

This item was submitted to [Loughborough's Research Repository](#) by the author.  
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

## **EcoDesign education strategies: a recent initiative for Industrial Design and Technology undergraduates at Loughborough University**

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

© Trentham

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Bhamra, T.A., V.A. Lofthouse, and E.W.L. Norman. 2019. "Ecodesign Education Strategies: A Recent Initiative for Industrial Design and Technology Undergraduates at Loughborough University". figshare. <https://hdl.handle.net/2134/1009>.

This item was submitted to Loughborough's Institutional Repository by the author and is made available under the following Creative Commons Licence conditions.



creative commons  
COMMONS DEED

**Attribution-NonCommercial-NoDerivs 2.5**

**You are free:**

- to copy, distribute, display, and perform the work

**Under the following conditions:**

 **Attribution.** You must attribute the work in the manner specified by the author or licensor.

 **Noncommercial.** You may not use this work for commercial purposes.

 **No Derivative Works.** You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

**Your fair use and other rights are in no way affected by the above.**

This is a human-readable summary of the [Legal Code \(the full license\)](#).

[Disclaimer](#) 

For the full text of this licence, please go to:  
<http://creativecommons.org/licenses/by-nc-nd/2.5/>

## **EcoDesign education strategies: a recent initiatives for Industrial Design and Technology undergraduates at Loughborough University**

*Dr Tracy Bhamra and Dr Vicky Lofthouse (Cranfield Institute of Technology) and Dr Eddie Norman (Loughborough University)*

### ***Abstract***

The emerging need to introduce students to sustainable design strategies requires curriculum developers to address some difficult issues. The effective introduction of sustainable design into industrial practice has been the result of significant initiatives that have provided training and support. Student designers need no less, but resources are only beginning to be developed and staff expertise is not widespread. It is essential for those engaged with this agenda to share the expertise they have if further generations of designers are not to emerge from universities with no more knowledge of good practice in sustainable design than their predecessors. This paper reports some initial curriculum development findings concerning the introduction of sustainable design options to Industrial Design and Technology undergraduates in the Design and Technology Department at Loughborough University. The development of these options has been supported by staff from the International Ecotechnology Research Centre at Cranfield University. The evolved structure and rationale for the options is described and some examples of the outcomes in terms of student project work are shown. Some tentative conclusions are suggested and the intended future developments outlined.

### ***Introduction***

In the 1970s the concept of education based on the 'Arts' and the 'Sciences' as separate cultures still held sway and Archer, amongst many others, wrote of the inadequacies of such a perspective.

Both of C P Snow's two cultures have been condescending towards the executive aspects of the material culture. Hence, perhaps, British society's failure to give adequate social, political and intellectual support to its own manufacturing industries ... (1976)

During the 1980s and 1990s some industrial design curricula for both undergraduates and postgraduates have been evolving to meet some of the challenges posed by the weakness of this position, for example the undergraduate degree programmes at Brunel and Loughborough Universities (see the special edition of *Studies in Design Education Craft and Technology* in Summer 1988) and the link course between the Royal College of Art and Imperial College in London for postgraduates (eg Wingfield, 1980). These have been a response both to the greater understanding of what is possible, as well as to what is needed. A survey of undergraduate courses led by Myerson in 1991 and a report by Ewing for the Design Council in 1987 documented some of the emerging practice, but also indicated slow progress. Ewing's report found 12 UK courses, 4 US courses, 1 course in Holland and 1 course in Japan which were involved in teaching design as a subject that linked industrial design with engineering and technology. Clearly these were a small fraction of the higher education courses teaching either engineering or industrial design separately. Some work has been done on understanding the nature of the issues (eg Norman, 1998), but it is only really now that 'sustainability' is on everyone's agenda that the need to get to grips with this area of industrial design education has become urgent. Beginning to address the issues associated with sustainable design inevitably requires a pedagogy that rises above the two cultures model.

Of course, sustainable design is itself a fast-emerging area and many people have made important contributions. These are just some of the more significant initiatives (in the context of this paper) to enable professional designers and higher education students to engage with this agenda.

