

Design for sustainability: the new research frontiers

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1 Introduction

Transition towards sustainability requires **radical changes** in the way we produce and consume and, more in general, in the way we live. The prospect of sustainability necessarily places the very model of development under discussion. In future decades we must be able to move from a society in which well-being and affluence are measured by the production and consumption of goods, to one in which people live better consuming (much) less. In fact, we need to learn how to *live better* (the entire population of the planet: *equity principle*) and, at the same time, *reduce our ecological footprint*. In this framework the link between the environmental and social dimensions of this problem clearly appears, showing that **radical social innovation** will be needed, in order to move from current unsustainable consumption models to new sustainable ones.

Given the nature and the dimension of this change, we have to see transition towards sustainability (and, in particular, towards sustainable ways of living) as a *wide-reaching social learning process* in which a *system discontinuity* is needed. Therefore a, system approach is important in order to seriously tackle the transition towards sustainability, i.e. so called **system innovations** should take place.

It is also important to frame this approach within a profoundly modified conception of the surrounding world; within the increasingly **interconnected** and **multicultural** context of globalisation (or *transnationalisation*). Nowadays it is very clear that contemporary social reality is no longer conceivable in terms of isolated, rooted and independent worlds, nations or communities. Within this context, a promising emerging economic model is that of **distributed economies** (e.g. distributed energy generation, distributed computing (peer-to-peer), and creative communities, cooperative networks), that could reduce the environmental impact, while facilitating a resources access democratization. So forth, in terms of sustainable consumption and system innovation, a key role could be played by **local-based and network-structured enterprises, initiatives and activities** (e.g. *Creative communities* and *cooperative networks*).

In this framework the paper reviews how the discipline of *design for sustainability* has enlarged its scope and field of action. From *material and energy low impact selection*, to *Life Cycle Design* or *Ecodesign* of product, to **design for eco-efficient Product-Service System**, to **design for socio-ethical sustainability** (where the equity principle of sustainability is directly addressed, and not indirectly as a potential result of a radical resources reduction in industrialized contexts). An emerging hypothesis is that a design approach that seeks to tackle radical innovation and sustainable consumption effectively should operate (and define the way to do so) on a

system innovation level. A design with a strategic approach towards the **promotion/development of local-based and network-structured initiatives**. A design for sustainable system innovation starting with the local, but at the same time (to avoid being limited to localism) developing a **transcultural - “migrant” creativity - attitude**, so as to be endowed with an effective social creativity, able to become part of the wider transition towards sustainability.

Finally, new roles to be played by design **Higher Education Institutions (HEIs)** as fundamental to this transition process are emerging: HEIs not only as places for (advanced) education and as diffusers of sustainable ideas, but even **incubators of sustainable** local-based and network-structured **enterprises**. In fact, since 1999 similar incubators exist in Brazil: Incubadora Tecnológica de Cooperativas Populares (ITCP). The *DIS, Design and system Innovation for Sustainability, INDACO-Politecnico di Milano* started a collaboration with some of those ITCPs, in order to adapt, develop and test system design for sustainability tools/methods for ITCP.

2 System innovations for Sustainable development

In the second half of the '90s a series of studies and analyses led to a clearer understanding of the dimension of change necessary to achieve a society that is effectively and globally sustainable. It was then realised that conditions for sustainability can only be achieved by *drastically* reducing the consumption of environmental resources compared to the average consumption by mature industrialised societies.

The debate about more sustainable consumption patterns has been included in the agenda of the major international governmental institutions over recent years starting with the United Nations. Particularly significant was the setting up of the *Sustainable Consumption Unit* of the UNEP (*United Nation Environmental Programme*) in May 2000. The initial assumption was that “in spite of the progress made by the industrial world and enterprise during the last decade [...]the extent to which consumption exceeds the Earth’s capacity to supply resources and absorb waste and emissions is still dramatically evident” (Geyer-Allely E., 2002).

Some studies (taking into account demographic growth forecasts and hypothesising, rightly, an increase in the demand for well-being in currently disadvantaged countries/contexts) have brought out a staggering result: conditions for sustainability are achievable only by increasing the eco-efficiency of the production-consumption system by at least ten times. In other words we can only consider sustainable those socio-technical systems whose use of environmental resources per *unit of satisfaction/service rendered* is at least 90% below what is currently to be seen in mature industrial societies¹.

These estimates are approximate and currently under scientific discussion. However, they are still valid to indicate the proportions of the change that should take place. A profound, **radical transformation** in our development model is necessary and the production and consumption system in this sustainable society will be profoundly different from what we have seen up to now. This scientific evidence leads political, scientific, philosophical and social debate to question not only production processes and artefacts (products and services, infrastructure and all the various forms of

¹ On this question see works by Wuppertal Institut für Klima, Umwelt, Energy; by the Advisory Council for Research on Nature and Environment (in particular: *The Ecocapacity as a challenge to technological development*, a study funded by a group of Dutch ministries); by the *Working group on eco-efficiency* sponsored by the World Business Council for Sustainable Development (see particularly the final report *Eco-efficient Leadership*, WBCSD, 1996).

anthropological settlement), but also patterns of consumption and access to goods and services. In other words the prospects are of **radical social innovation and system innovation in general** (UNEP, 1993; ERL, 1994; ERL, 1993).

Discussion about consumption patterns in the framework of a transition towards sustainability has been included in the agenda of the major international governmental institutions over recent years starting with the United Nations².

Over the next few decades we must enable ourselves to move from a society where well-being and economic health are measured in terms of growth in production and material consumption, to a society where we are able to live better consuming far less, and to develop the economy reducing the production of material products.

