Sustainability and design and technology in schools

RESEARCH

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Abstract

This article follows a presentation at IDATER '97 where the issues around sustainability and the unique role that design and technology can play within the school curriculum were presented. The scope of the theoretical justifications have been explained and practical examples of approaches to projects at Key Stage 3 and at A level/GCSE of the concept of sustainability are presented for comment.

The first section builds the argument for caution and an awareness of the issues involved, but uniquely focuses on the role of 'designers' and their ability to intervene in the future situation. Our fundamental attitude is not that of 'doom and gloom' but that the designer can and must make decisions not just on the short term needs of the producer, but on the wider environmental issues. The second section shows how this philosophy can be applied to design and technology teaching in schools such that the next generation of citizens are aware of not just the issues, but also how they can change their futures. We have outlined three basic steps which involve different degrees of change to existing schemes of work ranging from a minimal change merely logging the energy and materials in the project evaluation, to replanning the schemes of work giving the pupils a greater degree of involvement and understanding.

Introduction

The Earth seen from space gave the environmental movement its most powerful icon: a vibrant jewel in a black cosmos. It also serves to reminds us that we cannot escape the effects of our industrial activities. We are all sustained by the same biosphere. Manufacturing may be shifting to the low waged developing economies but resource depletion and pollution affects us all: rich or poor – north or south. The evidence is overwhelming: global population is expected to double some time in the next century and the market for material goods likely to increase eightfold with the less developed countries rushing to adopt western material lifestyles. This could lead to global warming, with average temperatures rising by 2-5 degrees, resulting in widespread desertification, erratic weather patterns and rising sea levels. Ozone depletion may increase skin cancer and alter ecosystems with uncertain effects. Deforestation and loss of bio-diversity is occurring at an unprecedented rate. More worrying is the rate of change: in just a few decades we have begun to threaten evolution spanning nearly 4 billion years (Myers 1994).

These problems are acknowledged at the highest levels in governments, organisations and business. Today, international, as well as national and local initiatives, find a unifying theme in the concept of 'sustainable development', first defined in the seminal report of the World Commission of Environment and Development (1987) 'Our Common Future'. In it, the authors describe sustainable development as: "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" However, like many environmental concerns, these are complex issues and do little to empower the individual in making informed environmental decisions on a day to day basis. The major question for many is: what can I do to reduce my impact on the environment? It is this question that this paper attempts to address by presenting a range of environmental approaches that can be readily adapted and used in the teaching of design and technology.

Environmental space

One of the more useful concepts to have evolved in recent years is the idea that each of us takes up 'environmental space' in terms of the amount of materials and energy we consume, and the amount of pollution and waste we create (FoE 1997). The Earth has finite overall environmental space because there are limits to the amount of resources we can extract and limits to the ability of ecosystems to tolerate pollution. In developed countries, each person's 'environmental space' is widely considered unsustainable (WCED 1987). Although only 20% of the population live in the industrialised north, it (we) currently consumes over 80% of the world's resources. Such inequities are not only unethical but also unsustainable.

But by how much do we need to reduce our 'environmental space' in order to achieve sustainability and a more just and equitable distribution of resources? A staggeringly simple but profound equation was proposed by biologists Anne and Paul Ehrlich (1990) to indicate the scale of the problem. They propose that environmental impact (E) equates to population (P), multiplied by material consumption per capita or affluence (A), multiplied by the environmental impact of the technology used to produce goods (T). This relationship is expressed as: E = P x A x T. As a benchmark our present situation can be shown as 1 = 1 x 1 x 1.

A call for a 60% reduction in releases of greenhouse gases, to cite the most pressing environmental problem, has been made by the United Nations International Panel on Climatic Change; which means environmental impact becomes 0.4 not 1. Population will double in the next forty years and consumption per capita expected to increase four-fold over a similar period.

