

# THE EVOLUTION OF DESIGN WITH CONCERNS ON SUSTAINABILITY

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## Abstract

This paper aims to analyse the birth and evolution of design with concerns over sustainability, in the context of social and civilizational changes experienced since the industrial revolution, with particular focus since the post-war period and in the context of sustainable development. It will examine several factors that influenced this design approach and that drove its evolution through different stages of maturity and complexity. It will analyse the various forms of design with environmental concerns, as well as the inclusion of other criteria in the context of sustainability, namely social ones. The aim is to settle knowledge that can allow us to draw some lessons to meet the challenges we face today.

**KEY-WORDS:** Sustainable Design; Design for Sustainability; Ecodesign; Green Design; Design Evolution.

## Resumo

O presente artigo pretende analisar o nascimento e a evolução do design com preocupações sobre a sustentabilidade, no contexto das alterações sociais e civilizacionais sentidas desde a revolução industrial, com particular enfoque desde o período pós-guerra e no âmbito do desenvolvimento sustentável. Serão abordados os diversos factores que influenciaram esta vertente do design e que impulsionaram a sua evolução ao longo de diversos estádios de maturidade e complexidade. Serão analisadas as diversas formas de design com preocupações ambientais, bem como a inclusão de outros critérios no âmbito da sustentabilidade, com o objectivo de sedimentar conhecimento que nos permita retirar alguma lição para enfrentar os desafios que se apresentam atualmente.

**PALAVRAS CHAVE:** Design Sustentável; Design para a Sustentabilidade; Ecodesign; Green Design; Evolução do Design.

## 1. Introduction

Designer and Professor Daciano da Costa stated in its lectures that designers should work as the critical conscience of society and, therefore, should look at Human needs and not just for its wishes. This expression clearly shows the potential that design has on the relationship between society, culture and environment, and the responsibility that designers have in creating a more benign material culture and a more sustainable consumption and production system. In consequence, this will develop a society with less impact on the environment and also foster greater social justice.

The main design challenge in this new century is to develop creative solutions that avoid or minimize the negative impacts of products, services or systems on the environment and on the social fabric. To do so, it would be wise to know and understand the evolution design embraced, so that it could keep up with the wide criteria sustainable development embodies.

## **2. Context and Precursors**

Before we talk about environment, social responsibility or sustainability it's necessary to understand the development model in which our society is based since the industrial revolution. This model is based on three premises: (1) continued growth, ie no development if there is no economic growth; (2) there is an almost endless abundance of resources; (3) it's easy and cheap to obtain and transform these resources because it's not necessary to pay the supplier Earth and there is plenty manpower. We know today that these three factors are not entirely true and have brought us some harmful side effects because it's impossible for a society to live on a finite planet and continue to grow *ad eternum* with a disorderly use of resources.

Despite the increase in well-being and quality of life, this development model has brought also significant environmental and social problems. We have 20% of the population consuming 80% of resources. If the remaining 80% of the population gets the same level of well-being in the same way, we will deepen the on-going ecological disaster. If the majority of the population can't access that level of quality of life, we will have a social catastrophe (Manzini and Vezzoli, 2008).

With the industrial revolution were born philosophical movements that reflected on its social, moral, ethical and environmental implications, both on humanity and on the planet. Thus, the foundation of sustainability is based on the connection between human beings and nature, as expressed in the Transcendentalist Movement in the early XIX century by Henry David Thoreau and Ralph Waldo Emerson. They believed in the appreciation of nature for its symbolism and spirituality and that it should serve as a guide to human evolution (Edwards, 2005). Thoreau is widely considered one of the grandfathers of environmentalism. By the end of the century appears the naturalist or conservationist movement, whose main figure is John Muir. This movement saw nature more pragmatically, as an ecosystem in which we belong, with an intrinsic value but also as the basis for our survival and therefore as something that must be preserved. Thus, one of the legacies of the XIX century to the following would be the need for an ethical approach based on respect for nature (Edwards, 2005).

