of the design and technology degree course. They suggested it should have as much emphasis placed upon it as knowledge of materials and processes. As one third year points out:

'Sustainability and eco-design tools are intended to be used throughout the design process as evaluator and development tools and so the correct emphasis needs to be placed upon this and the education of these

tools and ideals should be encouraged through all aspects of the course.' (Coles, 2002: 33)

Even Eddie Norman admitted a weakness of the programme being 'no requirement to follow it up with design practice modules' (Coles, 2002: 32). But he also put forward an argument for this lack of integration stating CAD/CAM also started that way and expressing a hope that sustainable issues will gradually 'move over' to become a more significant part of the core programmes over the next few years. However, are not matters of sustainability important enough to justify quicker transition from optional to mandatory course content?
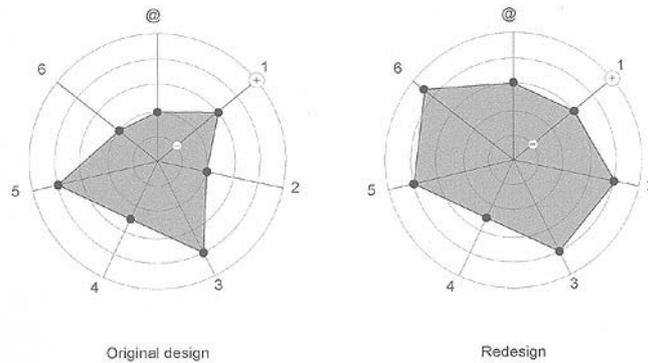
Is the initiative progressing?
One aspect of 'good' educational practice that has been fully justified over the years is the need for educational practices to remain current by developing positively over time.

The Department of Design and Technology's initiative was updated between 2001 and 2002. The optional modules saw the addition of text from 'sustainable solutions' (Charter *et al*, 2001) that replaced old journals from *The Journal of Sustainable Product Design*, that has now moved to a paper-based format, with overviews of more current eco-design cases. But the result was disappointing, Norman states:

> 'Authors of the standing of Martin Charter and Ursula Tishner ought to have been able to provide effective overviews of aspects of the eco-design agenda. The reality is disappointing in that the overviews provided are difficult reading – probably more difficult than the journals.' (Coles, 2002: 37)

The DEMI website (www.demi.org.uk) was also updated and this in turn updated the resource and information source used by students. In the 2000-2001 programme the DEMI website appeared to have many structural problems and it could have arrived more quickly. Its main problems appeared to be in the way it attempted to communicate the complex information that was available in a visually exciting and easily accessible manner. It seems to have developed positively in time for the 2001-2002 programme with more praise given by second year students. However, as one student comments, the '...dull nature of its layout' (Coles, 2002: 37) has meant students will still only regard it as a research aid rather than using it as a web-based self-learning tool.
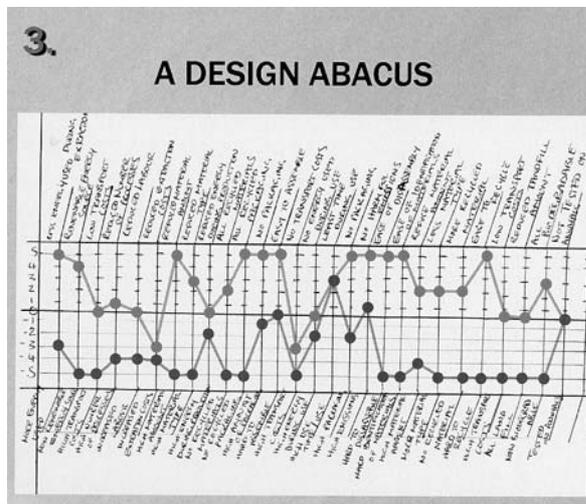
One aspect of the course that appeared to be overlooked was in the ability for third year undergraduate students and graduates to

remain up-to-date with the current standing of the sustainability agenda. This question was posed to Norman who responded:

> 'They [the students] know the main journals and where the main action is, so they are in a better position than most design students. It will always be difficult to keep up-to-date ...reading journals and going to conferences is the way.' (Coles, 2002: 38)

Although students are in a 'better position' than other design students, and indeed most designers, to search for relevant information