A context where economic growth can not be seen as the ultimate goal, and where, as Sen upholds (Sen, 2000), freedom is the initial means by which to achieve a development that must be orientated towards improving life; freedom as a guarantee that people are the protagonists of their own destiny and not the passive beneficiaries of a development programme³

How this may happen is at present difficult to foresee. It is, however, certain that there will have to be a **discontinuity** that will effect all facets of **the system**.

Given the nature and the dimension of this change, we have to see transition towards sustainability (and, in particular, towards sustainable ways of living) as a *wide-reaching social learning process* in which a *system discontinuity* is needed. Therefore a, system approach is important in order to seriously tackle the transition towards sustainability, i.e. so called **system innovations** should take place.

This complex issue can be summarised in the following question: how can we foster new quality criteria so as to separate the social demand for well-being from a relationship that is directly proportional to the increase in consumption of resources, characteristic of mature industrialised societies? And how can this process fit into and orientate transitions that are already in progress in mature industrialised societies, and those that are desirable for developing and newly industrialised countries?

In particular, what answers can the design world give to these questions?

Before looking at the answers that design research has given to these questions, we must take another step: we must place them in the context we are living in, a rapidly changing context of which we shall now recall some key factors.

3 A multicultural, interconnected, networked context

We must think of the transition towards a sustainable society in a profoundly modified framework, both in our conception of, and the reality of, the world around us: transformation in the nature of work, revolution in communication and information, emergence of genetics and biotechnology. In our modernity, individuals, ideas, images, products and money are in movement as never before possible and the fundamental characteristic of our modern subjectivity, where individuals and groups seek to include the global in their (modern) activities, is the effect that the interconnected elements of

² The setting up of the *Sustainable Consumption Unit* in UNEP (United Nation Environmental Programme) in May 2000 was significant, but already in 1993 the same organisation published *Achieving Sustainable Consumption Patterns: the Role of the Industry*, UNEP IE/IAC, Paris.

³ Sen proposes five types of freedom (correlated and linked to development policies): political (freedom of choice of government, freedom of the press, etc), economic (access to consumption and credit), social (access to education and health in function of access to economic activity), transparency (against corruption) and protection and security (from poverty and destitution, guaranteed by social security networks) (Sen A., 2000).

mass electronic communication and mass migration have, as Appadurai claims (Appadurai, 2001), on the workings of our collective, social imagination. It is an age in which the crisis of the nation state is evident, in which it cannot be taken for granted that effective public spheres are typically, exclusively or necessarily national; in which it seems hardly probable that nation states, in a complex interactive system, can in the long term govern relations between the global and the modern (Appadurai, 2001); a *liquid modernity*, to use Bauman's phrase, where everything is transitory, modifiable and experimentable (Bauman, 2005).

We live in a global context, (or rather *postglobal*, i.e. the crisis of globalisation (Deaglio, 2004)), that is becoming more and more **interconnected** and **multicultural**. It is by now evident that contemporary social reality is no longer thinkable in terms of worlds, nations or deep-rooted, independent, isolated communities. Although individuals continue to act in specific places, what has now become apparent to all is how the various geographical areas are linked together in different ways by a continual circulation of objects, people and information. This has changed and will continue to change relationship patterns, concepts and our perceptions of near/far, pertinent/aferent possible/impossible, belonging/extraneous.

We have entered a truly multicultural, interdependent world, which can be understood and changed only in a plural perspective that is able to converge cultural identity, global networking and multidimensional policy.

The new economy is organised, as Castelles says (Castelles, 2002), on global networks of capital, management and information, whose access to technological know-how lies at the root of productivity and competitiveness. Interactive computer systems operate in wide-ranging, open networks and the information technology paradigm has jumped from mere connection between computers to *co-operative computing*, which reaches beyond the position of the subjects involved in the interaction.

Out of *networking* as a fundamental form of competition in the new global economy (and from its accompanying new information technology) has emerged a new organisation model: the **networked enterprise** (Castelles, 2002). These are enterprises (and a growing number of organisations and institutions) that are organised in networks of variable geometry, the webs of which make the traditional distinction between large and small companies less important, and that provide services through their connectivity (their structural capacity to facilitate communication without interference between their component parts) and consistency (the degree of interest sharing between the goals of the network and those of its components). This is a new division of work based on the attributes and capabilities of each worker, rather than on the organisation of their working roles. Work is increasingly based on teamwork, *networking*, *outsourcing* and subcontracting.

Continuing along Castelles' line of thought (Castelles, 2002), our contemporary societies are increasingly built around a bipolar opposition between the network (globalisation) and the ego (identity). The networked society looks increasingly like a *meta-social* mess to the eyes of most people, where setting up a *meta-network* leads to the disconnection of non-essential functions, of subordinate social groups and of devalued geographical areas.

Interconnection and multiculturalism are key context factors that some people very explicitly interpret as aggravating circumstances (to defend oneself against), others as a necessary field of confrontation (the starting point), and others as an opportunity and driving force for sustainable innovation (to be exploited).

In this context what for some authors seems one of the most promising economic and infrastructural model seeking for sustainability is that of decentralised economies. Which could be described by two main characteristics. They are “local-based”, meaning they start from sustainable local resources and needs, but could be open non-local or global system. They are “network-structured”, meaning they get a critical mass and potentialities by the fact they are connected in network.