- The *EcoIndicator 95 and 99 Manuals for Designers* developed by the Pré Consultancy in The Netherlands (<http://www.pre.nl>);
- The UNEP manual *Ecodesign: a promising approach to sustainable design and production* (1999) based largely on work done at Delft University (<http://www.unepie.org>);
- The work done at RMIT (The Royal Melbourne Institute of Technology, (<http://www.cfd.rmit.edu.au>) and published as *A Guide to EcoReDesign: improving the environmental performance of manufactured products* (1997);
- The recent launch of the Demi website ( <http://www.demi.org.uk> ) developed for design students in higher education by a consortium of 8 UK organisations led by Goldsmiths University (Clare, 2001);
- The work of Edwin Datschewski (2001), (<http://www.biothinking.com>).

The decision to develop the undergraduate modules at Loughborough was taken knowing that these resources relating to these initiatives either existed or were emerging and the publication of *The Journal of Sustainable Product Design* (<http://www.cfsd.org.uk>), which began in April 1997, was also an important factor. The papers in this journal are not written ‘for students’, but, nevertheless, they are accessible to them.

This paper reports the introduction of options in sustainable design for second year Industrial Design and Technology undergraduates at Loughborough University which are emerging within this context. These modules are in their early stages and the purpose of this paper is to share thinking about strategies and resources and to give some indication of lessons learnt.

### ***The Loughborough Options***

Year 1 students have studied Mackenzie’s *Green Design* (1991) for the past decade and students have written Year 3 dissertations relating to sustainable design throughout the 1980s and 1990s, but there had been a long-standing desire within the Department of Design and Technology to introduce options to enable students to become more fully-engaged with the sustainable design agenda. However there was an equal recognition of the difficulties. Resources suitable for industrial design undergraduates had yet to be developed (although the recent development of the Demi website is acknowledged) and the traditional ‘research-led teaching’ approach expected in universities requires appropriate staff expertise. Consequently, when there were strong internal drivers for innovation in the Industrial Design and Technology undergraduate programmes in 2000/2001, an approach was made to the International Ecotechnology Research Centre (IERC) at Cranfield University to see if their support for an initiative in teaching Loughborough’s undergraduates could be negotiated. (Cranfield University has only postgraduate students.).

With a collaborative agreement reached, the essential structure of the new modules was planned. Following discussions and on the basis of previous research evidence (eg Norman, 2000), it was decided that ‘background learning’ would form the basis of the Semester 1 module and ‘designing’ would form the basis of the Semester 2 module. The research evidence had shown that for some areas of designing prior learning of associated technology was essential, if that technology was to be effectively used in the design activity. It was believed

that sustainable design was one such area. Tables 1 and 2 show the evolved semester teaching structures. It can be seen that the Semester 1 module draws heavily on the *Journal of Sustainable Product Design* and the Charter and Tischner book *Sustainable solutions: developing products and services for the future* (2001). Student-led seminars were believed to be an effective way of ensuring that these resource publications were appropriately interpreted for students. Each student produced a 15 minute PowerPoint presentation summarising what they believed to be the key issues dealt with by the author and this formed the basis of a seminar discussion with a lecturer and about 12 colleagues. Figure 1 shows the beginning of one of the PowerPoint presentations prepared based on Stuart Walker's paper ('Experiments in sustainable product design', Week 11, see Table 1). Assessment of the module in the first Semester was based on the PowerPoint presentation prepared (30%) and an end of Semester test based on all the work covered (70%). By enabling the students to 'read around' the worldwide efforts in the area of ecodesign, the hope was both to establish a sound basis for the designing in Semester 2 and to empower the students to explore areas that they found interesting. Knowing the major centres of activity and the major authors puts students into a strong position to investigate the ecodesign field.