Figure 7: Eco-Strategy wheels (S. Broadbent), Eco-Indicator 99 (R. Boaz), Design Abacus (L. Rogers)
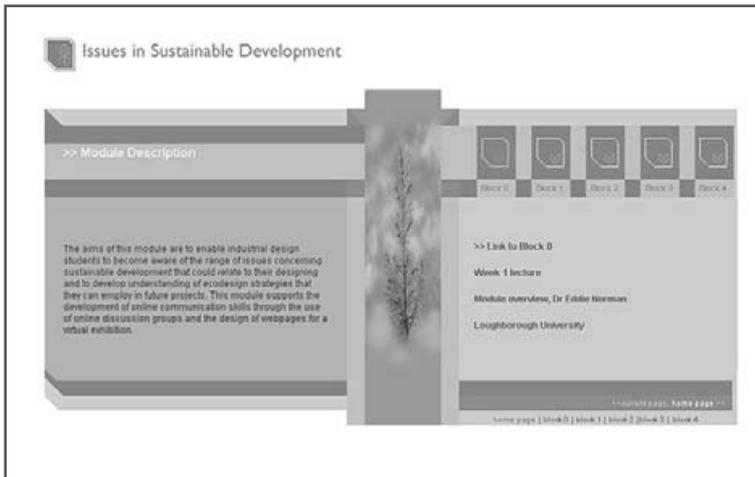
Figure 8: Design and technology sustainable design intranet site.

to remain current with the principles of sustainability, this can be time consuming and may result in the student discarding eco-design in return for an 'easier route'. It may also cause complications in the students' grasp of new concepts, as the way the information is presented may not reflect the manner in which they were taught and therefore be difficult to understand. This has led to the conclusion that a dynamic resource is required that can be used as a core teaching tool while the student is being taught but then also acts as a source of constantly updated information for graduate members. This approach was presented to Norman and he was asked whether he thought students would benefit from this type of resource. He explained that the Department was currently converting the modules to 'on-line versions' for next year.

The above review of the Loughborough initiative was written from a student's perspective, it is now interesting to hear from the viewpoint of a professional designer (KSB) who has worked for a number of manufacturing industries and consultancies.

Professional designer's review of the courses 2001-2003
The extensive breadth and sometime ponderous nature of sustainable design information has been suitably broken down into succinct student-friendly 15-minute long PowerPoint presentations. The seminars and papers that followed give the students a good foundation in the worldwide knowledge in the area of eco-design. Knowing the major sustainable design resources and relevant

Fig. 9: Examples of professional eco-design products. Ecobin, Aeron Chair, Sony recycled speakers, Dunlop recycled boots. Images from Datschefski, E (2001) The Total Beauty of Sustainable Products, Switzerland: Rotovision SA

websites puts the students in a strong position to investigate the eco-design field. The Cranfield University lectures are well received by the students and provide a clear structure to the sustainable design agenda. Using external experts also adds an extra motivational dimension to the Loughborough initiative.

With the background knowledge, the students' projects showed a good understanding of many of the eco-design issues, they are particularly proficient at implementing the eco-design tools for product analysis, such as the MET matrices and the eco-design strategy wheel (Fig. 7). Unfortunately, some student designs are aesthetically poor and they try to justify this by stating that it is 'eco-friendly'. This is the same as excusing poor low volume inclusive design, defending the design, as it had to take into consideration an extra design specification. Eco-design like inclusive design should cater for all, and ultimately be superior, so everyone will desire to own the eco-designed product regardless of whether it is seen as 'eco-friendly' or not.

Current and future developments
The lecture notes and previous examples of student PowerPoint presentations have been put on to the Department of Design and Technology's intranet site (Fig. 8). The students' PowerPoint presentations and their project display boards, accompanied by short descriptive narratives, are being collated into a database that will also reside on the Department's intranet site. This will build into a large and diverse database of examples of eco-redesign projects that will add extra value to the students' information resource area.

Since the original paper (Bhamra et al, 2002), the initiative has managed to acquire the interest of a number of British LEs to provide live projects for the students to undertake in Semester 2 (Fig.10). This not only adds an extra motivational dimension to the module, but also provides the students with an experience of dealing with real industrial briefs and specifications compared to the original initiative where off the shelf products (literally) were used.

Along with the existing Cranfield University lectures, the initiative has also managed to obtain the services of Edwin Datschefski, a leading figure in the sustainable design world, to come and talk to the students about his personal cyclic view on eco-design strategies, adding an extra motivational and inspirational

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Figure 10: Module structure for design for sustainable development – semester two