The IIIIEE in Lund define decentralised economies as a “selective share of production distributed to regions where activities are organized in the form of small scale, flexible units that are synergistically connected with each other”. Examples could be the distributed generation of energy, that, made with hydrogen or sun could lead together with environmental advantages a democratisation in the access of resources, therefore even socio-ethical advantages. Or could be a matter more information intensive if we speak about distributed comp. And connected to Open sources and peer-to-peer model.

And in this framework we may include even bottom up or gross root initiatives such us the so called creative communities. (e.g. Solidarity Purchasing Group) and cooperative network (e.g. Wikipedia).

This theme intertwines with other points of interest in research on so-called forms of alternative economy or alternative enterprises, founded on the concepts of co-operation, collectivity and collaboration (the so-called C factor (Razeto, 2004). In particular, it merges with research on “co-operative networks” and “creative communities” (Florida 2002; Manzini ; Manzini, Jegou, 2003), characterised by the self-organised activities of aware, critical, motivated citizens who are organized to a greater or lesser extent into networks and solidarity economy districts. In other words, it is linked to work on those forms of sustainable social innovation, i.e. solutions of high social quality and low environmental impact, that spring from active, bottom-up, social participation.

Because of their importance in a process of transition towards sustainability, we shall explore these phenomena in the following paragraph.

²⁸ The watchword of the United Nations Environmental Programme, and other institutions, became “cleaner production”: defined as “the continual redesigning of industrial processes and products to prevent pollution and the generation of waste, and risk for mankind and the environment”

4 The evolution of sustainability in design

What we have been describing so far is probably the most fertile territory on which design too, must be able to (and understand how to) work. However, it is useful to trace briefly some fundamental moments through which sustainability has been and has been interpreted by the design world, in order to gain a better understanding of the role of design research and practice in relation to sustainable consumption.

Historically, since the environment question was raised during the second half of the last century, the approach of mankind has moved from damage remedy policies (end-of-pipe approach) to actions increasingly aimed at prevention. In other words, we have moved from action and research focused exclusively on de-pollution systems, to research and innovation efforts that aim to reduce the cause of pollution at source²⁸ (or more generally, of the environmental impact).

In this framework we can identify some fundamental moments in the evolution of sustainability in design (Vezzoli, 2005; Pietroni, Vezzoli, 2004).

A first level on which theorists and academics have been working, is the choice of resources with low environmental impact: materials in one direction and energy sources in the other. Fundamental requirements have been and still are that resources should be: innocuous, recyclable, biodegradable and renewable.

In the second half of the nineties, attention partially moved to the product level. i.e. to the planning of products with low environmental impact. The environmental effects attributable to a product and how to assess them became clear; in particular the concept of life cycle was introduced, and the concept of *functional thinking* (Mont, 2002) (more technically: functional unit) was recontextualised (from an environmental point of view).

Over the last few years, starting with a more stringent interpretation of sustainability, that tells us we must work radical changes in production and consumption models, attention has partially moved to design for eco-efficient system innovation, therefore to a wider dimension than that of the single product.

Still more recently, design research has opened discussion on a possible role for design in the socio-ethical dimension of sustainability. In other words on various questions associated with the principle of equity in the availability and distribution of resources.

For a succinct understanding of the state-of-the arts in the discipline as a whole, we have charted these dimensions in a diagram that highlights, on one hand, the level of disciplinary consolidation (derived from the results of design research) and, on the other, their level and dissemination in planning practice (and in HEIs). With reference to the following diagram (fig 1), we find the new research frontiers in the bottom left hand corner (0% consolidation and dissemination); and in the top right hand corner (100% consolidation and dissemination) the point towards which we should steer the various dimensions of the discipline; i.e. towards a high degree of consolidation and widespread dissemination in planning practice.

In this chart, the choice of low impact material/energy and the LCD/eco-design of the product are positioned at a good level of consolidation (Vezzoli, Manzini, 2002; Vezzoli, 2004) and a discreet level of penetration in planning practice.

For eco-efficient system design, the level of consolidation is inferior and practice is, logically, far more sporadic.

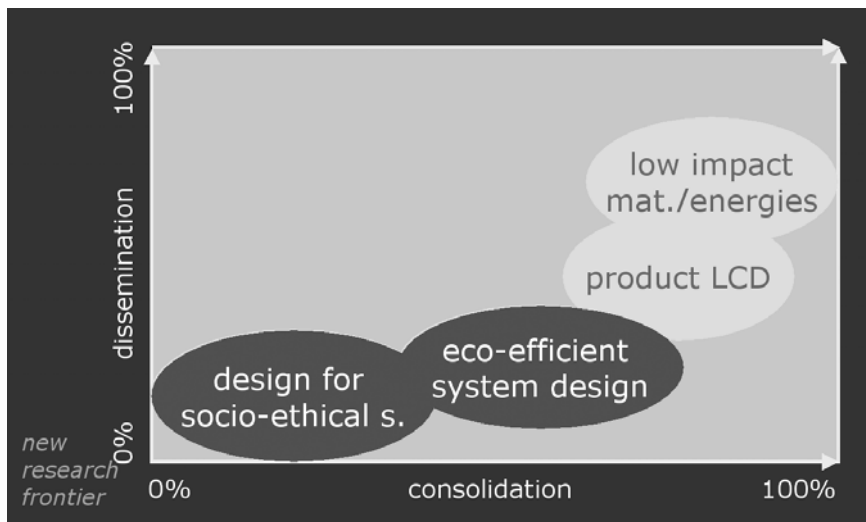


Fig. 1 Chart showing the consolidation and dissemination levels of design for sustainability

On the design for socio-ethical sustainability front, little has been elaborated at a technical level (it is, as we say, a new research frontier) and there are obviously very few teaching proposals.

