Designer Lead for Sustainability – A Review

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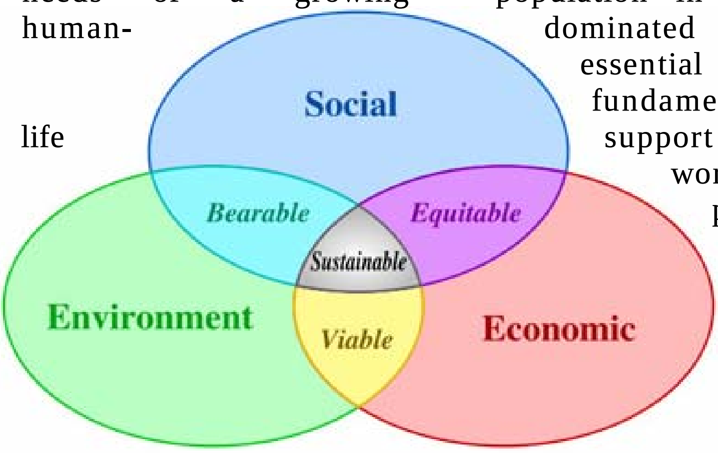
Many research works have been developed worldwide in order to integrate environmental issues into the design process. Resulting from these developments, various tools and methods have been emerging, including design for disassembly, design for recycling, selection of materials for green design, quantitative life cycle related methods such as life cycle assessment, qualitative life cycle related methods.

In recent times, we have seen an increase in raw material costs, opposition to incinerators and discharges, stricter environmental legislation, increased urgency to reduce climate change, increased sensitivity to environmental issues from consumers, etc., all of which place a strong demand on environmentally-friendly product design. Many research works have been developed worldwide in order to integrate environmental issues into the design process. Resulting from these developments, various tools and methods have been emerging, including design for disassembly, design for recycling, selection of materials for green design, quantitative life cycle related methods such as life cycle assessment, qualitative life cycle related methods. The evolution of product design is very positive and the tools and methods have become more complete and robust. However, the existing tools and methods have their weaknesses: they are product-centred rather than service-centred, multiple life cycles are rarely considered, they are generally oriented towards improvement rather than innovation, sustainability criteria are hardly taken into account, and so on. To overcome these weaknesses, it is necessary to develop a new category of design methods. Many researchers have already started the work concerning more "service-centred", "sustainable" or "eco-innovative" design processes. The research has revealed new knowledge in models, heuristics, methods, tools, learning processes, software, etc. The world's present development path is not sustainable. Efforts to meet the needs of a growing population in an interconnected but unequal and human-dominated world are undermining the Earth's essential life-support systems. Meeting fundamental human needs while preserving the life support systems of planet Earth will require a world-wide acceleration of today's halting progress in a transition toward sustainability. Sustainability is the ability of a system to be sustained indefinitely. This system could take any form and could be beneficial or detrimental to the human race and as rightly said "The earth does not belong to us. We belong to the earth", by Chief Seattle.



Model of Sustainability: Triple Bottom Line

Sustainable Design can therefore be defined as: **"The design of systems that can be sustained indefinitely"**

Sustainable Product Design defined as: **"The design of objects that aid the sustainability of the systems in which they operate"**

"Sustainability" is on the lips of nearly all chief executives of the industrial companies as they attempt to go carbon neutral in making and distributing their products and services. That means revamping materials, manufacturing, distribution, and their energy use. Sustainability is usually measured according to

Triple Bottom Line Environmental, Economical and Social factors.

To understand the terminology better below are discussed few practices with their examples and their understandings.

• Make designs less complex
Simple, elegant designs can reduce material, weight, and manufacturing processes. Simple designs usually also mean less material variety and can help make a product more recyclable.

Example: Benjamin stools from IKEA are a simple and elegant design. They are made of a single material, with a utilitarian but elegant form factor. This makes them lightweight and incredibly portable. They can be used as a sitting stool, a stepping stool, a coffee table, etc.

Understanding: Keeping designs simple can sometimes lead to overlooking an opportunity to increase the usefulness of a product without increasing its ecological impact.

• Make products more Useful
At first glance, this may seem to contradict point number 1, but there is a big difference between usefulness and complexity. Taking advantage of a natural or logical extra use for a product will not only make the product more desirable and interesting, it will also help reduce the number of products headed for landfills. Multiuse products can reduce consumption and increase convenience.

Example: The shape of the flat-head screwdriver on many pocket knives has been cleverly designed to also function as a bottle opener. The usefulness of the device has increased with no added material or complexity.

