‘CLEANER DESIGN’ IN FACADES - A ROUTE MAP FOR THE FUTURE

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ABSTRACT

The drive towards reducing costs and improving products by improved design and improved procurement methods is not unique to facades. It is common in most industries and the concepts and techniques for delivering this can be transferred across industry boundaries. Facade technology must learn from other areas to optimise the opportunities available.

One new driving force is ‘Cleaner Design’ and it involves satisfying the customers’ requirements whilst using the minimum amount of resources and creating the minimum amount of environmental impact over the entire product life cycle. It is a proactive form of environmental management and encourages a move from the traditional linear approach to product life (manufacture, use, dispose) to a cyclical approach that encourages material to be re-used or recycled.

Cleaner Design is a tool for reducing cost and environmental impact during manufacturing. It reduces the environmental impact of the product during use, improves the options at ‘end-of-life’ and optimises design, manufacture and marketing for recycling and re-use.

Cleaner Design provides a model and a set of tools for the facade industry to borrow and customise. It can be used to improve design and procurement technology and also to reduce costs at all stages of the product life cycle.

INTRODUCTION

The world is in the middle of a second ‘industrial revolution’. The key to the first industrial revolution was the use of machinery to increase labour efficiency. The key to the second industrial revolution is the use of ‘Cleaner Design’ to improve overall resource efficiency.

- ‘Cleaner Design’ reduces the resources used and converts those that are used into higher added value products in the most effective way.

- ‘Cleaner Design’ reduces overall environmental impacts and improves profits.

- ‘Cleaner Design’ provides competitive advantages.

The product life cycle

In the future, improving resource efficiency through ‘Cleaner Design’ will require management and control of the total product life cycle. The keywords of the future will be:

- Manufacture

- Use

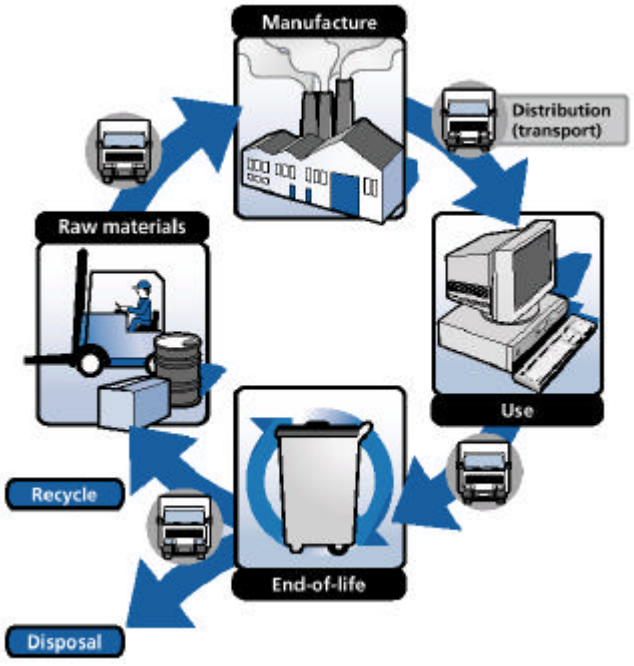
- End-of-life

- Raw materials

The generic product life cycle provides a basis for planning the actions needed to improve the whole process of facade design and procurement. Whole life costing is the start, but it is actions that consider the whole of the product life cycle that really count.

One study[1] has shown that:

- 93% of production materials do not end up in saleable products.
- 80% of products are discarded after a single use.
- 99% of materials used in the production of, or contained within goods, are discarded in the first six weeks.



The generic product life cycle

Construction of facades is probably more efficient than these global numbers but the message is clear - all products consume and waste vast amounts of materials through poor management of the product life cycle. On average 80% of a product's overall cost and environmental impact is a result of decisions taken during the design process. Focusing on these decisions by using Cleaner Design produces improvements in resource efficiency, profitability and reduces environmental impact.

What is cleaner design?

Cleaner design is a proactive environmental management tool to reduce the environmental impacts of a product throughout the life cycle. It is also a method of addressing wider issues, such as product cost, resource depletion, waste and pollution.