If we then examine the theoretical contributions made by design culture in the field of consumption, not all of them are necessarily recent. Already at the end of the sixties, for various reasons, the theory and culture of design in Italy anticipated a critique of consumption patterns³¹, or at least some of the leading figures in the culture of design acted as spokesmen for issues relating to the responsibility of designers for consumption patterns, although in different ways and not directly and exclusively associated with environmental impact. We can recall the criticism of consumer society made in denouncements by some Italian exponents of *Radical Design* on the one hand, and the reaction of Tomas Maldonado on the other, who appealed to a new “design hope”. The question of designer responsibility was again brought up at the beginning of the seventies, though never resolved in its implications for design practice. Victor Papanek and Tomas Maldonado express similar positions, as far as regards the role of consumption. Papanek writes: (design can and must become a means for young people to take part in the transformation of society” (Papanek, 1973).

Over the last few years, starting with a more stringent interpretation of sustainability, contextualised in the development framework we have just outlined, attention has partly moved to **design for eco-efficient system innovation**; therefore to a wider dimension than that of single products. This all intertwines with the opening of discussion on a possible role for design in the **social and socio-ethical dimension of sustainability** (associated with the principle of equity in the availability and distribution of resources).

When addressing socio-ethical sustainability, the equity principle of sustainability is directly addressed, and not indirectly as a potential result of a radical resources reduction in industrialized contexts (as we see before with the approach to system design for eco-efficiency).

³¹ For a further study of the Italian situation see (Pietroni., Vezzoli, 2004).

In the following paragraphs we shall therefore focus our attention on system design as far as regards eco-efficient innovation and on social and/or socio-ethical design as far as regards sustainability because, as we have been saying, these are the most significant ambits in which to act to promote radical changes for sustainable consumption (also through design), seeking to identify the correlated design skills.

5 System design for eco-efficiency

Over the last few years some design research centres, starting with a more stringent interpretation of environmental sustainability (that requires a systemic discontinuity in production and consumption patterns) have reset part of the debate on design for sustainability starting from system innovation. Some authors have observed that the criterion for product lifestyle design meets obstacles in traditional supply models of product sales (Stahel, 2001; Cooper, 2000).

They therefore state the necessity to widen possibilities for innovation beyond the product, particularly to innovation of the **system** as an integrated mix of **products and services** that together give “**satisfaction**” to a particular demand for well-being. Systems where attention is paid to the eco-efficiency deriving from the possible partnerships/interaction between socio-economic stakeholders belonging to a particular value chain, or as Normann defines it a particular value *constellation* (Normann, Ramirez, 1995).

Taking the definition given by the United Nations Environment Programme (UNEP, 2002), a Product-Service System (PSS) is described as: “the result of an innovative strategy that shifts the centre of business from the design and sale of (physical) products alone, to the offer of product and service systems that are together able to satisfy a particular demand”. It is also claimed that a systems approach can “lead to a systemic minimisation of resources, as a consequence of innovative stakeholders interactions and related converging economic interests”.

To clarify this concept we can take the system of “satisfaction” in having clean clothes as an example. For this *satisfaction* I do not need only a washing machine, but also detergent, water and electricity (and the services that supply it), and maintenance, repair and divestment services. So when we talk about system innovation in this context, we mean an innovation that involves all the different socio-economic stakeholders in this *satisfaction system*: the washing machine and detergent producers, the water and electricity suppliers, and those responsible for maintenance and divestment³⁶.

We shall try to describe very briefly why a PSS is potentially eco-efficient. The fragmentation of stakeholders in the various phases of a product’s lifecycle (in the traditional economic framework of industrialised countries), means that the eco-efficiency of the *lifecycle* system does not coincide with the economic interests of the individual constituent stakeholders. For example (fig.2), the producer (of the washing machine, but also of the detergent and the electricity) has an interest in reducing material and energy consumption during the production phase. On the contrary, he has no direct economic interest either in limiting consumption during use, or in reducing divestment impact and valorising the resulting waste. Sometimes the producer is even

³⁶ In reality, this interpretation of system innovation forms part of the foundations and criteria already expressed in *Life Cycle Design*. However, here it emerges more clearly (as the basic assumption), that the starting point is the reconfiguration of the system that achieves certain results. The environmental value must in any case be assessed on the overall effects of the life cycles of the products and services that make up the system on offer.

interested in selling products with a short life span, with the only aim of accelerating replacement. So, we shall talk about eco-efficient system innovation as that deriving from a new convergence of interest between the different stakeholders: innovation not only at a product (or semi-finished) level, but above all at configuration level, i.e. when setting up new forms of partnership/interaction between different stakeholders in a *satisfaction system*.

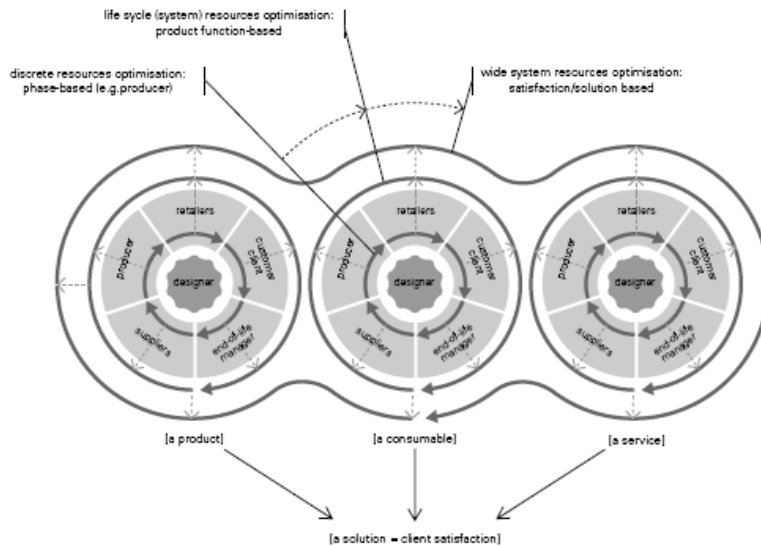


Fig. 2 Convergence scheme between the interests of stakeholders in a satisfaction system, working towards system sustainability

Let's take a real example to better clarify these concepts.