Thus: 0.4 (**E**nvironmental impact) = 2 (**P**opulation) x 4 (**A**ffluence) x **?** (**T**echnological impact)

To balance the equation, the environmental impact of the technologies we use to produce goods (in other words design), needs to be 0.05 not 1, a reduction of 95%, or **a twentieth of current levels**. Clearly sustainability cannot be achieved through design alone and in the absence of draconian population control, we are left with affluence. So it appears from the arguments so far that a dual approach is required to attain sustainable 'environmental space', firstly by reducing the environmental impact of the goods we produce; and secondly, by consuming less.

Design response

Problems of such magnitude leave many feeling helpless. Well-meaning behaviour like recycling newspapers and bottles probably do more to massage our conscience than save the planet. There is a need to empower people (children as well as adults) with the knowledge, ideas and tools that not only address current needs but also those of future generations (United Nations 1992 et al).

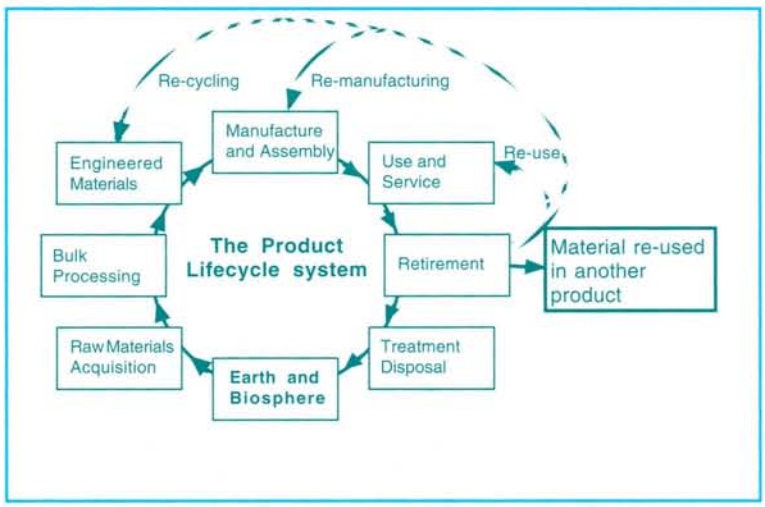

Figure 1: Modified from the 'Lifecycle Design Guidance Manual: US Environmental Protection Agency 1994'

Lifecycle thinking

Designers have begun to recognise that reducing the environmental impact of products requires a life-cycle approach. What this means is that at every stage in a product's life-cycle materials and energy are used and waste and pollution is created – from the extraction of raw materials from the ground – (including all the stages in between: materials processing; product production; distribution; product use) – to retirement and disposal. A typical product life-cycle is shown in Figure 1 and shows various inputs and outputs. With an understanding of the many environmental impacts of a product during its life-cycle – from cradle to grave – it is possible to target design effort to reduce impact. What this kind of approach highlights is that although materials recycling, for example, can reduce environmental impact, it is by no means the whole picture and in many instances a relatively minor factor. This life-cycle thinking was first developed by scientists to address the environmental impact of large industrial processes.

Ecodesign

Building on life cycle analysis described above, ecodesign is a design approach that aims to: "address all environmental impacts of a product throughout the complete life-cycle of the product, whilst aiming to enhance other criteria like function, quality, and appearance" (Eco2 1994). In order to facilitate such aims a matrix was devised to relate life-cycle phases to environmental costs as shown in Figure 2. Within each cell of the matrix a number of guidelines are included which can help designers reduce the environmental impact of goods. Such a

Lifecycle of the Product

Environmental Impact	Production	Use	Disposal	Distribution
Energy	Design to reduce energy in production	Design to reduce energy in use	Design to reduce energy in disposal	Design to reduce energy in distribution
Material	Design to reduce material in production	Design to reduce additional materials in use	Design to reduce material waste in disposal	Design to reduce materials used in distribution
Pollution	Design to reduce pollution in production	Design to reduce pollution in use	Design to reduce pollution in disposal	Design to reduce pollution in distribution

Figure 2: Eco-Design Matrix

life-cycle approach also prevents narrow environmental thinking and promotes an holistic design view. This way of presenting ecodesign shows a range of relationships between recyclability, energy efficiency and use of non-toxic materials etc. Which means that design for energy efficiency or low waste – or designing products that use recycled, non-toxic or fewer materials – cannot be regarded as ecodesign alone, but rather as constituents of ecodesign. Many companies now acknowledge the value of ecodesign in reducing their overall environmental impact and as part of future product strategies. In this respect it is likely that ecodesign concepts will become as commonplace as cost constraints are today.