Understanding: Be careful not to let added usefulness detract from the functionality of the product. Poor functionality can lead a consumer to abandon the product altogether for a better functioning model.

• Reduce material variety
Designing as many aspects of the product as one can from the same material makes recycling the product at its end of I ife easier, more efficient, and more profitable.

Example: At its Chupai, Taiwan plant, Philips Electronics designed the Typhoon, a high-end color monitor, using green product design techniques. As a result, the monitor requires 35 percent less time to manufacture than a conventional monitor due to a 42 percent reduction of material and components.

Understanding: Be sure to not use harmful materials in the name of reducing material variety. Non-recyclable, nonrenewable and toxic materials should generally be avoided when possible. Deciding early on to use recycled, recyclable, renewable and biodegradable materials for major components of the design will help reduce material variety without negative side effects.

• **Avoid usage** of toxic **or harmful materials or chemicals** Materials like PVC, neoprene or polystyrene, and toxic chemicals and additives like bisphenol A and formaldehyde should be avoided when possible. Many of these materials have suitable non-toxic counterparts, like copolyesters or bioplastics, and additives can be eliminated by choosing materials wisely.

Example: Nalgene water bottles have recently switched one of their material selection (a polycarbonate that contained bisphenol A) to a copolymer with almost identical properties but without the associated health risks.

Understanding: Make sure to consider the energy input for the entire production cycle of the alternative material chosen and the likely disposal method for the product. If proper disposal or recycling can be guaranteed, less friendly materials may be a safe, best performing, lowest energy material choice for the job.

• **Reduce size and weight**
Lightweight products can reduce carbon emissions and cost by making the shipping process more efficient. Weight can often be saved by focusing on choosing lightweight materials, simplifying designs, and eliminating unnecessary fasteners and components.

Example: The HP Pavilion Slimline PC is 1/3 the size and half the weight of a traditional tower Pc. Using weight/spacesaving design approaches, HP and LUNAR were able to create a design that delivers all the processing power and features of a regular PC with less impact on the planet.

Understanding: Don't sacrifice durability in the name of weight savings. Less durable products need to be replaced more often and shipping a lightweight item twice can cause more harm than shipping a heavier one once.

• **Design packaging in parallel with products**
If a product is designed with a stylish and sustainable packaging scheme in mind, a client might absorb that idea. Lightweight packaging that uses sustainable (recycled, recyclable, or biodegradable) materials can reduce carbon emissions and raw materials waste alike. Optimize manufacturing processes

Determine which manufacturing processes make the most sense for your product. For lower volumes or less complex parts, consider vacuum forming instead of injection moulding. For some complex metal geometry consider casting instead of machining.

Example: When a metal must be coated, consider powder coating instead of painting. The powder coating process allows for excess powder to be collected and reused in the coating process, as opposed to paint overspray, which cannot be recovered.

Understanding: Manufacturing processes are complex systems and often energy or materials waste can be hidden within these systems. Talk with your manufacturer to make sure you understand the entire process and consult indexes like the OKALA 07 impact factors table to make sure that all aspects of the process are considered.

• Packaging along with product design
Many companies are not only looking at the product design from sustainable point of view but also its packaging material and system are considered.

Example: P&G's focus on packaging in the last 15 years has produced staggering results. According to bsr.org, "The company has used computer models to develop products that are more concentrated and require less packaging, such as bottles that are stronger yet lighter in weight, packages that do not require outer cartons, and the use of stronger lighter materials in place of heavier ones." The results of this packaging design blitz are that "overall packaging per case has been reduced by 27% and waste, air and water emissions have been reduced by 37%" since 1990.

Understanding: Always keep in mind that unnecessary packaging complexity, while sometimes creative, is unnecessary. Remember that all of the tips in this guide pertain to packaging design as well.

• Design for upgradeability
In the electronics industry, the technology in a product can become obsolete long before the design. Designing products that can be upgraded to keep up with rapidly changing technical performance can save materials and money.

Example: The HP Media Smart Server was designed with simple upgradeability at its core. Purchasable with varying starting amounts of storage, its capabilities can be upgraded by simply adding a drive when the time is right: a process that HP and LUNAR made sure was a simple task for all.

Understanding: Products that are designed to be upgradeable without being designed to be durable may break before they are ready for an upgrade. This could result in adding undue complexity to a design that won't be upgraded after all.