In this period the Arts and Crafts movement sought to promote craftsmanship quality, not only material but also intellectual, in face of industrialization and provide some sense of authenticity to the production of objects, something that ceased to exist due to the gap between industry and nature. Despite the goal of creating affordable products full of meaning and beauty for all have failed, this vision of artistic production used as a guide for industrial production continued largely through the design activity. Deutsche Werkbund and Bauhaus helped define the profession of designer in the general terms that we know today: in this blend of artistic integration with incorporation of industrial standardization and simplification.

The World War II brought the realization of the fragility of the Human condition. For the first time humankind saw that it would be possible to have a future without the human species, either for ideological or technological reasons. However, as a way

for global economic recovery, after the war were defined instruments to foster economic growth (as the Marshall Plan) and social cohesion (as the EEC, now EU). This became an era marked by high economic growth, in which the promotion of consumption played a role in the economic and social recovery. And design helped this process through exercises in style and deepening the concept of planned obsolescence. There was a big formal refinement, that changed rapidly, subdued to fashion criteria. The styling of Cadillacs and the streamlining work of Raymond Lowey are key examples of this *modus operandi*. But this increase in production and consumption was based on dirty technologies, something that was evident in some notorious environmental disasters, as the great London Smog of the 50s and the case of Minamata Bay in Japan.

The awareness that such actions were not the most appropriate was immediate. Vance Packard's books are a good example, particularly *The Waste Makers*, from 1963, where he criticized the influence of the consumer society and the planned obsolescence of desire. One major precursor of design with environmental and social concerns was designer, architect and inventor Buckminster Fuller, who since the late '30s (and up to '80s) outlines its concerns, developing several products, concepts and theories that advocate a more efficient use of resources.

The birth of the modern environmental movement in the '60s, which many attribute to the pioneering book by Rachel Carson, *Silent Spring*, in 1962, led to a greater awareness of environmental problems and their impact on human health. This gave notice to society of the problems of having an economic model without environmental and social responsibility. The sense that we are in this together came from the perception of living in a finite planet, something that was crystalized in 1968 when NASA took a picture to Earth (Gore, 2006), where, for the first time in history, we could see it floating alone in the silence of space. However, the awareness that we are polluting and destroying the resources was only possible due to technological developments that allowed the detection of toxic substances in the environment (Lovelock, 2001). This demonstrates well the duality existing in the evolution of societies that allows the occurrence of these paradoxes.

Design started to develop some studies and debates on its impact on the environment and society. This is the case of Victor Papanek's book *Design for the Real World* in 1971, where design is presented as a profession that has potential to harm both natural and human environment. Papanek states in the preface "there are professions more harmful than industrial design, but only a very few of them." However, on the same page that "in this age of mass production when everything must be planned and designed, design has become the most powerful tool with which man shapes his tools and environment (and, by extension, society and himself)"(Papanek, 1997, p. ix).

Papanek defines the design profession and the impact it has, not only environmentally, but also socially and economically, by drawing a dark view of the activity as it was and pointing paths through innovation, nature, ethics and accountability of the designer, through education of designers and also through the use of materials and processes that cause a lower impact on the environment. It is therefore a design concept with a large entailment on environmental, ethical and social responsibility. It's also a design vision more focused on solving real problems than the ephemeral development of products. This integrated view of the problems would be split apart later on, during the maturity of environmentalist in the 90s, only to be reintegrated in the new century.

Complementing the impact of Papanek claims, three events fostered the emergence of the first scientific studies on environment and the first environmental laws. They were: the report on the limits to growth and consumption of resources by the Club of Rome in 1972; the oil shock; and the 1st UN Conference on the Human Environment also in 1972 in Stockholm (which created the United Nations Environment Programme - UNEP).

Alongside the environmental concerns it was also discussed and developed a design approach more focused on social issues, namely in supporting the development of countries in need. The conference "Design, Society and the Future" in 1969, the conference "Design for Need" in 1976, (both organized by ICSID) and the Declaration of Ahmedabad, in 1977 (work of UNIDO and ICSID) are examples of those developments. They were seeds for two design approaches that will walk alongside with environmental design: design for development and inclusive design.

This context allowed, so even though a minority, the development of environmental and social consciousness of designers and with it the possibility of creation of the first tools and processes of environmental impact assessment.