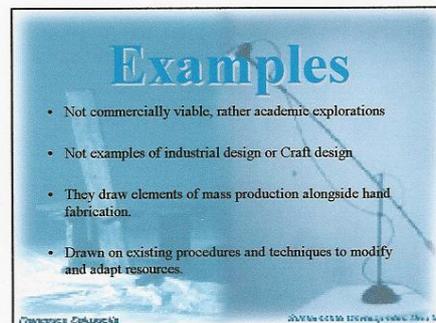
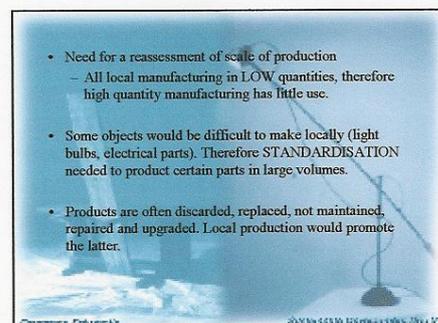
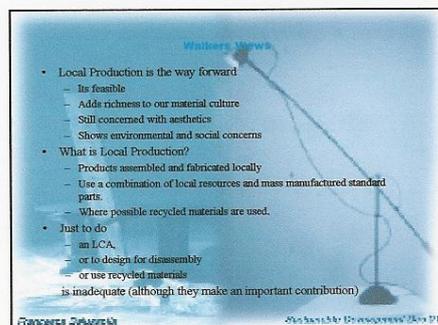
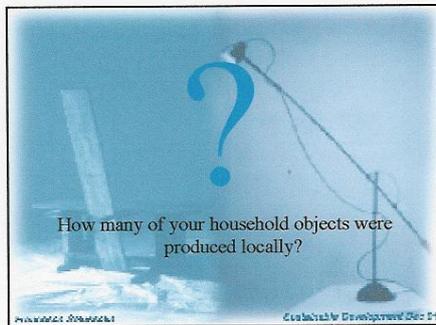
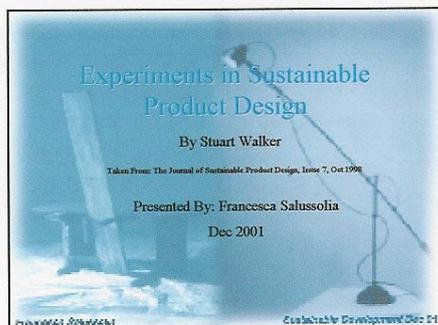


Fig.1 The first six slides from a PowerPoint presentation prepared by a Year 2 student, Francesca Salussolia

Table 1 The structure of the *Issues in Sustainable Development* module (semester 1) for Industrial Design and Technology second year undergraduates at Loughborough University in 2001/02

