Design for Deconstruction

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Chris Morgan and Fionn Stevenson report on a recent Scottish study and new guide which identifies how Designers can reduce the impact of their buildings on the waste stream, while also reducing costs for Clients and Occupants.

Introduction

The construction and demolition industries are responsible for around half of the waste now filling up landfill sites around our increasingly landfilled island. Not only is the amount of waste we generate an indictment of our way of life and work, but we are rapidly running out of places to put it. In some parts of Scotland, there is already no more landfill available.

A report on Scotland's ecological footprint identified waste as the number one concern, accounting for 38% of the overall footprint, followed by food (29%) and energy (18%) well behind.

So reducing our waste is crucial, and the role of the construction industry is central to this as the single largest non-domestic waste producer in the UK. There are many initiatives to remove materials from the waste stream, but the very best strategy – not generating it in the first place – sits uneasily with prevalent notions of unlimited economic growth and our consumer culture, and in design terms has received very little attention.

A recent study commissioned by the Scottish Ecological Design Association and funded by a Sustainable Action Grant from the Scottish Executive has sought to address these issues. The study is the first of its kind because, in addition to generic advice, it seeks to give specific guidance on conventional, commercial building details, offering fully costed and approved alternatives. These illustrate real life design and specification decisions that have to be taken to reduce the likely waste stream from the building. Conventional and commercial details have been chosen in order to try and engage the mainstream industry and tackle the sheer volume of non-recoverable material currently being built. The alternative details are designed for maximum applicability rather than ultimate "greenness".

The guidance will be available on the web on April 15th 2005, with all the information additionally available in downloadable format. The website is accessed through SEDA's website, www.seda2.org (part of the Green Building webring).

Whilst it is theoretically possible to dismantle every building and re-use or recycle most if not all components, in practice it is difficult, and therefore expensive, and therefore rarely achieved except on a very small scale.

Buildings today are generally put together in such a way that recovery of anything except the most isolated and valuable components is minimal, but it doesn't have to be like that. Without too much difficulty, and without much discernible change in the building appearance or performance, the study has shown that buildings can be designed so that re-use of most components is simple and cost effective, and recycling of the remainder can keep most if not all of the built form out of the waste stream.

Most of the waste associated with construction is from the continual processes of refurbishment and

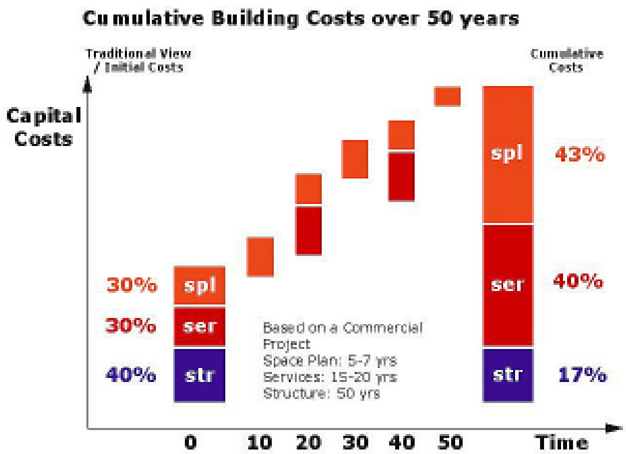

Diagram 1 Cumulative Costs. Graph showing Client Costs associated with Space Planning (orange), Services upgrading (red) and original structure (blue) extended over a notional 60 year building lifespan. Client costs clearly reflect waste arisings. After Duffy.

upgrading (see diagram 1). The study identifies measures whereby buildings could be designed with inherent flexibility, so that they can be refurbished and adjusted to the changing needs of occupants with minimum of disruption, waste and cost to the Client. They can also be designed to allow for easy repair and maintenance of components which are worth repairing, so removing yet more from the waste stream.

'Re-use, Recycling and Downcycling'

Often used interchangeably, these terms actually describe three very different circumstances, with very different implications.

National Waste Strategies across the UK have adopted waste hierarchies which identify the various options available, and their relative potential to help tackle waste. Generally, preventing or reducing the waste at source is to be preferred over all other options, re-use is preferable to recycling, recycling is preferable to downcycling, while reclamation of energy is more or less the last resort for otherwise unrecoverable materials, and disposal to landfill is identified as the option to avoid.