### **3. Green Design**

Since the late '70s we see a gradual development in design with environmental concerns, focusing only on one or two important aspects of the environmental impact of a product, such as the elimination of toxic materials or the use of recycled materials. This design approach, entitled green design, following the trend in industry to adopt systems of end-of-line, had two main objectives: prevention of waste and better material management (Dewberry, 1996). This industrial policy implied the use of less material to perform the same function and also the ability to recover some value from materials through the reuse or recycling. For such results were needed disassembly and separation strategies.

The solving problems approaches were primarily focused on ways to re-design, just trying an environmental improvement for the same product concept and without a life cycle perspective. This meant that certain choices could cause environmental impacts at other stages of the product life, but as there was concern holistically analyse the solution were not noticeable these possible interactions at other stages.

The green design developed over the '80s was parallel to the green consumerism movement, where it was tried to enhance industry reactive attitude to create greener solutions, entitled environmentally friendly (Leal, 2000). Green products started to appear, sold with emphasis on some aspect of environmental improvement. However, this model of consumerism proved fallacious, because in addition to several companies advertised features that were not truly ecological, it created the illusion that consumption may not have impact on the environment, which is counterproductive from the standpoint of true pedagogy on the impact that the system of production and consumption has on the planet - the use of the term "environmentally friendly" is the best example. This led to the need to implement environmental labelling systems certified by independent entities.

In a vision still very close to the radical environmental approach of the 60s and 70s, well expressed in hippie culture, green design also developed a stream associated with a smaller commercial intention, a more low-tech look, with materials of perceived lower quality. As is the case of the use of wastes in the manufacture of clothing, the use of corrugated or rattan in chairs or recycling plastics of different

colours to a shelf. These objects had a clearer message and its symbolic perspective surpasses its functional capacity. Some of these objects have become the hallmarks of green design, but the use of a less radical approach eventually won preponderance due to commercial interests.

When we talk about sustainability the most important aspect of this decade is the work of the United Nations Commission for Environment and Development, also known as the Brundtland Commission, which drafted the report *Our Common Future*, where they make an analysis of world problems and present the concept of sustainable development as a process of change that seeks to reconcile environmental concerns with development needs. The Brundtland Commission defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). This development strategy is based on the interdependent relationship of three factors: economic development, environmental protection and social equity - triple bottom-line of sustainability. However, this principle of interdependence only later began to shine in design practice.

The '80s brought the discovery of the ozone layer depletion and saw the world suffer some of the worst man-made disasters: gas explosion at a refinery in Bhopal, India, nuclear reactor explosion in Chernobyl, Ukraine (former USSR) The oil spill from the Exxon Valdez super-tanker on the clear shores of Alaska. These events helped increase the awareness of society to environmental problems. Added by economic growth and the increase in material comfort this decade gave way to a greater possibility of intervention by designers.

Another very important event for the design was the creation of the non-profit network for designers with environmental concerns called O2 (1988). It had the aim of sharing information and promoting discussion on how to integrate environmental aspects and sustainability in design. Two of its most influential members Kazazian and Flint were also interested in moving away from environmentalist aesthetic finishing of rough green design to something more elegant and witty (Kiser, 2000).

As a result of the work developed in the context of green design two main documents resulted: the books of 1991 by Paul Burrell and by Dorothy Mackenzie, both entitled *Green Design*, present case studies with solutions focused on only one strategy (such as reducing material) and also expose the possibility of designers show their responsibility to society. However, the authors recognize that improving the environmental performance of manufacturing industry is not enough and that we need an approach cradle-to-grave (cradle-to-grave) in design and manufacturing (Mackenzie, 1997), putting the environment as a concern since the beginning of the process and extending the responsibilities of creators and producers.

#### **4. Ecodesign**

Although green design never ceased to be, since the late '80s emerged an approach to design that focused on the environmental problems of a product throughout its entire life cycle, without compromising other criteria such as quality, cost and appearance (Dewberry, 1996). This approach would be called *ecodesign*. The prefix *eco* appears associated with the word *design* not only to demonstrate the environmental concerns that underlie the development of products, but also to express that the economic imperative cannot be relegated. This means that *ecodesign* aims to diverge from the rough and vernacular aesthetic of green design, attempting a widespread inclusion of environmental criteria in product

development. For that to occur environmental issues should be considered at the same level as all other traditional criteria, such as the ergonomic, functional and aesthetic.