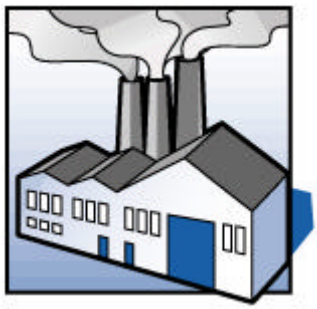
Cleaner design involves meeting the customers' requirements whilst using the minimum amount of resources and creating the minimum amount of environmental impact. Cleaner design moves from the traditional linear approach to product life (manufacture, use, dispose) to a more cyclical approach to allow material to be re-used or recycled at the end of its life.

The future?

The tasks facing the construction industry will change - past experience and methods will no longer be sufficient to meet the new challenges, demands and legislation. This paper looks at the important issues and tasks and tries to provide a route map to the future for profitable and sustainable operations. The time horizons, keywords and key tasks for the future are shown below.

HORIZON	KEYWORD	KEY TASK
0 - 2 Years	**Manufacture**	**Targeting efforts**
2 - 5 Years	**Use**	**Optimising Usage**
5 - 10 Years	**End-of-life**	**Minimising Outputs**
10 - 15 Years	**Raw materials**	**Minimising Inputs**

MANUFACTURING - TARGETING EFFORTS



In the short term, manufacturing is the key area and the key task is targeting the efforts to improve resource efficiency in the areas with the most return. This involves:

- Targeting actions to reduce the cost of materials.
- Targeting actions to reduce the cost of controllable overheads.

It means changing the emphasis from reducing labour costs in manufacture and construction to more important areas. It means keeping the labour and sacking the kilogrammes (materials costs) and the kilowatt-hours (utilities costs). It means designing the product so that manufacturing uses less process materials, energy, water and other resources. This increases profits, increases resource efficiency and reduces environmental impact.

Cleaner products

Cleaner design reduces the amount of materials used and changes the type of materials used, actions that both directly reduce the product cost.

Reducing the amount of material used is a fundamental of good design and is not unique to Cleaner Design - techniques such as Value Engineering, Product Design Specifications and Taguchi Methods should be used to generate robust designs that deliver the functions that the customer has specified whilst using the least material. Good materials selection creates designs that meet the requirements of both existing and future legislation, e.g. easier disassembly and increased potential for recycling. Increasing the use of recycled materials can often significantly reduce the product cost with no detrimental effect on product properties or performance and using recycled materials reduces the overall environmental impact of the product.

Correct materials selection involves the use of materials that reduce waste and energy consumption during manufacture and reduces or eliminates the use of hazardous materials during production. Reducing the number of components and materials used will reduce raw material and assembly costs (an area for significant cost savings) and increase the recyclability of the final product.

Cleaner manufacturing

An often neglected area is the design of products to minimise the consumables needed and used during manufacture. Reducing production costs by a product design that uses less energy, less water or creates less waste during manufacture not only reduces operating costs but also improves environmental performance. The next generation of product designers needs to consider not only the raw materials used but also the consumables used during manufacture. Cleaner design is design for both manufacture and assembly to:

- Lower the production costs.
- Reduce the use of raw materials and utilities.
- Reduce the use of hazardous materials.
- Reduce the amount of waste sent to landfill.

Designing the product so that less pollution and waste occur during manufacture will also reduce local environmental impacts and may lead to safer working conditions for employees.

Manufacturing and the impacts it generates are not separate processes in cleaner design; they are integral to the process of reducing cost and environmental impact.

Targeting efforts

Targeting the efforts means a renewed focus on the cost of materials and the controllable overheads. The short-term actions are:

- Set demanding but realistic objectives for reduced costs and impacts.
- Start work to reduce energy consumption in manufacturing.
- Start work to reduce waste in manufacturing.
- Start work on Cleaner Design to reduce the costs and environmental impacts.
- Use life-cycle assessment (LCA) and product specific checklists to benchmark environmental performance against previous products or competitors' products. Use existing company records, product specifications and other documents to do this.
- Dismantle current products (both internal and competitor's products) to see how easy they are to recycle.
- Keep abreast of forthcoming changes to legislation through journals, trade associations and business support organisations.

The route map

The first stage of the route map is shown below. This can be used as a guide to improving business profitability and reducing environmental impacts. Cleaner design is an integral part of good business practice to reduce costs, maintain competitive advantage and demonstrate the benefits of good environmental performance. Being good to the environment is business common sense.