• Create durable and high quality designs
People want high quality products that will look and function beautifully long after the competing product has died, and they're willing to pay a little more for that type of design. Designed properly, products can transcend the "throwaway" culture that dominates electronics today.

Example: Craftsman hand tools have established a well earned reputation for being built to last. While some brands of less expensive tools are cast with shoddy processes causing them to fail, Craftsman has built their brand on selling high quality, durable tools, and backing them up with a no questions asked lifetime warranty.

Understanding: Not all products should last forever. Inherently limited use or single use products, like medical disposables, food packaging, toothbrushes (the heads, at least) should be designed to be the opposite of durable. Design temporary items to be absorbed back into the technical nutrients chain by making them fully recyclable, or back into the earth by making them biodegradable or compostable.

• Design for life and after death
Most products don't last forever. Products designed to have secondary usages aftertheir primary function has lapsed can add value to the product, and may fill a need that would be filled by another purchased product instead.

Example: Adding graduated lines to the side of a salad dressing bottle make it useful as a measuring device after its initial use.

Understanding: Trying to work unnecessary second uses into a design can often increase the complexity. Design a product's second life such that it requires no extra parts or complexity that wouldn't be needed in the original design.

• Make it modular
Modular designs are not only more easily recycled at the end of their life but also more easily repaired, and therefore last longer. Modular designs can also be more efficiently manufactured and shippprl. reducing energy consumption atthe beginning ofthe product's life.

Example: An example of this principle is the Aeron Chair by Herman Miller, Aeron chairs are not sent back to retailers for repair, Instead, if the chair breaks, replacement parts are ordered and the chairs are easily repaired on site.

Understanding: Making designs overly complicated in order to make them modular can do more harm than good. Try to design for modularity that can be had for "free" using creative features on injection molded parts or pieces of sheet metal that can accomplish multiple tasks.

• Use-recycled, recyclable, renewable, and biodegradable materials
This one's obvious, but should always be kept in mind. Design with recycled or easily recyclable plastics (HDPE, PP, PS, PVC), biodegradable plastics (PLA, PHB, polyamide, bio-derived polyethylene), paper, cardboard, wood, stainless steel, aluminum, etc.

Example: San Francisco based Green Toys makes children's toys entirely out of recycled milk jugs from local recycling facilities. All of the Green Toys products are both recycled and recyclable.

Understanding: Sourcing sustainable materials from distant locations can sometimes prove more harmful than beneficial. Biodegradable plastics produced in Australia, molded in China, and then shipped to the US can be more detrimental than standard plastics produced and manufactured c1oserto the product's point of sale.

• Minimize fasteners
Minimizing fasteners can make large portions of the product more easily recyclable at the end of life since removing snap-on parts can be done completely and quickly without the use of tools. This also eliminates multiple fasteners from the product BOM and reduces the amount of assembly time necessary to get products out the door, which reduces cost on two fronts.

Example: Dell computer bezels are assembled with snaps that are for "free" by integrating them into the design of the part that is already being injection molded. This also allows them to be more easily accessed for maintenance and more easily separated for recycling at the end of their lives.

Understanding: Sometimes a single fastener can avoid large amounts of part complexity and material variety. Also, if the fastener is made of the same material as the parts it is joining, the entire assembly may be able to be recycled without disassembly.

• Don't use paint

Painting a material generally makes it harder to recycle at the product's end of life because the paint cannot be easily separated from the material. As a result, many painted products are either not recycled or are irresponsibly melted down to burn off the paint, creating toxic fumes and lower quality recycled material. Design products to take advantage of the natural beauty of materials. Example: The HP Photosmart 7850 printer has plastic parts made almost entirely out of highly recyclable, non-painted plastics. In addition to making the plastic components more easily recyclable, having mold-in color means they can be scratched or worn without degrading their appearance. This choice also saves HP the costs associated with adding a painting stage in the manufacturing process.

Understanding: Eliminating paint on appearance parts could result in lower yields in the molding process. Discuss this with the part manufacturer to determine acceptable yield rates. Also verify that unusable parts will be reground and reused to make good parts.

Conclusion

The success of sustainable systems is therefore measured on the Triple Bottom Line, including social, environmental and financial. Sustainability requires that the system does not make a loss in any of the three areas. However, in reality this means that the system must aim to make a profit, in order that inevitable occasional losses balance out and do not result in the degradation and collapse of the system.

Initially it may be possible to design products or systems that only fall into one or two categories. However, in the long run designers should be aiming to address all three areas and create entirely sustainable systems, recognizing that all three issues are heavi Iy interl inked.

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