In the '80s the focus was on industrial processes and that often led to the designation Clean Product Development, but in order to extend the achieved improvements was necessary to create environmental management systems. To complement this approach design had to take advantage of something that began to develop within companies as a way to facilitate the inclusion of the several design for the environment strategies, the DfX approach. Since different strategies had been developed with specific objectives, such as design for recycling (DfR), design for maintenance (DfM), the acronym DfX was used describe this kind of separation of the different strategies, where the letter X could be replaced by each one of those strategies. This approach, because of its simplicity, allowed companies to incorporate step by step in its operation the most relevant environmental concerns, serving as stepping stones from green design to later stages (Hemel, 1998).

However, it was necessary to adopt a product life cycle approach, from cradle-to-grave, but, to do so, it was necessary to know in a systematic way which were the environmental problems and how design could contribute to its resolution.

The answer to the first part came from the consolidation of scientific research, which was to be projected worldwide after the release of the Brundtland Report in 1992 in Rio de Janeiro, the UN Conference on Environment and Development. This occasion gathered more than 180 world leaders and hundreds of delegates and non-governmental organizations with the aim of reaching an agreement on the principles and action strategies. This was through the Rio Declaration and the Agenda 21 - an action program for the operationalization of sustainability. As a result of preparation work done for the Rio Conference and Agenda 21 were developed many theories and tools to assess the impact of man on the planet, including the Ecological Footprint, Natural Step, MIPS or the concept of eco-efficiency.

We know today that designers have an important role to play in tackling the sustainability crisis, because their connection with consumption and production. But to relate the connection between the product and the environment, to assess potential impacts, take informed decisions and to set improvement priorities, designers needed tools to help them incorporate environmental concerns in the product development process. With this purpose the Dutch Government, Philips and University of Delft developed the IDEMAT in 1990, a database of materials that presents ecological indicators that help designers to evaluate the impact of the product (Fuad-Luke, 2002). Later on there would be developed many ecodesign tools, whether in business or in academic context, with different degrees of complexity and demand for information and with different objectives: analysis of environmental strengths and weaknesses, selection of priorities and improvements with the greatest potential, supporting the generation of ideas and coordination with other criteria (Tischner et al., 2000).

It is also at this stage that the first PhD researches are carried out in ecodesign, which meant a more organized and systematic body of discipline, supported by practical implementation of several pilot projects in the industry, like the Dutch IC Ecodesign Project.

Through a systematic approach to product lifecycle was possible, working on the principles of green design, to develop ecodesign strategies that fit the diverse

products and that addressed all phases of the life cycle. The most adopted strategies were presented in the manual *Ecodesign - A Promising Approach to Sustainable Consumption and Production* (Brezet and Hemel, 1997), which were based on the LIDS Wheel (Hemel, 1995): (1) Selection of low-impact materials impact; (2) Reduction of materials usage; (3) Optimization of production techniques; (4) Optimization of distribution system; (5) Reduction of impact during use; (6) Optimization of initial lifetime; (7) Optimization of end-of-life system; (8) New concept development.

Across the Atlantic the focus goes to the designation Design for Environment – DfE - through an approach, which despite having a life cycle perspective, is still more focused on industrial processes and engineering. Examples are the works: *Industrial Ecology* (Graedel and Allenby, 1995) and *Design for Environment* (Fiskel, 1996) both with a very technical and pragmatic approach, showing a path to compatibility between industry and environment, through the establishment of an industrial ecosystem that maximizes the use of resources. This is, therefore, a very focused approach in eco-efficiency of the production system.

However, some researchers, including EcoReDesign program in Australia, have considered the term DfE the same as ecodesign. Add to this another a set of terms that, in part or in whole, aim to contribute to the describe a design with environmentally concerns, we have the ideal recipe for an epistemological confusion, absolutely undesirable academically.