Week	Activity	Notes
1	Module overview. Preparation of seminar presentations Use of PowerPoint.	Presentations of some <i>Journal of Sustainable Product Design (JSPD)</i> papers by EWLN i.e. <ul style="list-style-type: none"> <li>• <i>JSPD</i>, Issue 1: April 1997, 'Editorial', Martin Charter and Anne Chick</li> <li>• <i>JSPD</i>, Issue 7: October 1998, 'Active disassembly', Joseph Chido, Professor Eric Billet and Dr David Harrison, Brunel University, UK</li> </ul>
2	<i>Practice Seminars</i> <u>Sustainability by Industrial Design</u>	Based on: <ul style="list-style-type: none"> <li>• <i>Sustainable Solutions</i>, Chapter 20, 'Awareness' – Sustainability by Industrial Design', Philip Thompson and Chris Sherwin</li> <li>• <i>JSPD</i>, Issue 7: October 1998, 'The 'eco-kitchen' project - using ecodesign to innovate', Chris Sherwin, Dr Tracy Bhamra and Professor Steven Evans, Cranfield University, UK</li> </ul>
3	<i>Visiting Lecturer (VL)</i> <b>'Sustainability and ecodesign strategies'</b>	... What is sustainability? Ecological footprints, the sustainability triangle, Papanek's 6 priorities for design and examples (1. Design for the Third World 2. Design of teaching and training devices for retarded, handicapped or disabled people 3. Design for medicine, surgery, dentistry and hospital equipment 4. Design for experimental research 5. Systems for sustaining life under marginal conditions 6. Design for breakthrough concepts), the meaning of ecodesign and 'Green' design
4	<i>Student-led seminars</i> <u>Sustainable Product Design</u>	Based on: <ul style="list-style-type: none"> <li>• <i>Sustainable Solutions</i>, Chapter 6, 'Sustainable Product Design', Ursula Tischner and Martin Charter</li> <li>• <i>JSPD</i>, Issue 2: July 1997, 'Mainstream appliance meets eco-design', Andrew Sweatman, Manchester Metropolitan University UK and John Gertsakis, EcoRecycle, Australia</li> <li>• <i>JSPD</i>, Issue 3: October 1997, 'Moving companies towards sustainability through eco-design: conditions for success', Professor A L N Stevels, Philips Sound &amp; Vision, The Netherlands</li> </ul>
5	<i>Visiting Lecturer (TB)</i> <b>'Ecodesign and Business'</b>	... the birth of environmental concerns, environmental problems (destruction of ecosystems, direct impact on human health, raw material depletion), factors influencing companies, legislation, WEEE Directive, increasing consumer awareness, demands by producers on suppliers, the cost of non-conformance, the benefits to the environment, company responses, ecodesign issues (materials extraction and processing, manufacturing and distribution issues, product use and packaging issues, after-use and disposal issues).
6	<i>Student-led seminars</i> <u>Managing EcoDesign</u>	Based on: <ul style="list-style-type: none"> <li>• <i>Sustainable Solutions</i>, Chapter 12, 'Managing EcoDesign', Martin Charter</li> <li>• <i>JSPD</i>, Issue 1: April 1997, 'The development and implementation of DfE programmes', Dr John Ehrenfeld and Michael J Lenox, Massachusetts Institute of Technology, US</li> <li>• <i>JSPD</i>, Issue 2: July 1997, 'The IC EcoDesign project: results and lessons from a Dutch initiative to implement eco-design in small and medium-sized companies', Carolien G van Hemel, Harriet Bottcher and Rene Hartman, The Netherlands (Delft University)</li> </ul>
7	<i>Visiting Lecturer (VL)</i> <b>'Ecodesign and industrial design'</b>	... Review of the meaning of ecodesign, Good design (rationalised number of materials and components, consideration of consumer and safety issues, appropriate function, styling, ergonomically correct, environmental legislation addressed), ecodesign looks further (selection of materials with least environmental impact, packaging issues and transportation, length of life considerations, reduced energy use by consumers, end of life considerations, rethinking/challenging current scenarios).
8	<i>Visiting Lecturer (TB)</i> <b>'Ecodesign tools'</b>	... steps (analyse, report, prioritise, improve). Tools (eg LCA, abridged LCA, software, checklists, pilot projects, workshops), Innovation tools (TU Delft). LCA, uses, phases (goal definition, scope definition, inventory analysis, input assessment). Problems with LCA. Abridged LCA, MET matrix, AT&T, the Ecodesign strategy wheel. Ecodesign checklists.
9	<i>Student-led seminars</i> <u>Tools for EcoDesign and Sustainable Product Design</u>	Based on: <ul style="list-style-type: none"> <li>• <i>Sustainable Solutions</i>, Chapter 14, 'Tools for EcoDesign and Sustainable</li> <li>• <i>JSPD</i>, Issue 5: April 1998, 'The Recyclability Map: application of demanufacturing complexity metrics to design for recyclability', Burton H Lee and Kosuke Ishii, Stanford University, US</li> <li>• <i>JSPD</i>, Issue 10: July 1999, 'Progress towards sustainable design in the white goods sector', Edwin Datschewski, BioThinking International, UK</li> </ul>
10	<i>Student-led seminars</i> <u>Sustainability and Services</u>	Based on: <ul style="list-style-type: none"> <li>• <i>Sustainable Solutions</i>, Chapter 8, 'Sustainability and Services', Walter R. Stahel, The Product-Life Institute, Switzerland</li> <li>• <i>JSPD</i>, Issue 4: January 1998, 'Systematic shift: sustainable development and ID pedagogy' Stuart Walker, The University of Calgary, Canada and Ralf Nielsen, The University of Southern Louisiana, US</li> <li>• <i>JSPD</i>, Issue 3: October 1997, 'Learning from the introduction of green products: two case studies from the gardening industry', Annica Bragd, University of Gothenburg, Sweden</li> </ul>

11	Final seminar paper Discussion of a sample test paper, Revision	<ul style="list-style-type: none"> <li>• <i>JSPD</i>, Issue 7: October 1998, 'Experiments in sustainable product design', Stuart Walker, The University of Calgary, Canada.</li> </ul> <p>... then all the Semester's work</p>
12	Sample test paper answers and discussion	Tutorials by request