The 'solar heat service' is a service providing a result, consisting in 'selling' heat as a finished product. Hot water is produced by new equipment that combines sun, energy and methane, with economic and energy savings. Solar plants are designed in order to maximize the contribution of solar energy. Hot water is measured by means of a specific heat meter and the whole system is monitored, in order both to control in real time how the system works, and also to apply the Guarantee of Solar Results, a specific contract through which the installer makes a commitment to get a pre-determined level of efficiency. AMG has already tested this service in a Tennis Club in Palermo city (Italy), providing hot water for the dressingrooms. The innovative feature of this Product-Service system is that AMG will not invoice the client for the methane consumed to obtain hot water, but rather, hot water is sold as an entire service. AMG sells heat, and calculates the thermal kilowatts consumed by its clients; for instance, in 2001 one litre of hot water costs 0,2 euro cents. With AMG the consumer pays for receiving a comprehensive service, from the installation, to the thermal-energy meters, and to the transportation of methane to the boilers. With equipment maintenance provided as well, the customer is overall buying a 'final result'. This new product-service mix is sold as a complete service, which can significantly benefit the environment. The combination of methane and solar energy used to produce hot water supplies is 70% of what is needed. The company thus becomes motivated to innovate in order to minimize the energy consumed in use. Billing is by unit of service and not per unit of consumed resources. The less methane consumed (the higher the use of

solar energy and the system efficiency) the higher the income for AMG. AMG estimates this will lead to a decrease in emissions of 100 tons of carbon dioxide per year.

Other examples could be given to illustrate possible convergence between economic and environmental (eco-efficient) interests in a systems approach, but it is as well to observe that, naturally, not all Product-Service Systems are eco-efficient. For this reason, in terms of the development of new systems it is expedient to operate and adopt appropriate criteria and guidelines³⁷.

Coming back to design, the introduction of Product-Service Systems (PSS) into design for sustainability, requires new skills of a more strategic nature. We shall now attempt to clarify this statement.

Firstly, it means that we must learn to design products and services together.

Then (a more complex question and somewhat foreign to today's design culture) we must learn to promote and facilitate new configurations (partnership/interaction) between different "stakeholders", to find innovative solutions able to lead to a convergence of economic and environmental interests.

To visualise the mode of approach it may be useful to think of and draw a parallel with the design questions that more typically concern a "traditional" designer, who in designing a product defines the technical, performance and aesthetic characteristics of its components and its connections, in order to describe the configuration of the product components that are not characterised by materials (with specific performance functions) and by their connection systems. In this way a systems designer for sustainability must imagine and promote innovative types of "connections" – partnership/interaction – between appropriate components – socio-economic stakeholders – of a system responding to a particular social demand for satisfaction. In other words the components of a satisfaction system are characterised by socio-economic stakeholders (with their skills and abilities) and by the interaction occurring between them (partnerships, or more generally, interaction). Therefore designing the configuration of a system means understanding who are the best socio-economic stakeholders (components) and what are the best interrelationships (connections)¹².

In the perspective described of design that contemplates several socio-economic stakeholders active at the same time, designers must likewise equip themselves with the necessary skills to operate in a participatory design context (i.e. among different entrepreneurs, institutions, NGOs, associations and services) for system development that includes the offer (products and services).

We could say that these skills are part of so called *strategic design*.

Such considerations have started on a pathway towards a convergence of system design for environmental sustainability with the *strategic design* area. For this reason the expression **strategic design for sustainability** has come into use (Manzini,

³⁷ The criteria that achieve and determine (or otherwise) system eco-efficiency, have been drawn up inside a design tool called *Sustainability Design-Orienting (SDO-MEPSS)* toolkit (developed in a European research project entitled MEPSS, Method for PSS development, funded by EU, 5FP, Growth. Use/access free: www.mepss-sdo.polimi.it):

- optimised system life
- reduced transport/distribution
- reduced resources
- minimised/valorised emissions/waste
- increased renewability/biocompatibility
- innocuous/poisonous

¹² It could be found the terminology of Sustainable Innovation Networks (SINs).

Vezzoli, 2001). Therefore design for environmental sustainability must use and integrate the methods and tools of strategic design (and vice versa).

The required skills can be summarised as follows:

- the ability to design products and services together to fulfill a given demand, and to design an integrated system of products and services coherent with a “satisfaction-based” perspective
- the ability to promote/facilitate new stakeholder configurations (interactions/partnerships) aiming at system convergence of interests
- the ability to operate/facilitate a participatory design process among entrepreneurs, users, NGO, institutions, etc.

These are skills and abilities that are relatively new for a designer, but as we said are connected to the disciplinary area known as strategic design (Manzini, Collina, Evans, 2004) or Product-Service System design (van Halen, Vezzoli., Wimmer, 2005), areas already endowed with their own body of theory and their own methods and tools.