DRIVERS	STRATEGIES
• Continued profitability and survival. • Increasing resource costs (e.g. Climate Change Levy). • Increasing disposal costs (e.g. Landfill Taxes). • Increasing environmental legislation.	• Improve relative resource efficiency for all resources used. • Reduce the amount of resources used in absolute terms. • Introduce Cleaner Design concepts at the design level to reduce future costs.
TACTICS	**RESULTS**
• Survey, measure and target resource usage costs. • Work with customers to reduce materials usage and costs. • Benchmark resource costs to set targets for reduced usage. • Invest in improved technology to reduce resource usage.	• Real cost savings from improved resource efficiency. • Energy bills reduced by 10-20%. • Cost of waste reduced by 25%. • Profits improved by 25-30%.

USE - OPTIMISING USAGE

A new critical cost

In the medium term, the challenge will be to reduce the cost of ownership. Buildings, as with many consumer products, generally use more energy and resources during their usage stage than during the manufacturing stage.

Reducing the cost of ownership requires additional considerations in design - the focus is on reducing the cost of usage and prolonging the life of the product and the resources embedded in it. Planned obsolescence is not an acceptable strategy, if it ever was in the long-term.

Facade specifiers are increasingly aware of the resource efficiency of competing products. The growth of 'energy rating' of consumer products and forthcoming EC Directives on the energy rating of buildings will inevitably be translated into requirements for more information and better choices by facade specifiers. This emerging pressure is already driving the development of more resource efficient products with reduced operating costs. In the medium term, Cleaner Design will be a major tool to optimise resource efficiency and reduce environmental impact during use.

Usage patterns

It is important to look beyond what the product is designed to do. Information is needed from users about what they actually do with a product, i.e. their 'product habits'. A simple example of 'product habit' is to leave a kettle to boil and then return later to reboil the hot water. Feedback from suppliers and users can reveal opportunities for reducing the functionality or parts of the product or packaging that customers regard as unnecessary, e.g. surplus modules and features.

Functional and usage analysis of the product are becoming key tasks and existing techniques such as Value Engineering and customer surveys (now part of ISO 9000:2000) are being used to produce Product Design Specifications based on 'critical' and 'desirable' functions rather than a design based simply on drawings, materials specifications and 'what we did last time'.

Designers need to use Cleaner Design as an incentive and a tool to optimise total resource usage during the product life, to tune the product design to the real needs and usage patterns of the user and to increase the value added for the specifier.

Designing for use

Opportunities to reduce resource consumption and environmental impacts during the product's use should be identified during initial product research and designers need to start to focus on issues such as:

- Using customer surveys as an integral part of the design process - These can identify important areas of the product's efficiency and whether it has any redundant functions that can be removed to reduce production and usage costs. Asking customers to rank the product's efficiency and the various functions can pay huge dividends by revealing the true customer needs and requirements.

- Using fewer resources in use - Designing the product so that use and maintenance requires less material, consumables, energy and other resources. This will reduce the environmental impact of the product and the costs of using the product, e.g. electricity and water consumption.

- Creating less pollution and waste in use - Designing the product so that it causes less pollution, produces (or results in) fewer emissions, has less waste and has reduced environmental impact during use.

- Optimising functionality and service life - Optimising functionality to reduce the need for additional products or resources to achieve the same task and making the product more efficient in use. Making the product adaptable to different tasks, related either by the technology or by the function can optimise the functionality.

- Giving the product a longer service life by making it easier to repair and maintain - This will increase repeat sales and will require fewer products to be manufactured, thereby reducing the impacts associated with production, delivery and disposal. Designing the product to last longer starts with looking at the records of complaints and reasons for maintenance of current products.

- Fitting better controls (preferably automatic) to optimise energy and material use without user intervention. Providing instructions on how to use the product efficiently is a good first step but automatic controls that remove the need for user intervention is better.

Although such measures can sometimes (but not always) increase the purchase price, the user inevitably achieves long-term benefits from reduced energy and resource consumption. The rise of labelling schemes on household items is making users more aware of the lifetime benefits of resource efficient products. These can form a core part of the actions to improve market share and profitability.

In the future the issue of resource efficiency during the usage stage will become part of the basic Product Design Specification and basic design of any product.

The route map

DRIVERS	STRATEGIES
• Increased profitability. • Continued growth of 'push-pull' taxes and legislative instruments, such as Climate Change Levy and Landfill Taxes. • Increased market demands for improved and documented environmental performance.	• Improve the design process and outputs to reduce the usage cost of products. • Improve the manufacturing process to reduce the usage cost of products.
TACTICS	**RESULTS**

• Integrate potential usage costs into the product costing calculations.
 	