However, one of the major problems in getting to grips with ecodesign is the diversity of the issues that impinge on it: from technical issues like the impact of human activity on the atmosphere and biodiversity to the importance of values in human decision-making. The visiting lectures from the Cranfield staff were vital in providing an overview and clear map in an otherwise disorientating agenda. The four 'overview lectures were 'sustainability and ecodesign strategies', 'ecodesign and business', 'ecodesign and industrial design' and 'ecodesign tools'. Hence they cover the path from the general issues of why sustainability is a vital area for all humans to consider and why businesses are taking an interest and on to what industrial designers can do about it and how. Of course, it is these latter areas that the students want to get to, but it is essential to understand the broader context. Ecoredesign – designing a better product from an ecoefficiency perspective eg a more environmentally friendly kettle or toothbrush – is the start of improving the environmental performance of products, but it is by no means the end. Real sustainability requires major reductions in the resources consumed by humans, and this generally means changes in lifestyle.

Industrial designers are at the centre of the interaction between people and products. They can influence how people interact with products and hence the environmental impact of the product in use. If the whole life cycle of a product is analysed – the production of materials, manufacturing and distribution, use and disposal - for many consumer products the major environmental damage occurs in the use phase. Whereas engineers and scientists might have the greatest influence concerning environmental impacts during materials production and manufacture, it is industrial designers who are likely to exert the greatest influence on product use. Designers are also key to product life. The issue of 'product life' and 'fashion' are closely related. Consider the following quotation from Stuart Walker:

Thus, if we are to transform our ways from the 'unsustainable' to the 'sustainable' we need to employ those approaches that are precisely characterised by 'fashion'. The transition will be achieved by stimulating incremental changes in the right direction - each consequent step being an improvement over the last so that we quickly progress towards more responsible, sensitive and wholistic practices. Hence, and if done with care, fashion in design can be used as an important tool for generating swift, positive change. (1999, p5)

For the ecodesign activities in the second semester students were asked to work in one of four areas:

- personal communications (eg mobile phones);
- music delivery (eg hi-fi and 'walkman');
- convenience cooking (eg toasters and sandwich makers);
- personal care (eg hairdryers and shavers).

The ecoredesign strategies employed were based around the UNEP manual *Ecodesign: a promising approach to sustainable design and production* (1999). The students were introduced to the manual and then helped through each stage. The initial task is the selection of the most appropriate aspects of the product to work on. The associated analysis was carried out by using MET (materials – energy – toxicity) matrices and environmental checklists. They complete spider diagrams to show their intended strategy and attended creativity workshops in order to help generate ideas.

The students then pursued these ideas with tutorial support. More detail of the semester programme is shown in Table 2.

Table 2 The structure of the *Design for Sustainable Development* module (semester 2) for Industrial Design and Technology second year undergraduates at Loughborough University in 2000/01

Week	Activity	Notes
1	Introduction to Semester 2 and the Delft EcoDesign manual (Eddie Norman)	<ul style="list-style-type: none"> <li>Selecting product area</li> <li>Collecting (and reading) extracts from EcoDesign 'Promise' manual</li> <li>A first look at the Promise Manual</li> </ul>
2	Continued discussion of the Delft EcoDesign manual (Eddie Norman)	<ul style="list-style-type: none"> <li>Class exercises concerning the EcoDesign strategies from the Promise manual</li> <li>Initial presentations concerning how the selected products work and are made</li> </ul>
3	Introduction to the Demi website (Eddie Norman)	<ul style="list-style-type: none"> <li>Demi 'exercises'</li> </ul>
4	Selection criteria (Tracy Bhamra) Based on Module 3.3	<ul style="list-style-type: none"> <li>Introduction of Environmental analysis (MET &amp; checklist)</li> <li>Introduction to environmental drivers (internal &amp; external)</li> <li>Improvement options using wheel &amp; options checklist</li> <li>Students apply these ideas to products in groups</li> <li>Introduce concept of selecting feasibility options.</li> </ul>
5	Feasibility Study (Eddie Norman) Based on Section 3.3.4	<ul style="list-style-type: none"> <li>Feasibility study of the improvement options generated in week 4</li> <li>The students need to end up with a top 3 - feasibility options</li> <li><u>Email these to Vicky at end of session</u>, to allow detailed preparation for Wk 6</li> </ul>
6	Developing Ideas (Vicky Lofthouse) Based on Module 3.4	<ul style="list-style-type: none"> <li>Working in product groups to generate ideas focused on 3 top feasibility options identified in wk 5.</li> <li>Introduction to creativity techniques</li> <li>Use of creativity techniques to facilitate mass idea generation – in product groups (Future forecasting, brainwriting, using metaphors...)</li> <li>Selection of best options – in product groups</li> </ul>
7		<ul style="list-style-type: none"> <li>Tutorials concerning the development of ideas generated in Week 6</li> <li>Group discussions with Dominic Clare (Demi project researcher)</li> </ul>
8	Feedback seminar (Vicky Lofthouse)	<ul style="list-style-type: none"> <li>Individuals in product groups feedback developments so far</li> <li>What they have developed to date?</li> <li>Why?</li> <li>How it is going?</li> <li>Discussion on further improvements</li> </ul>
9		Design and Development (tutorials)
10		Design and Development (tutorials)
11		Design and Development (tutorials)
12		Individual projects - Presentation of 2 boards (60%) 1- sustainability issues of design 2- redesigned product + folder (analysis and sketching, 40%) <b><i>The project display must be complete by 2.00 pm on Friday of Week 12</i></b>