All of which seems reasonable enough, but there are some anomalies in such self-evident hierarchies, some grey areas, and some confusion about terms which is worth mention.

Reuse involves the new use of a material or composite component more or less as it is. This can involve very little processing, such as a roof tile or slate, or quite a lot of processing, such as with stripping and re-finishing of doors.

Recycling involves reprocessing a material or component into the same material or component, such as is common in glass manufacture, or with concrete recycled into aggregate for concrete.

Downcycling is where a material or component is reprocessed into a lower grade use material, for example concrete or brick into hardcore, or timber into chipboard. The term 'recycling' is often used to describe what is in fact 'downcycling' However, some of the value of the original material is being lost in this process, hence the need for some clarification between the terms.

The term 'reusable' describes a building material or component that can be reused, but does not necessarily mean that it can be recycled. For example a brick can be reused, but only downcycled, whereas a steel beam can be reused and recycled.

The term 'recyclable' describes a material or component that can be recycled, but not necessarily reused. For example, metal flashings can be recycled but tend to be too deformed to reuse, and both glass and plasterboard can be theoretically reused as well as recycled but this is very rare.

The industry which supports reuse is still small compared to the industrial infrastructure which has developed to support recycling. Recycling is often the strategy of choice by the construction industry to deal with waste, but most recycling processes involve a great deal more primary energy, and therefore pollution, than most reuse processes. This is why it is important to emphasise the need to prioritise reuse as a strategy over recycling.

An indication of this industry preference for recycling is the development of a number of products where materials have been admirably extracted from the waste stream, only to be turned into 'recycled' (sic) components which are impossible to do anything with at the end of their service life but dump in landfill. Equally however, there are components which can be reused, but not recycled, nor even downcycled, and so the cycle of reuse is only delaying the inevitable landfill!

Clearly neither of these *options* offer truly sustainable solutions, and the concerned Specifier should *ideally* concentrate only on those materials which *can* be demonstrably reused **AND** recycled or safely composted in the future with the minimum of energy and pollution.

Natural materials, at least those which are not compromised by toxic, or non bio-degradable coatings, treatments or adhesives, may be safely composted and so ultimately represent a zero waste option. Quite apart from issues of embodied energy and pollution with which BFF readers will be familiar, this advantage lends considerable weight to the use of natural materials in general.

Some Emergent Principles

A number of principles emerge from the study which are briefly summarised below, and illustrated by some of the specific measures described afterwards:

- Allow sufficient space and section heights, and configure sequences of spaces to allow for several occupancy patterns, to optimise the long term usefulness of the building.

- 'Layer' building envelopes to reflect the different anticipated lifespans of the various component parts. For example fit out and finishes are likely to suffer from wear and tear, and services are likely to need upgrading before any work is need

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to external finishes or structural components, so allow for these to be easily repaired and removed without undue damage to other building layers. (See diagram 2)

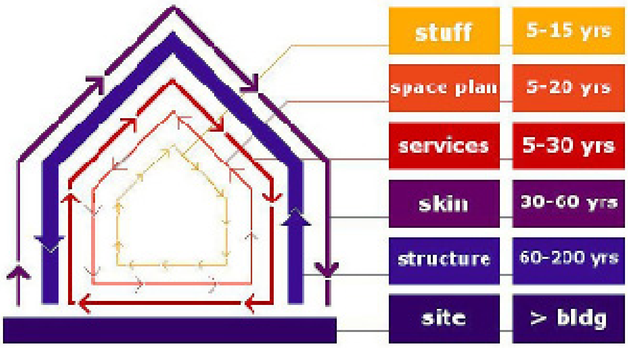

Diagram 2 "Layers" – Diagram showing the potential 'layering' of a building construction which takes into account the different lifespans of different elements and enables more frequently upgraded components to be repaired and removed without undue disruption to other more permanent layers. After S. Brand.)