As far as design practice is concerned, the first design methods and tools have recently been developed, such as tools for the development of design orienting scenarios, for the strategic convergence of different stakeholders, for interaction designing and for the generation of ideas for highly sustainable systems. For example: qualitative brainstorming tools focused on the devising of partnership/interaction between eco-efficient valid stakeholders (Vezzoli, Tischner, 2005); or tools for the design and visualization of the material, information and economic flows and relations between socio-economic stakeholders in a particular system of offers (Jegou, 2005; Sangiorgi, 2005).

6 System innovation for socio-ethical sustainability

When addressing socio-ethical sustainability, the equity principle of sustainability is directly addressed, and not indirectly as a potential result of a radical resources reduction in industrialized contexts (as we see before with the approach to system design for eco-efficiency).

As we said, the design area has recently opened - or re-opened – the discussion on its role in the socio-ethical dimension of sustainability, or rather, on the possible role of design in the general questions associated with the various forms of social injustice.

This recognised reality takes into account (as in the assumptions of the concept of sustainable development) the so-called *principle of equity*, whereby every person, in a framework of fair distribution of resources, has a right to the same *environmental space*, i.e. to the same availability of global natural resources; or to put it better, to the same level of satisfaction that can be had from these in different ways.

What we can observe is that when the issue of sustainable consumption crosses that of socio-ethical sustainability, the spectrum of implications, of responsibilities, extends to several different issues such as (World summit on sustainable development, 2002): the principles and rules of democracy, human rights and freedom; the achievement of peace and security; the principles of world equity in the availability of resources (reduction of poverty and injustice); improvement in the circulation of information, of training and of employment; respect for cultural diversity, regional identity and natural biodiversity.

As discussed in a previous paragraph the socio-ethical and environmental dimensions are closely linked. The question is extremely complex, but can be summarised in the following questions: how can we foster new quality criteria to free

the social demand for well-being from a relationship that is directly proportional to the increase in consumption of resources, characteristic of mature industrial society? How can the reduction in consumption of resources per unit of satisfaction move side by side with their fair distribution on a local and global level?

If, as in this context, we talk about design, it is important to identify the answers that design culture and practice can give to these questions.

Today we can observe new, although sporadic, interest on the part of design research to move on this territory; to specify a possible design role in the socio-ethical dimension of sustainability; to trace its boundaries and understand the possible implications. This is an extremely vast and complex issue (and its implications for design have been little analysed and are difficult to face without falling into easy, hardly constructive moralism). Therefore to formulate a research hypothesis on a possible role for design, not only in terms of understanding the complexity, but also of a possible design world operativeness (specific capacity to work changes) some practical, though still provisional, definitions have been drawn up.

Some criteria on which a possible design role could be organised; criteria by which design could orientate, (and assess) the results of a design process (Tischner, 2005). The following criteria are the result of a recently concluded European research project⁴¹ that attempted to bring the complexity of the socio-ethical issue in line with a possible design activity⁴².

- **equity and justice/stakeholder relationship**
- **living conditions/quality of life**
- **health and safety**
- **employment and working conditions**
- **respect for cultural diversity**
- **socially responsible consumption.**

Associated with such criteria some researchers¹³ the following (operative and provisional) definition of “**emerging contexts**”: **socio-economic areas** (not necessarily countries) in which some or all of the (above defined) criteria by which to evaluate/orientate the socio-ethical character of satisfaction systems, presents more or less seriously critical aspects .

With this definition we can find emerging contexts in the metropolises and the rural areas of both developing and newly industrialized countries, and of mature industrialized countries. We also presuppose a very elastic use of the word “emerging”, in so far as it tends to include contexts with different levels of criticality in relation to different criteria (contexts may even be included that are critical only with regard to one criteria).

Obviously, the definitions and criteria given have many limits and are liable to all the successive re-definitions or subdivisions. However, at this early stage they resulted useful in setting up research.

⁴¹ MEPSS. Methodology for Product-Service System Development, EU 5FP, growth.

⁴² For a further study of the criteria and their use cf. Vezzoli, Tischner, *Sustainability Design-Orienting toolkit (SDO-MEPSS)*, use of design support software, free on www.mepss-sdo.polimi.it, 2005.

¹³ Being part of LENS (LEarning Network on Sustainability), informal network, that involves seven universities from the following countries: the Indian Institute of Technology; the School of Architecture and Urbanism, Universidade de São Paulo (Brazil); the Academy of Art and Design, Tsinghua University, (China); the School of Design, Hong Kong Polytechnic University, (China); the Dept. of Industrial Product Design, Istanbul Technical University, (Turkey); the Ewha Woman’s University from South Korea; Politecnico di Milano University.

At this point a good (and useful) question with which to start exploring the issue is the following:

Is system innovation (PSS) also applicable in emerging contexts?

In effect this question was put to a group of international researchers⁴³ some years ago, in a project funded by the United Nations Environment Programme (UNEP). The question was put, simply because what had been studied, said and acquired on the development of Product Service Systems, had been studied relative to the environmental and economic aspects, and for mature industrialised contexts. Not for the socio-ethical dimension and for what we have called *emerging contexts*.

This question is the forerunner of another: if the answer to the first is affirmative, can a system approach favour the socio-ethical qualification of these contexts as well as their eco-efficiency?

And if so, with what particular characteristics?

The response to these questions, from the above mentioned international group of experts sponsored by the UNEP, is the following hypothesis:

PSS (system innovation) may act as business opportunities to facilitate the process of social-economical development of emerging context - by jumping over or by-passing the stage characterised by individual consumption/ownership of mass produced goods - towards more advanced service-economy "satisfaction-based" and low resources intensive (UNEP, 2002).