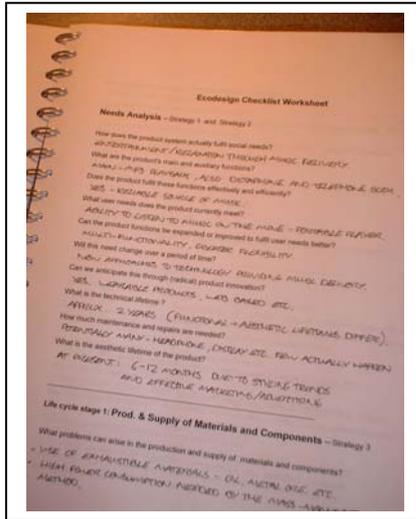
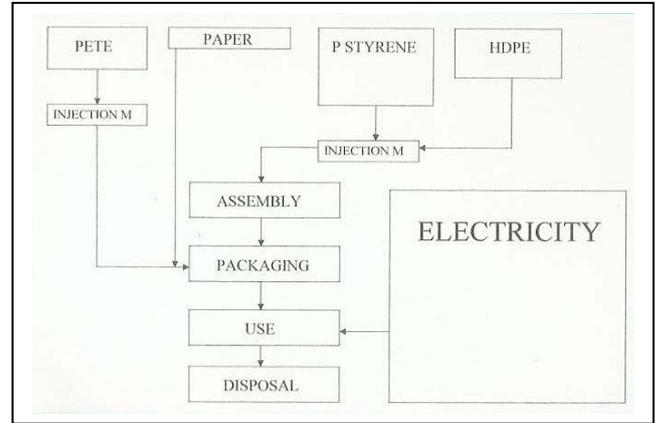
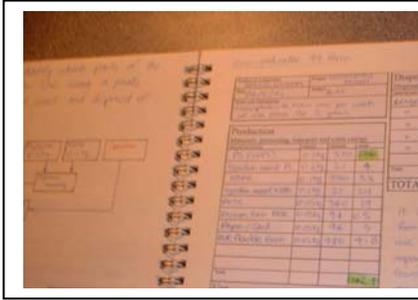
Good results were achieved in all these areas, but this paper presents the work of two (of the twenty-five students) who chose to work in the area of 'music delivery' in order to give the flavour of the students achievements. Stuart Cooper worked on an MP3 player and Ben Manwaring on headphones. In essence the students' work in semester 2 fell into three phases:

- analysis of the product and its use;
- identifying the ecodesign opportunities;
- ecoredesigning.

A selection of the work of these two students is shown below under these three headings.



# Identifying the ecodesign opportunities



**FLEXIBLE LEASING SYSTEM FOR PORTABLE MP3 PLAYERS**

**Ecodesign Strategy Wheel showing improvement aims and level of ambition.**

- @ - New concept development
- 1 - Physical optimisation
- 2 - Material selection
- 3 - Optimise production
- 4 - Optimise distribution
- 5 - Product use
- 6 - End of life