• Design products to be resource efficient during use.
 	
• Train product designers in techniques such as:
 	
  • Design for Manufacture (DFM),
 	
  • Design for Assembly (DFA)
 	
  • Life Cycle Analysis (LCA).
 	
• Implement cleaner design as formal part of design process.
	• Improved focus on customer needs for reduced cost-in-use.
	
	• Achievement of real cost savings from Cleaner Design.

END-OF-LIFE - MINIMISING OUTPUTS

Destination shortages

The issues for manufacturing and use are largely internal - the improvements required are driven by internal costs and the need to reduce these. This will change in the medium to long-term future. The major drivers will become external and will be legislation and the cost results of the legislation. Legislation is now being used as a tool to internalise the social costs of products that were previously ignored by manufacturers. It is not going to get any easier.

In the 5-10 year horizon the key task will be minimising the outputs at the end of the product life. Disposal is becoming increasingly expensive for waste at any stage of manufacture. The current trend in legislation, e.g. WEEE (for electronic equipment) and EOLV (for cars) is to increase the cost of disposal and to allocate a large part of it to the producer ('producer pays'). The issue is one of shortages of destinations for outputs. The drive for reductions in CO_2 emissions is a 'destination shortage' because the atmosphere cannot accept more CO_2 without being degraded. This destination shortage is now being made the responsibility of the producer through legislation and taxation, e.g. landfill taxes, CO_2 taxes and effluent taxes.

The options for product re-use, recycling or recovery must minimise the total cost of the product and avoid end-of-life costs that were not accounted for in the 'first' cost of the product. The key to success is to appreciate why the product is no longer used and what then happens to the product. Part of the challenge with cleaner design is to improve the end-of-life options to minimise the costs and environmental impacts.

The choices

At the end-of-life, the product (or parts of it) can be re-used, remanufactured, recycled or disposed of to landfill. The further down this hierarchy the higher the cost end-of-life cost. To reduce costs, greatly improved control of the product at end-of-life is needed.

To provide direction for the future, designers need to find out what is currently happening to the products. Examination of current disposal methods can reveal opportunities for increasing the product's recycling potential and decreasing end-of-life burdens. Typical questions are:

- Is the product typically disposed of to landfill? This will be subject to increased costs in the future and can give rise to environmental impacts through leachates and landfill gases.
- Can the product be re-used or recycled instead of being sent to landfill?
- Is it possible to salvage parts or components for re-use or remanufacture?
- Does the product contain materials or components that can be recovered and recycled?
- Can parts be stamped with labels indicating their recycling potential?
- Can a product take-back service be developed using existing distribution channels or must new recovery channels be developed to collect used products and reduce costs?

Making re-use, remanufacture and recycling easier

Designers need to consider the costs of the end-of-life stage of products now - if this is ignored then the eventual costs will be unduly high when legislation changes. Designers must:

- Make re-use, remanufacturing and recycling easier for all products - this will reduce the eventual costs by reducing raw material use and diverting material away from landfill.

- Design the product for re-use in its current form (i.e. without re-processing) to extend the life.

- Design for product remanufacture or recycling by improving the physical organisation of the product, i.e. the structure and way it is put together. Reducing the number of fastenings and making fastenings easier to remove will make the product easier to disassemble and recycle.

- Design to enable recycling by reducing the number of materials used - single material products are much easier to recycle.

- Design to eliminate materials that can be hazardous during remanufacturing or recycling.

Reducing the impact of disposal

The most common current end-of-life option (disposal) will become the most costly option in the future. If there is no viable cost effective alternative to disposal then designers must attempt to reduce costs and the environmental impact of disposal. To reduce the cost of the landfill option, designers should:

- Design the product to allow the volume to be reduced before disposal.

- Choose materials, where possible and appropriate, to build in biodegradability.

- Reduce or eliminate the use of hazardous materials in the product design to avoid additional 'special waste' charges.

Cleaner design in the future will not be easy but excessive end-of-life costs are less acceptable. Whatever options are chosen for the product end-of-life stage, it is certain that the costs will rise in the future and cleaner design offers a unique opportunity to minimise these costs at source.