Figure 3

Eco Design in the context of sustainability

	Present Position	Towards Sustainability
Nature	Design for Corrective Action	Sustainable Design
Design Target	Symptoms	Causes
Focus	Product/Micro view	Systems / Macro View
Perspective	Intensive information Short term Linear	Extensive information Long term Cyclical
Characteristics	Standard of Living End of Pipe Solutions Growing Market!	Quality of life Questions needs Ethics - Equality
Design Response	Technological Fix Clean up problems Hardware Resource intensive More products	Dematerialisation Leasing / Services Software / Sharing People intensive 20 Factor

However, although using ecodesign principles can reduce environmental impact, it does not necessarily mean that a product is sustainable in the longer term. In some instances certain product groups will be considered so polluting that they are simply not produced. Equally, others will be thought too frivolous and short lived to use up scarce resources required for more pressing needs. Sustainability requires a much broader and global vision which places people's needs and access to resources in the context of environmental limits. As the Ehrlich equation suggests, the volume of goods consumed also needs to be significantly curtailed, and goods consumed need to be more fairly distributed between the developed North and developing South.

Sustainable design

The concept of sustainability refocuses design concerns towards social conditions, environment, development and ethics (Dewberry & Goggin 1996).Ideas such as: questioning the need for a product; achieving 'more from less'; a concern for quality of life instead of material standard of living; a focus on causes of environmental problems rather than their symptoms; and an onus on 'service' as opposed to 'ownership' – all raise the question of how design will change to accommodate such 'radical' thinking (Figure 3).

Ultimately the ability to follow through this degree of change will depend on human behaviour and value systems, and whether designers – as part of the current economic paradigm – can influence a shift in attitudes towards this goal. But designers make the link between people and production in the form of products and in many ways shape the way people respond to designed goods. In this context, it is possible to imagine how designers and design and technology teachers can begin to promote a sense of reverence and respect for our material surroundings, and encourage a more environmentally harmonious existence.

Figure 4

Sustainable design in design and technology Eco-Log

1

Basic principles

Dont try to go any further back than this project
Keep the limits of the evaluations to the areas that the pupils have actually used/ don't consider the wear and tear of equipment, or the on costs to support the activities.

Basic costs and environmental costs

There is a strong correlation between the raw material costs and the costs to the environment for producing that material. Your own experience and raw material costs will give a representative starting point

Energy Costs

Relating electrical power wattage and time used will give a fair starting point
Electricity we have said can be charged at Xp for 1000 watts for 1 minute (it is cheap)

Recycling / Environmental costs

This gives a chance to have a value for the cost of recycling waste materials, and to add something for the impact on the environment. We have used a hign cost as Y p and a low cost of Z p

Stages in the project	Material cost (p)	Energy costs (p)	Recycling costs	Total
Construct mould cut to shape/ coping saw / jig saw smooth and correct shape Vacuum form 'bubble' Trim bubble to shape jig saw / scissors-stanley knife Backing sheet Cut to shape apply graphics fix to bubble				

Overall Total

Possible savings and eco-evaluations
Using hand processes except for the vacuum forming would have saved
Being able to choose different materials for the mould and the backing board (like clay and card) could have made the mould reuseable, and easier to shape, but in the end may not have looked as good,
The vacuum forming wated a lot of material each time. Could there be some way of only forming as much plastic as you need.