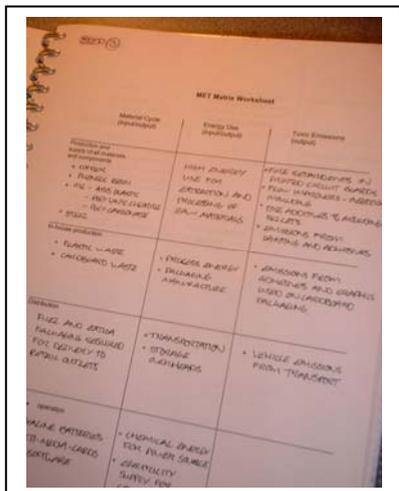
**ECO-REDESIGN AIMS AND IMPROVEMENT CRITERIA:**

**Primary aim:**

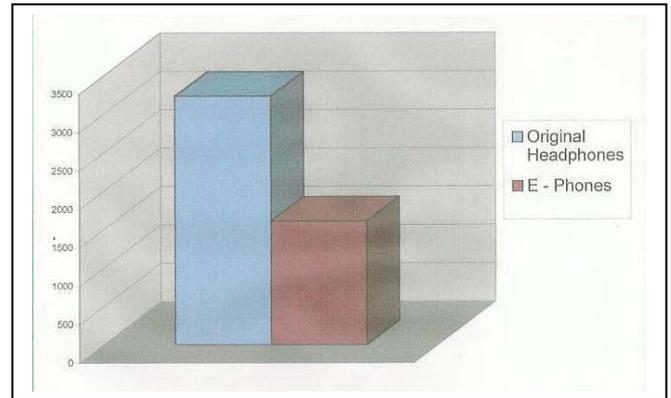
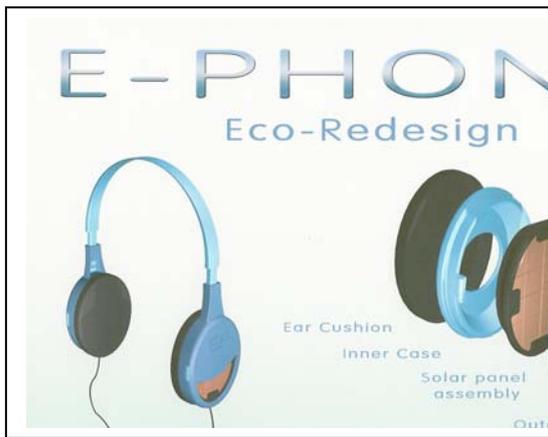
- @ New concept development - Provide a service.

**Secondary aims:**

- 1 Physical optimisation - Easy maintenance/repair. - Design for modularity.
- 2 Optimise material use - Reduce material use. - Use of recyclable materials.
- 4 Optimise distribution - Less packaging.
- 5 Reduce impact during use - Reduce consumables.
- 6 Optimise end-of-life systems - Reuse of components. - Refurbishment of product.



EcoRedesign



**FLEXIBLE LEASING SYSTEM FOR PORTABLE MP3 PLAYERS**

**CONSUMER LEASING OPTIONS:**  
**Start with base unit** - Generic motherboard with modular component fixings. Large clear display. Playback controls. AC fly-lead. Ni-cad rechargeable battery.

**DECISION 1** - choose processor according to audio format required, (mp3, mp4, atrac3, other new formats).

**DECISION 2** - choose internal memory capacity, dictates playback time and influences monthly payment, (16, 32, 64, 128 MB).

**DECISION 3** - choose one or more interchangeable HDPE covers, available in a range of colours, finishes, forms, and textures, (Old covers can be part-exchanged for newer ones, they are fully recyclable, and can be remoulded into the PCB housing on the base unit).

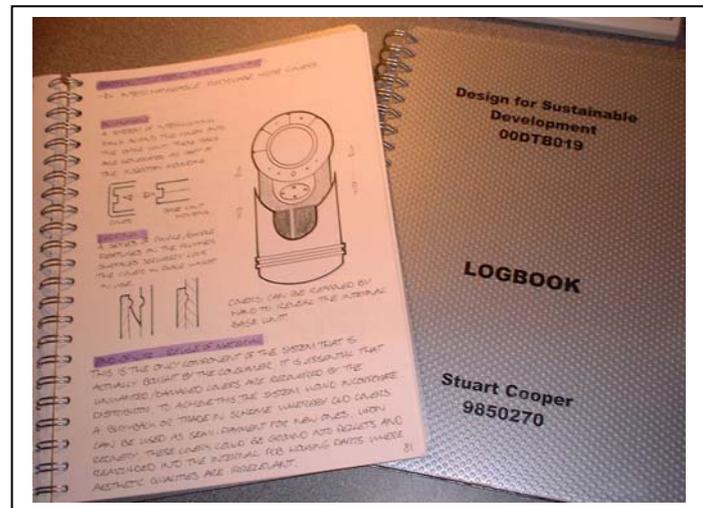
**FINAL STAGE** - user is required to: download file transfer software from the internet, provide standard audio headphones, and supply standard USB cable.