Another term in the same line of thought of ecodesign, which found resonance not only in America but also in Europe, was the Life Cycle Design. LCD presents an approach in which the integrated view of the entire life cycle of the product is essential and that, despite being closer to engineering processes, it also introduces the need to make trade-offs between potential conflicts as ecodesign does. This kind of decision based on the entire life cycle was lacking in green design. LCD also stresses the need for companies to develop their business in a changing environment, with new legislation, environmental management systems, eco-labels and with new demands from consumers and other stakeholders (Behrendt et al., 1997). With this view the principle of extended producer responsibility, which arises in the mid-90s, is also seen as a way to encourage companies to aggregate the various environmental strategies.

Thus, we see in the 90 the birth of products that adopt these strategies and there is indeed a significant environmental improvement by product. However, it has become clearer that due to the continuous increase in population and its increasing standards of living, the impact of the of production and consumption system on the environment and the demand for resources continues to increase. This also means more social stress. To successfully reach a sustainable society it would require a drastic reduction in the consumption of natural resources, when compared with the average of industrialized societies, something like 90%, which means an eco-efficiency factor of 10 (Manzini and Vezzoli, 2008). This finding meant that we would need a design approach that could go beyond the evolutionary mode of ecodesign, and could interpret the changes that took place with globalization and the information society and would not leave behind generational and social factors identified in the Brundtland Report.

## **5. Sustainable Design**

The findings presented above, made throughout the 90s, and the put in action of sustainable development created a framework for design to develop a new

approach that allowed contributing to an effective paradigm shift in the production and consumption system. This approach was called sustainable design or design for sustainability (DfS).

Lets go back to the basic principles of sustainability that should guide this approach: the 3 E's (Economy, Ecology, Social Equity). The first pillar relates to economic sustainability. This is the "E" that less relates to the traditional concept of environmentalism. It mainly relies on the idea that it is essential for a sustainable future to have a vibrant economy that can provide jobs and security. It is, however, necessary to include in this concept the idea that profit is the sole ruler of activities. The second pillar concerns the ecology. Environmental sustainability requires a long-term viability of our use of resources and is dependent on the services that ecosystems provide us: clean air, clean water, decomposition of wastes, pollination, etc.. Environmental sustainability can be achieved if three basic conditions are met: (1) the utilization of renewable resources must be less than their natural replacement rate, (2) the rate of use of non-renewable resources should be lower than the rate of implementing alternatives, and (3) the pollution rate should be inferior to the regeneration capacity of the planet. The third pillar widens the concept of sustainable development to social equity. Here it is understood that the welfare of the individual is interdependent with the welfare of the community where it is integrated and society in general. So, social cohesion, tolerance and respect for human rights are essential. An individual feels that is integrated into a community where there is a participatory and equitable distribution of resources (Edwards, 2005).

These three pillars and the way to interconnect and harmonize were discussed at the 3rd Conference of the United Nations in Johannesburg in 2002, which created a sustainable development implementation plan. In European level this related to strategy for sustainable development developed by the European Commission. These documents had a big focus on changing consumption and production patterns to a sustainable path. This is very relevant as framework for the assertion of sustainable design, particularly in the context of economic and financial crisis in which we live, where a paradigm shift it is even more important. These aspects would be discussed again at the 4th UN Conference: Rio +20, where, once again, there was no formal commitment by governments to concrete goals.

A sustainable design approach therefore means a rapprochement with some of the guiding concepts of the pioneers of design with environmental and social concerns as Victor Papanek and Buckminster Fuller. We thus come full circle: the preponderance of environment on green design (specially in some of its less commercial trends) was smoothed on ecodesign with the need for economic sustainability of products are now both are being harmonized and balanced with the inclusion of the social criteria in the sustainable design approach.

However, how operationalize this approach is still in progress. Sustainable design still has a body that is mostly theoretical and philosophical (Walker, 2006), as opposed to ecodesign where development of tools has allowed its practical implementation within the profession. Within the scope of sustainable design there have been several approaches to attempt to solve this problem. We know that the design focus needs to change from product to the satisfaction of needs, using new solutions that require less energy and materials (Nieminen, 2008, Bhamra and Lofthouse, 2007), however the increase in environmental qualities of products can not be made without considering the socio-cultural sensitivity that will frame them (Manzini and Vezzoli, 2008).