- Use building components which are easily handled so that both installation and removal are easy and safe.
- Use *robust* building components which are of good quality, so that they are worth reusing, and monomeric (not composite) so that they can be more readily identified and recycled.
- Ensure that there is sufficient information about the location, access to, fixings, and composition of components, so that repair, retrieval, reuse or recycling opportunities are known and made simple.
- Avoid toxic materials as these not only generate health risks to occupants, but may attract additional imposed costs at the time of disposal.
- Bear in mind that non compromised (see above) biodegradable materials can ultimately be safely composted and so represent a zero waste option in the long term.
- Provide service voids where possible and ensure adequate access to these.
- Simplify fixings through minimising the number and variety of types necessary. Ensure that simple hand tools can be used to dismantle components, avoid the need for specialist plant which will only attract additional costs in the long term. (Although in some cases recovery of large components (such as steel) is preferable in terms of increasing reuse options)
- Use fixings generally that allow for easy dismantling. For example, use mechanical fixings in preference to chemical bonds wherever possible, screws in preference to nails, weak mortars in preference to strong ones, bolts over welds.
- Design components and joints to be reasonable durable, especially if some maintenance or reuse is anticipated.
- Bear in mind that coatings and treatments can preclude the reuse or recycling of certain components and in others significantly complicate the reuse or recycling process. Inherently durable materials are therefore to be preferred to those that require coatings or treatments to perform adequately.

Some Specifications to Promote Deconstruction

A small number of specifications are given below to illustrate the sorts of changes that can be made. These and many others are more fully covered, costed and independently approved in the Guide.

Use Lime Mortars and Renders instead of Cement
Most modern block and brick walls use cement based mortars and renders. These tend to be very hard, often harder than the blocks and bricks themselves, which makes it very difficult to separate the components for re-use. Normally these walls are crushed at the point of demolition and, in many cases downcycled into hardcore. Lime mortars and renders are softer and enable much easier dismantling of masonry walls, making it possible to reuse the components, which is obviously preferable. Lime mortars and renders are more expensive than standard cement based ones, but bulk silo delivery of lime has closed the gap somewhat, and there are other advantages to lime including the breathability (which can serve to better protect the wall from moisture related damage) and the fact that lime bonded walls do not need movement joints.

Built Up Roofing Systems
Bonded or 'sandwich' panels commonly used for roofing are unlikely to be reused and very rarely capable of being economically separated for recycling or downcycling of individual components. This is an example s of the mechanical fixing over the chemical. Other examples include choosing dry gasket sealed components over silicon sealed ones, screwed timber skirtings over nailed or glued ones, *and* dry fixed board fire-proofing over applied intumescent coatings.

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Pre-cast Flooring over Insitu Cast Elements
Pre-cast elements such as plank systems or beam and block can, if grouted with relatively weak compounds, allow for complete re-use, whereas cast insitu elements can generally only be crushed and downcycled. Of course these flooring bases cannot be reused if subsequent screeds are directly bonded, so screeds have to be of the separated or floating types.

Natural, Flexible or Loose Fill Insulation
There are a number of circumstances where rigid batt type insulants are used and cut – poorly – around obstructions such as loft trusses, cavity ties, raised floor stands etc. Not only does this practice compromise the energy performance of the building, the resultant batts are very unlikely to be re-used. Substituting flexible batts allows for better thermal performance and since no damage has to be done to the batts, there is more potential for reuse. Loose fill insulation also allows for better performance and can be reclaimed, but perhaps less easily than simple batts. An additional consideration is that some synthetic fibre products may soon begin to attract greater costs is respect to demolition and removal (for reuse or otherwise) because of health and safety concerns. Whilst such concerns are likely to be contested, the concerned Specifier may wish to consider natural insulation alternatives to avoid any potential on-costs or health risks.

Mill Finished Metal
While recycling of metals can be undertaken more or less whatever they have been coated with, such separation can increase the complexity, cost and pollution associated with the process, so using mill finished and inherently durable metal components has both economical and environmental advantages over coated and bonded alternatives.

Durable Ceiling Tiles
A number of fairly economical ceiling tile systems are available, but many are fragile and components easily damaged, whereas far more durable alternatives exist which contain significant potential to reduce the waste stream.

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