Week	Thursday (1.00, ZZ1.06)	Notes	Logbook progress
1 (6 Feb)	Briefing from companies and organisation of groups		Draft a group abacus Disassembly: identify all materials and processes and how the product works (howstuffworks.com)
2 (13 Feb)	Introduction to the Promise Manual	EcoIndicator tutorials	EcoIndicator Analysis User analysis
3 (20 Feb)	**Group A** Workshop with Tracy Bhamra (Introduction to environmental analysis (MET and checklist), environmental drivers (internal and external), improvement options using wheel and checklist and the concept of selecting feasibility options	**Group B** Progress tutorials	*Week 3 or 4 After your workshop* Complete environmental analysis (MET and checklist) Analyse environmental drivers (internal and external), Establish improvement options using wheel and checklist Complete the selection feasibility options
4 (27 Feb)	**Group B** Workshop with Tracy Bhamra (Introduction to environmental analysis (MET and checklist), environmental drivers (internal and external), improvement options using wheel and checklist and the concept of selecting feasibility options	**Group A** Progress tutorials	*Week 3 or 4 After your progress tutorial* Investigate the demi and biothinking websites and other sources of inspiration (e.g. Eco-design Handbook)
5 (6 March)	**Group A** Workshop with Vicky Lofthouse (Generating ideas, creativity techniques (future forecasting, brainwriting, using metaphors ...) and selecting the best options	**Group B** Progress tutorials	*Week 5 or 6 After your workshop with VL* Initial development and analysis of Eco-redesign ideas *Week 5 or 6 After your progress tutorial* Complete analysis of several inspirational designs or products
6 (13 March)	**Group B** Workshop with Vicky Lofthouse (Generating ideas, creativity techniques (future forecasting, brainwriting, using metaphors ...) and selecting the best options	**Group A** Progress tutorials	
7 (20 March)	Presentation by Edwin Datschefski		Progress your Eco-redesign (including a new EcoIndicator analysis)
8 (27 March)	Portfolio presentation and web design workshop		
Easter			
9 (1 May)	Tutorial presentations of your initial Eco-redesign proposals	Web design Tutorials)	Continued development and analysis of Eco-redesign proposals
10 (8 May)	Progress tutorials	Web design Tutorials	Selection of the most promising sustainable design concepts
11 (15 May)	Progress tutorials	Web design Tutorials	Portfolio and web presentation planning
12 (22 May)	Progress tutorials		
Friday	Submission of portfolios and web files		

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element to the sustainable development module.

Outcomes of the reviews

Loughborough University's sustainable design initiative is an essential module for undergraduate design students. Manufacturers and design consultancies are being driven by internal and external stimuli to apply sustainable design strategies throughout their design processes. It is therefore becoming essential for all industrial design graduates to have a good foundation and knowledge of eco-design strategies so they can apply these skills in directing the design process.

It is shown that the support provided by Cranfield University, along with a number of resources available as guides to implementing sustainability, provided a sufficient basis for the development of this programme and that its introduction to the Department of Design and Technology was made 'at the right time'. The use of a variety of teaching methods, strategies and tools allowed students to gain a clear understanding of the principles surrounding sustainability. However, it is apparent that these tools, methods and strategies need to be continuously developed and reassessed in order to remain current. It is also discussed that students must be encouraged to update their knowledge of environmental issues once they have graduated. A dynamic resource is therefore required and is currently being developed by Loughborough University's Department of Design and Technology.

What is not clear is what emphasis the Loughborough initiative should take within the wider sustainability agenda. There are two conflicting views on the 'education for sustainability' programme at Loughborough University. The first is that the aims of the Loughborough initiative are sufficient for a sustainability course within higher education, allowing students the opportunity to be introduced to the principles of sustainability and attempt an eco-redesign project. This mimics the position of industry, which will require this knowledge when legislation is implemented, which will be around the same time as students' entry into the industry. Companies will need to rethink their products to include a selection of environmental considerations. The design students who took the sustainability options at Loughborough University will have the knowledge to apply these changes effectively. This approach relies on industry and, more importantly, government policy and legislation creators to move industry forward and thereby increase the importance and integration of sustainability. This will lead to education for

sustainability also increasing to a core course topic.

Another view is that the approach adopted does not properly reflect the importance of sustainability, its 'optional' nature undermining the need for sustainable action. It only educates students with the ability to implement eco-redesign solutions and ignores the focus on the design of truly sustainable new products and services that is required for the development of a truly sustainable society. The argument against this approach is that higher education students are already dealing with a multitude of information and considerations and that to ask them to produce highly sustainable solutions may be 'asking too much'. This brings us to the additional need for 'education for sustainability' to become a concept woven into nearly all aspects of the industrial design and technology course at Loughborough University. This would act to stress the importance of the subject and make it easier to understand the concept's relationship to all aspects of the design process.

These contradictory views highlight one important question that needs to be asked. Should universities be taking a leading role in the struggle towards a sustainable society, providing examples of what can be achieved and allowing students to experiment with highly sustainable concepts, or should they follow industrial practice, their rate of sustainable advancement being determined by action within industry?

Whatever approach is adopted, higher educational institutions must act as partners with professionals in discussing, promoting and implementing ideals into real life situations. This allows students to gain a greater understanding, reinforced by professional experience and produce tangible examples of the benefits that can be gained from sustainable solutions.

The student output will hopefully produce some excellent results not only to obtain a good module mark, but also for the participating companies which will hopefully in turn lead to further collaboration between industry and the Department of Design and Technology at Loughborough University. It is hoped that an article based on the students' work with these companies will appear in a later issue of this Journal.

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