To be clearer let's look at some examples (collected by the group engaged by UNEP).

Greenstar solar e-commerce and community center.

Based so far in India (Parvatapur), Jamaica and Ghana. It is a modular, scalable, highly portable "station" is delivered for villages in the developing world, as e-commerce centers. It is solar powered and connected to the web through a satellite or digital modem. Residents of remote rural communities can sell their wares worldwide and become shareholders in Greenstar.

Virtual station: virtual offices.

Based in Fortaleza, Brazil. It supplies a full range of services and infrastructure for a complete office. Clients only pay for the periods of use; spaces are equipped with computers, printers, scanners, access to internet, TV, copiers etc; reception, personalised phone answer, answering and remittance of fax reception/transmission. Infrastructure/equipment sharing leads to intensive use and access to the most efficient. Facilitate the set-up of small company.

GAS Lambrate, a solidarity purchasing groups.

It is a solidarity purchasing groups based in Milan. It is a group of 40 persons debating on consumption and organized to a collective purchase, with shared criteria:

- *cost reduction due to de-intermediation*
- *preference for local, season and biological produces*
- *preference for small local producer or social cooperatives*

⁴³ The work involved a group of researchers (including the author) from several countries in the more or less industrialised world; it was set up in 2000 and ended with the publication in 2002 of: UNEP, *Product-Service Systems and Sustainability. Opportunities for sustainable solutions*. United Nations Environment Programme, Division of Technology Industry and Economics, Production and Consumption Branch, Paris, 2002.

- *direct contact with suppliers + production site.*

More generally the following opportunities for environmental and socio-ethical sustainability, in development and system innovation in *emerging contexts*, have been highlighted (UNEP, 2002; Soumitri, Vezzoli, 2002; Penin, Vezzoli, 2005).

First of all, if PSS are eco-efficient at system level it means that they may represent opportunities, at least at a macro level, for a context with fewer economic possibilities to respond more easily to unsatisfied social demands.

Secondly, PSS offers are more focused on the context of use, because they do not only sell products, but they open relationships with the end user. For this reason, an increased offer in these contexts, should trigger a greater involvement of (more competent) local, rather than global, stakeholders; fostering and facilitating a reinforcement of the local economy.

Furthermore, since PSS are more labour/relationship intensive, they can also lead to an increase in local employment and a consequent dissemination of skills.

Finally, since the development of PSS is based on the building of system relationships and partnerships, they are coherent with the dissemination of network-structured and locally-based enterprises (towards bottom-up re-globalization).

This last consideration is very important because it takes us back to the intermediary consideration made earlier in this paper, where we discussed the convergent strategies between environmental and socio-ethical dimensions.

Starting with these observations reported, it has been proposed the system approach as an opportunity and coherent mode of linking environmental and socio-ethical dimensions. So, the revised hypothesis is as follows¹⁴:

A system Innovation (PSS approach) may act as a business opportunity to facilitate the process of social-economical development in an emerging context - by jumping over or by-passing the stage characterised by individual consumption/ownership of mass produced goods - towards a more "satisfaction-based" and low resource intensity advanced service-economy, characterized by the development of local-based and network-structured enterprises and initiatives, for a sustainable re-globalisation process aiming at a democratisation of access to resources, goods and services..

7 System design for sustainability

In brief, among the (few) researchers working on this issue there are two basic hypothesis:

- the first one is that system innovation approach fit to couple eco-efficiency with socio-ethical sustainability
- The second one is that local-based and network-structured enterprises and initiatives is a promising model.

Assuming these hypothesis and criteria for an exploration in the field of design research, we must first of all ask ourselves what skills and abilities a designer or design researcher should have and exercise to contribute to this type of innovation.

¹⁴ Hypothesis defined within the LENS (see previous note), on which the network is working on.

We shall now address this issue in relation to an ability which recalls/adjusts what we have already said for eco-efficient system design, in relation to a strategic-type ability to operate. By which a designer for (environmental and socio-ethical) sustainability should possess such skills and abilities as to be able to **promote and/or facilitate new sustainable “networked enterprises” starting from local (human and material) resources (that can be integrated into more extensive networks)** (Manzini, 2005; Penin, Vezzoli, 2005).

This ability can be described as the ability to:

- promote/facilitate new locally based “sustainable network enterprise”
- elaborate and/or co-elaborate orienting scenarios to build up partnership/ interaction between different stakeholders aiming at sustainable value production
- facilitate participatory design among different stakeholders to define their relationships and offer systems (products, services, communication).

These are skills and abilities that are relatively new for a designer, but as we said are connected to the disciplinary area known as *strategic design* (Manzini, Collina, Evans, 2004) or *Product-Service System design* (van Halen, Vezzoli, Wimmer, 2005).

They are skills, abilities and tools that will necessarily have to be reinterpreted and adapted to the specific conditions of *emerging contexts*. Adapting or reinterpreting means understanding what aspects of these design methods and tools will remain valid; it means understanding what specific characteristics will mark the partnerships and interactions most likely to emerge. Some example could be: social co-operatives that include emerging/marginalized people, who offer similar products; or eco-fair trading districts that create local synergies in multi-satisfaction based product and service offers, building on collective, co-operative and collaborative relationships.

The first signs of this of such a design research focus has emerged. Penin (Penin, 2006) has adapted few strategic design tools for emerging contexts. Those tools have been tested recently in an *incubator of social cooperatives*, based at the University of Sao Paulo (Brasil).