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The role of design and technology

As an area in the curriculum which always causes pupils to look into the future and produce answers to needs by practical application, design and technology is uniquely placed both to consider the issues of sustainability and to deliver understanding via practical project-work. The critical thing in all of this is that pupils are aware of their ability to choose, or design, a certain course of action; and, having done it, are made aware of the consequences of their decisions and endeavours. We are suggesting that this fundamental aspect of the subject has the ability that no other curriculum area has, to equip pupils for their futures.

A Key Stage 3 project was chosen deliberately from the DATA *Guidance Materials* pack, as a typical piece of project-work where the planning and National Curriculum coverage is well documented. The chosen project is called 'The Bubble and the Market' and it involves an examination of product packaging and the production of a vacuum formed bubble pack to package a chosen object. The approach to pupils understanding the issues of sustainability takes 3 forms, eco-logging, eco-choice points and life-cycle design. We are well aware of the pressures on teachers to produce more from less, in all aspects of their work and so have made the examples deliberately limited yet, we feel, sufficient to illustrate our approach.

Figure 5

Eco-Choice points

2

Basic principles

Limit the number of materials and energy choice points to 3 or 4 as a maximum.
Make sure that the pupils are aware of the resons and consequences of the choices that they are making.
Use the idea of choice points in conjunction with the idea of logging energy use.

Stages in the project	Choice points	Reasons for choice Advantages / disadvantages
Construct mould cut to shape smooth and correct shape for moulding	Choice of possible mould materials **Softwood,** **MDF** **Clay**	Choices evaluated based on the cost of the materials, the ability to recycle the materials the energy used in their processing the quality of the end result
Vacuum form 'bubble'		
Trim bubble to shape		
Backing sheet Cut to shape apply graphics	Choice of backing sheets **Plastic sheet** **high quality card** **recycled board**	
Fix backing board to bubble	Choice of fixing methods of bubble to board, **Glue gun** **snap fit moulded in place** **adhesive tape**	

Eco-logging

This approach can be applied to any existing piece of project-work, and involves the pupils as part of their evaluations, listing the processes and materials that have been used in the project and then making a log of the amount of material and energy that has been used and also a view as to how much has been wasted, or how difficult is it to recycle what remains. Figure 4 shows an example of a log, and gives some rules of thumb to make the scope of the evaluation manageable.

Eco-Choice points

Logging of materials and energy usage is only the first step, it only sets the agenda for further work. The pupils understanding must involve deliberate choices and an analysis of the consequences of having chosen certain options. Using the same project we have indicated a range of constrained choices that pupils can make, in order that they can evaluate these choices in terms of materials and energy usage. This can therefore be used in conjunction with the eco-logging, or as a discussion point within the project. Figure 5 shows a deliberately small range of choice points that could be used in this project.

Designing for extended life-cycle

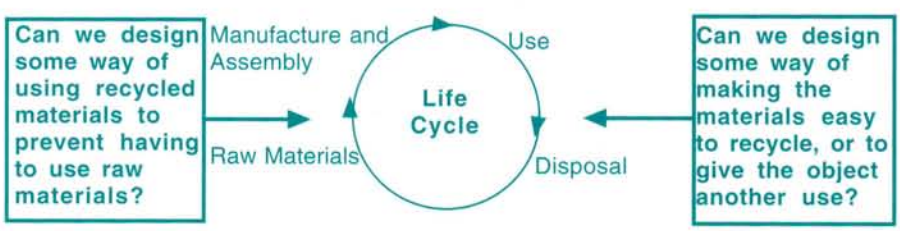
Traditionally the bubble pack has a very short life and serves to contain the product from the producer into the shop and then be thrown away when the consumer gets the product home. As such it reinforces the 'throw-away society' and comes into direct conflict with the issues of sustainability. The use of 'new' materials at all stages of school project is how we, as teachers, give it value to the pupils. If, however, we are seeking to question this value system from a wider perspective, then the ability to reuse or modify once used materials should take on a different value in the eyes of the pupils. By designing the package in such a way as the next stage in its life-cycle is not to be thrown away. The object could either be used again for the same function, or can become worth something in its own right. Thus the time before it becomes 'rubbish' is extended. The pupil-designer can affect what was initially a short life package by the way that they design it. Once the basic concept is established then all that is required is that the brief for the project is modified. Pupils will to come to terms not only with the immediate gratification of what they are designing and making now, but also what it was before and what it will be next. Figure 6 shows how such thinking could be applied to this project.