Since the late 90's that designers and scholars have defined principles, strategies, methodologies and tools in order to try to incorporate all elements of sustainability within the design activity. Here are some of the most significant examples:

- (1) Cyclic-solar-Safe Protocol (Datschefski, 2000) includes also a social component and another of efficiency. The author refers to it as an operation mode that exists in nature and that can supports 99% of man-made environmental innovations.
- (2) Cradle to cradle is another approach based on eco-effectiveness. Was developed by W. McDonough and M. Braungart (McDonough and Braungart, 2002) with the purpose to promote a correct use of biological and technical nutrients (the two different types of resources), without crossing these two systems and using the concept of true recycling - reprocessing materials for the same level in the value chain.
- (3) Another approach, has been based on the ecodesign and its tools, is to design sustainable products where one contemplates the inclusion of ethical and social factors in the various tools (Charter and Tischner, 2001). The biggest obstacle to this approach is connected to the lack of influence of design in most categories of relevant social issues, as well as the absence to date of a systematic consensus on these issues. Something that currently is being solved through international standards on social responsibility and the support of emerging tools like S-LCA (UNEP, 2009).
- (4) There are also approaches more focused on the product-service systems (Tukker and Tischner, 2006) and complementary approaches between efficiency and sufficiency (Manzini and Vezzoli, 2008), but always trying to have a system vision.
- (5) Recent approaches require greater awareness and accountability by the designer and a wider range of its action, trying to design systems and behaviours, whether through participatory modes of design, co-design or open source design (Chick and Micklethwaite, 2011) and presenting an approach of engagement and social activism (Fuad-Luke, 2009).

This multiplicity of attempts to formulate a practical sustainable design development, besides meaning some lack of consensus on the path (since the objective is clear), still suffers from two problems. The first is the lack of a systematic and global operationalization of sustainable design: whether it shows the various concepts in a very practical and concrete manner, which means they will probably overlook a lot of relevant information, because it is diffuse and difficult to handle, making thus sustainable design only a kind of "increased ecodesign"; or adopts a completely radical approach, which departs too much from the practical reality of companies and customs of society, which could mean lack of acceptance by consumers, who are the engine of the economy and can have a significant impact on their behaviour. The second problem concerns the lack of understanding of the time factor and the impact of the entire system without resorting to other methodological frameworks that go beyond the scope of the design.

## **6. Conclusion**

In this time the confusion between the designations green design, ecodesign and sustainable design still exist in many designers and is used without any great sense of total understanding. This removes credibility and meaning to all of them. We can, however, conclude that the evolution of environmental and social awareness, which also served as the basis for sustainability, created a framework

for the design activity to unfold according to environmental and social needs and concerns. This evolution in design is therefore a reflection of the socio-cultural and environmental awareness and is reflected on the production and activity: from pollution treatment, to prevention through rethinking the production process, to the re-design of products and services and, finally, to the discussion about social behaviour for a sustainable production and consumption. This shows that the role of design has evolved and has integrated new concerns, thus making it a more responsible design that has oscillated between large focuses on environmental concerns and encompassing social and ethical concerns.

The operationalization of sustainable design is therefore essential to enable design to contribute effectively in all levels for a more sustainable production and consumption system. However, despite design holding some power over this system, its influence doesn't go as far as controlling other determinants, such as world population growth. So, for a sustainable outcome it's necessary to question the entire development model and present new solutions. The "how" we can make the transition to a sustainable model is still not clear.

## **7. Bibliographic References**

BEHRENDT, Siegfried *et al* – Life Cycle Design: A Manual for Small and Medium-Sized Enterprises. Berlin: Springer Verlag, 1997. ISBN: 3-540-62793-6

BHAMRA, Tracy. & LOFTHOUSE, Vicky. – Design for Sustainability: A practical approach. Hampshire: Gower, 2007. ISBN: 978-0-566-08704-2

BREZET, Hans. & HEMEL, Carolien van – Ecodesign: A Promising Approach to Sustainable Production & Consumption. Paris: UNEP, 1997. ISBN: 9789280716313