Finally, it is obvious nevertheless not all system innovation are socio-ethically sustainable. But so far very few are the tools and methods developed to orientate the strategic design process. among this it could be mentioned the section on socio-ethical sustainability of the *Sustainability Design-Orienting (SDO) Toolkit* (Tischner, Vezzoli, 2005)¹⁵.

In the detailed framework of different dimensions that design research and practice must face, we can foresee that system design for environmentally, socially and ethically sustainable innovation will represent (very complex, but at the same time also stimulating and ethically rewarding) grounds on which to find work hypotheses and disciplinary answers.

8 Design HEIs: incubators of sustainable locally-based and networked-structured enterprises

This is indeed a very complex path to follow, and, the Higher Education design Institutions (HEIs) could have a key role to play (Penin, Vezzoli, 2004; Vezzoli, 2005).

¹⁵ Edit by Vezzoli and being part of the already mentioned MEPSS, EU 5FP research.

⁵³ This concept has actually been experimented within the informal LENS network mentioned in a previous note.

The first step for this (as every) new research front is to build a scientific community of reference, to clarify and verify the research hypothesis with reference to other hypotheses or theories that dwell on similar themes.

All this can start taking place in HEIs, since these are by definition delegated with research and the training of new generations of designers.

On these grounds we propose a possible role for HEIs: not only as places for (advanced) education **and diffusers** of sustainable ideas, but even as **incubators** of sustainable (locally based and “networked”) enterprises”.

Universities should then look outwards, becoming disseminators of sustainable ideas and innovations. In other words we should rethink HEIs as places for the promotion of new ideas for sustainability.

One interesting possibility⁵³ is that of taking the campuses of these universities as “workshops” and “display windows” for sustainable ideas and innovations.

Briefly, the idea is to see the campus as a sort of prototype community. A community where different human activities occur and whose characteristics make it an excellent laboratory for radical socio-technical innovations. However, at the same time the visibility universities have with respect to enterprise, but also more generally for society at large, makes them good display windows⁵⁴.

8.1 Incubators for sustainable local-based network-structured enterprise

Finally, HEIs as facilitators in the creation of sustainable locally-based “networked enterprises”.

This could occur through the development of appropriate incubators whose aim should be to create enterprises that involve several local stakeholders, that promote long-term local development, with local, regenerative, low resource intensity solutions.

The target would in the first place be emerging/marginalized local stakeholders, who could then involve other (not only local) stakeholders such as institutions, NGOs, companies, etc.

As typically happens with incubators, the university would supply the place, the work facilities, and certain internal skills. Among these skills is also that of design (system design for sustainability), that we shall now hypothesise in some of its basic possible characteristics.

Since 1999 similar incubators actually already exist in Brazil. Within the university has been established a network of Popular Co-operative Technological Incubators (ITCP). These are part of the university corpus and have the aim of creating new jobs for groups of people with low incomes, in a perspective of local development and in a context of a solidarity economy, through the dissemination of technical and scientific know-how produced within the university.

For this reason the *DIS, Design and system Innovation for Sustainability (INDACO-Politecnico di Milano)*, recently started a collaboration with some of those ITCPs, in order to adapt, develop and test system design for sustainability tools/methods for ITCP¹⁷.

⁵⁴ For further examination see (Penin, Vezzoli, 2004).

¹⁷ Lara Penin in January 2006, made a workshop at ITCP-USP in Sao Paolo, and Carlo Vezzoli in August 2006 made a workshop at ITCP-UFPR with the COEMBRA cooperative, in Curitiba.

The hypothesis is a specific characterisation of these incubators by design skills. Coherently with what has been said earlier, these design skills and services are not (only) those that come traditionally to mind, i.e. those of product or communication design, but they are those of system (or strategic) design: in other words, the **promotion and facilitation of unprecedented partnerships/interactions between “stakeholders” (networked enterprises) in satisfaction systems seeking a convergence of their socio-ethical, environmental and economic interests.**

In this hypothesis, the offer modalities from such a design service could be of two types, at an initial stage.

The first elaborates *sustainable orienting scenarios* (Manzini, Jegou., 2003) for building of partnership/interaction in specific areas, and consequently identify possible stakeholders to involve. Herefore this would be a pro-active role on the part of those managing the incubator.

The second modality starts with the request and acceptance of one or more stakeholders to join the incubator. From their specific skills or areas, sustainable orientation scenarios can be co-generated for the constitution of partnership/interaction starting from the specific participant skills. This could be followed by the identification and involvement of other stakeholders.

For this approach, as mentioned previously, it would be possible to draw on skills, abilities and tools that have already been developed in the ambits of strategic or system design, operating the necessary adaptations for the particular conditions of specific *emerging contexts*.

Some first pilot projects have been developed where these complex, but crucial areas of design research for sustainability can be investigated. In conclusion, a field trial on such complex issues is not only to be hoped for, but is absolutely necessary before attempting to formulate credible operational hypotheses.

The results are very promising and the idea is to extend with a financed project this approach and study to all the network of incubators in Brasil.



Fig. 3 Images of the workshop at ITCP-UFPR, with the COEMBRA cooperative, in Curitiba, facilitated and promoted by Carlo Vezzoli in August 2006.

9 Conclusions

When talking about design for sustainability, we have seen how part of the pathway has already been trodden. However, for design research we anticipate fundamental years for the promotion and orientation of the system innovation, not only technical, but also social, cultural and ethical, that the transition towards sustainable development requires. In this context the design university has a key role to play in various dimensions and in various directions. And this is a responsibility, but at the same time a challenge and an opportunity to update the idea and the role of design in itself.

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