Figure 6

Considering and extending the life-cycle of the components and materials

Basic Principles

View the design and making of this object as part of a much larger scheme, which recognises the cyclic nature of materials, and the need to extend the timre before the object is no longer usefull



Can we use materials that have already been recycled like card or paper or plastics.
Can we reuse and remodel materials that have been used for other projects or are about to be thrown away.
Can we use materials that can be easily recycled for use in this context like clay for mould making.

Can we make it so that when this object has been used as packaging that it can become something else?
(can it be designed to be a valuable object in its own right eg. door number, plaster mould, storage container.)
Can the materials be easily recycled / remoulded etc.
Can this object be used as a part of the next project (Project 7 working as designer makers)

References

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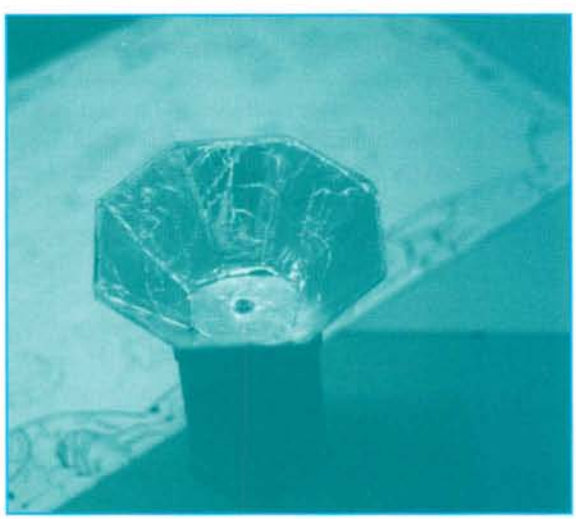
Designing for sustainability: and A-level case study

The concepts of sustainability were introduced to a group of A level pupils (it would seem to be just as applicable to GCSE) and then they were asked to design an eco-torch capable of being sold as an emergency torch by friends of the earth which would show some of the principles of sustainability. The results demonstrated very clearly the breadth of understanding of the pupils in a unique way. What they produced and the materials and means of production chosen indicated whether their concept of reuse of materials in the design went further than a crude definition. Some showed a limited view based on simply buying the materials that were needed, whereas others demonstrated a greater understanding and actively attempted to reuse existing items as containers or components. Similarly the concept of extending the life cycle showed whether their understanding went beyond the notion that one could recycle plastic to actually saying what it could be used as without elaborate and expensive recycling. Two examples of the results of the work are shown on the previous page.

In conclusion

Young people today are under enormous pressure to conform and to consume all manner of products. They would seem to be at a particularly vulnerable stage in their lives, and have been, in most cases, successfully convinced by manufacturers that the solution to their insecurities about themselves is to surround themselves with icons to support their frail egos. We do not underestimate the power of young people's culture on their views of the world, neither do we assume that this work will change that culture overnight. We do believe that only by giving them an awareness of the issues and the capability to intervene in their situation will they be able to judge for themselves the choices that they have. And we must remember that the changes that we spoke of at the beginning of this article will be happening in their lifetimes, but maybe not ours. It is therefore more important that they have a defensible concept of sustainability than that we do.



The aim of the work is to illustrate the possibilities of the approach and to begin to collate work of a similar type. If this work is interesting to you or you have your own examples to share then please contact us on: email p.goggin@gold.ac.uk t.lawler@gold.ac.uk or Design Studies Goldsmiths London University New Cross London SE14 6NW