The route map

DRIVERS	STRATEGIES
• Increases in disposal regulations. • Increase in cost of disposal. • Market effects of product disposal costs. • EMS will become an essential qualification for business continuity.	• Improve resource efficiency and reduce resource usage to minimise effects of rising disposal costs. • Active management of tradeable resource credits, e.g. carbon trading, PRNs. • Development of a 'take-back' strategy to deal with end-of-life requirements.
TACTICS	**RESULTS**
• Monitor resource intensity and use legislation as a tool for success. • Change or modify accounting systems intensity to enable resource credit trading. • Form partnerships for 'take-back' plans. • Remove hazardous materials.	• Minimising the inevitable effects of increasing disposal and end-of-life costs. • Environmental design and control becomes an essential cost control tool.

RAW MATERIALS - MINIMISING INPUTS

Planning for scarcity

The resources of the world are finite but the demands being placed on them are increasing rapidly. These demands will increase even more rapidly as the nations of the Far East aspire to and attain the living standards of the West. These changes will inevitably require huge amounts of raw materials and both the resource depletion rate and prices will increase.

The challenge in the long-term will be to control prices by planning for scarcity. This will mean reducing the usage of virgin materials and increasing the usage of recycled materials.

Current materials

Many materials currently used cannot be (or are not) recycled and create significant environmental impacts during their production. These should be investigated to find alternatives with lower costs and environmental impacts. Suitable materials might:

- Be recycled or contain recycled materials.
- Be obtained from suppliers that are environmentally conscious.
- Be capable of recycling at the end-of-life stage.

Examination of current materials must be ruthless in the search for reduced cost and environmental impact. In Germany products made from recycled materials often attract a price premium, in the future this may become the norm rather than the exception.

The first target for improved costs and environmental impacts is to use less material. Reduce the amount of material used in the product by:

- Analysing how the main product function is delivered and whether it can be delivered with less material or even without the material at all.
- Retaining the current form but reducing section thicknesses or numbers of fixings.
- Reducing the part count by combining parts.

The second target is to reduce the environmental impact of the materials used in both the product and the production process. Reduce the environmental impact of the materials used in the product by:

- Using renewable materials and recyclates instead of virgin materials.
- Using materials that have less environmental impact during their production.
- Eliminating hazardous substances from both the product and the production process.

The future

In the future, the raw materials used will define the cost of the product even more than today. Incorrect materials choices will increase not only the initial cost but also the final cost. The correct materials choice will only be possible by knowing the impact and costs of the materials used over the complete product life cycle. This can be achieved by:

- Collecting information on possible material substitutes that are less hazardous, from renewable or recycled sources or produced with less environmental impact.

- Identifying materials databases containing information on environmental impacts.

- Requiring suppliers to provide detailed materials declarations as part of the supply contract.

Planning for scarcity and reduced environmental impact involves transforming the marketplace. The winners will be companies who manage the transformation and the losers will be those taken by surprise by the changes.

The route map

DRIVERS	STRATEGIES
• Raw material shortages, caused by resource depletion and demand, will increase prices of both products and utilities. • Increasing competition and price for recycled materials. • Legislative requirement for environmental design standards.	• Strategy for purchase of recycled, renewable materials. • Strategy for use of renewable energy. • Long term and sustainable corporate environmental plans. • Full implementation of cleaner design principles.
TACTICS	**RESULTS**
• Define real product needs, reduce the amount and number of materials used and introduce recycled and renewable materials. • Work with customers to gain acceptance of new life cycles of all products.	• Winners and losers. • Transformation of the marketplace.

CONCLUSION

Façade design and procurement will inevitably change over the next 15 years. The markets and issues will change to reflect the demands for sustainable development and continued profitability.

The key issue for the future will be increasing the total resource efficiency of the facade and the major technique will be Cleaner Design. Cleaner Design concentrates on the complete life cycle of the product and provides the basis for improved resource efficiency, increased profits, and decreased environmental impacts. Implementing Cleaner Design will revitalise the way we do business and reduce the total cost of procurement for the facade industry.

These changes will transform the industry - companies that are pro-active will benefit and prosper, reactive companies will see their competitive advantages and markets disappear.

The signs are clear; the pressures are there - the only thing left is action.

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1. Factor Four: Doubling Wealth - Halving Resource Use. von Weizsacker, E; Lovins, AB; Lovins, LH. Earthscan Publications (1997). ISBN 1853834076.