**Effective music delivery within five simple stages.**

TRACK 1  
ARTIST

TRACK 1  
ARTIST

ACTUAL SIZE, 1ST ANGLE PROJECTION



The students' projects formed an exhibition which attracted considerable attention during the summer months and one measure of success could be that 49 (from approximately 120) of Loughborough's undergraduates chose to take the sustainable design options in 2001/02 in comparison to the 25 'pioneers' of 2000/01. It is important not to underestimate the contribution these 25 pioneers made. Taking 'new' modules is always an act of faith, there is always plenty of enthusiasm from the lecturing staff, but not everything will run smoothly. Every effort was made by the staff and the students and the vital result is well-established options in sustainable design within the undergraduate Industrial Design and Technology degree programme. No doubt within a few years, sustainable design will be an essential and integral part of every undergraduate course and we hope this paper will make its contribution to this cause.

### *Some tentative conclusions*

- PowerPoint presentations by students are an effective method of ensuring that text-based resources produced for designers are appropriately communicated.
- Student-led seminars were effective in ensuring that the key aspects of the papers and chapters selected were understood.
- The module structures adopted – dealing with background issues prior to designing – was effective in facilitating good ecodesign outcomes from the students.
- Collaboration with expert Visiting Lecturers is an effective method of introducing new modules and results in strong student motivation.

### *Future developments*

One of the students who opted to take the modules in 2000/01 – Rhoda Coles – decided to base her Year 3 Dissertation around a review of this initiative to introduce sustainable design to Loughborough's students. Rhoda's research has included discussions with her colleagues in Years 2 and 3 and an evaluation of the impact of the modules on the students' placements and major projects. It is hoped that an article based on her research will appear in a later issue of this journal.

Staff efforts are going into putting the module online. One of the Department of Design and Technology's graduates – Kevin Badni – has now returned to the Department after many years experience in several design consultancies. Kevin is using his multimedia expertise in order to make the module effective on the University's Intranet. In the longer term it is hoped to develop this resource, so that it can provide a basis for continued professional development. Colleagues interested in knowing more about our work are welcome to contact us by email.

[E.W.Norman@lboro.ac.uk](mailto:E.W.Norman@lboro.ac.uk)

### *References*

Archer B (1976) *The three R's*, A revised version of the lecture delivered at the Manchester Regional Centre for Science and Technology, Department of Design Research, Royal College of Art, London, UK

Charter, M and Tischner, U (2001) *Sustainable solutions: developing products and services for the future*, Greenleaf, Sheffield

Clare D (2001) 'Design education for sustainability'. In *IDATER 2001* E W L Norman and P H Roberts (Eds), Department of Design and Technology, Loughborough University, UK.

Datschefski E (2001) *The total beauty of sustainable products*, Rotovision SA, Switzerland.

Ewing P D (1987) *Curriculum development report on industrial design engineering*, The Design Council, UK.

Mackenzie D (1991) *Green design: design for the environment*, Laurence King, London, UK

Myerson (1991) *Technological change and industrial design education*, CNAA, UK .

Norman, E (1998) *The nature of technology for design*, International Journal of Technology and Design Education, 8, 1, 67-87.

Norman, E (2000) 'The teaching and learning of technology for design'. In *Proceedings of the Design and Technology international Millennium Conference* R Kimbell (Ed), DATA, UK, 128-134.

Walker, S (1999), 'The attraction of opposites: reconciling fashion with sustainability', *Proceedings of the IDSA Design Education Conference*, Chicago, [http://www.idsa.org/whatsnew/99ed\\_proceed/paper022.htm](http://www.idsa.org/whatsnew/99ed_proceed/paper022.htm), (accessed 22/12/00)

Wingfield L (1980) *A new approach to design education and practice*, CME