CHARTER, Martin & TISCHNER, Ursula – Sustainable Product Design. In CHARTER, Martin & TISCHNER, Ursula (Eds.) – Sustainable Solutions: Developing Products and Services for the Future. Sheffield: Greenleaf Publishing, 2001. ISBN: 1874719365

CHICK, Anne & MICKLETHWAITE, Paul – Design for Sustainable Change: How Design and Designers Can Drive The Sustainability Agenda. Lausanne: Ava Publishing, 2011. ISBN: 978-2-940411-30-6

DATSCHEFSKI, Edwin – The Total Beauty of Sustainable Products. Crans-Près-Céligny: RotoVision, 2001. ISBN: 2-88046-545-1

DEWBERRY, Emma – Ecodesign, Present Attitudes and Future Directions: Studies of UK Company and Design Consultancy Practice. UK: Open University, 1996. PhD Thesis.

EDWARDS, Andres – The Sustainability Revolution: Portrait of a Paradigm Shift. Gabriola Island: New Society Publishers, 2005. ISBN: 978-0-86571-531-8

FISKEL, Joseph – Design for Environment: Creating Eco-Efficient Products and Processes. New York: McGraw-Hill Professional, 1996. ISBN:0-07-020972-3

FUAD-LUKE, Allastair – The Eco-Design Handbook: A Complete Sourcebook for the Home and Office. London: Thames and Hudson, 2002. ISBN: 0-500-28343-5

FUAD-LUKE, Allastair – Design Activism: Beautiful Strangeness for a Sustainable World. London: Earthscan, 2009. ISBN: 978-1-84407-645-1

GORE, AI – Uma Verdade Inconveniente. Lisboa: Esfera do Caos, 2006. ISBN: 989-8025-09-3

GRAEDEL, T. E. & ALLENBY, B.R. – Industrial Ecology. New Jersey: Prentice Hall, 1995. ISBN: 0-13-125238-0

HEMEL, Carolien van – Tools for setting realizable priorities at strategic level in Design for Environment. International Conference on Engineering Design. Prague: 1995

HEMEL, Carolien Van – Ecodesign Empirically Explored: Design for the environment in Dutch small and medium sized enterprises. Delft: TU Delft, 1998. PhD Thesis.

KISER, Barbara – A Blast of Fresh Air: The History of O2. O2: 2000

LEAL, Rui – A Insustentável Leveza do Fazer: Um Estudo sobre Design & Ambiente nos Finais do Século XX. Porto: FAUP, 2000. MsC Thesis.

LOVELOCK, James – Gaia: Um Novo Olhar Sobre a Vida na Terra. Lisboa: Edições 70, 2001. ISBN: 972-44-1075-7

MACKENZIE, Dorothy – Green Design: Design for the Environment. London: Laurence King Publishing, 1997. ISBN: 1-85669-096-2

MCDONOUGH, William. & BRAUNGART, Michael – Cradle to Cradle: Remaking the Way We Make Things. Nova York: North Point Press, 2002. ISBN: 978-0-86547-587-8

NIEMINEN, Eija – Creative Sustainability: Case Studies on User-Driven Business Innovation. Helsinki: Designium, 2008

PAPANEEK, Victor – Design for the Real World: Human ecology and social change, London: Thames and Hudson, 1997. ISBN: 0-500-27358-8

TISCHNER, Ursula, *et al.* – How to do ecodesign?: A guide for environmentally and economically sound design. Frankfurt: Verlag, 2000. ISBN: 3-89802-025-8

TUKKER, Arnold. & TISCHNER, Ursula – New Business for Old Europe: Product-Service Development, Competitiveness and Sustainability. Sheffield: Greenleaf Publishing, 2006. ISBN: 978-1874719922

UNEP – Guidelines for Social Life Cycle Assessment of Products. Paris: UNEP, 2009

VEZZOLI, Carlo. & MANZINI, Ezio – Design for Environmental Sustainability. London: Springer-Verlag, 2008. ISBN: 978-1-84800-163-3

WALKER, Stuart – Sustainable by Design: Explorations in Theory and Practice. London: Earthscan, 2006. ISBN: 9-781-84407-305-4

WCED, Our common future. Oxford: Oxford University Press, 1987. ISBN: 0-19-282080-X