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Design for Sustainability (DfS): the interface of sustainable production and consumption

Joachim H. Spangenberg [a,*], Alastair Fuad-Luke [b], Karen Blincoe [b]

[a] Sustainable Europe Research Institute SERI Germany e.V., Vorsterstr. 97-99, D-51103 Cologne, Germany
[b] International Centre for Creativity, Innovation and Sustainability ICIS, Hornbækgård, Hornbækgårdsvej 2, DK-3100 Hornbæk, Denmark

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ABSTRACT

Nowadays design is faced with the challenge to contribute to the transition towards a sustainable society. Design for Sustainability (DfS) is the response to this challenge. It includes but goes beyond what Design for the Environment or ecodesign provides, by integrating social, economic, environmental and institutional aspects and by offering opportunities to get involved, express one's own identity beyond consuming standardised mass products.

DEEDS, a Leonardo research project, had the mission to embed sustainability in design and design in sustainability. For this behalf, the project partners approached the issue from the angles of design, sustainability science and sustainable consumption analysis, developing tools and rules (the SCALES principles) to support DfS and to incorporate it into design education and practice.

The paper describes the framework conditions as explored by sustainable consumption research, the obstacles identified by DEEDS and gives hints how to overcome them based in the lessons learnt in the course of the project.

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1. Introduction: how we got here

> "Everything was fine in the ancient past. Nature produced no embarrassing shapes and colours, humans were busy struggling for survival and had no time to decorate their fist wedges with scrolls. Everything was fine, because in the ancient past there were no designers." (Schmidt and Drommert, 2009, own translation)

1.1. Design through the ages

Or were they? Products humans manufacture usually have a function (if there is no obvious function, we call them art), and this function is intended to provide a certain service, solving a problem. If we call the process of shaping a solution and giving the necessary tools a form "design", then shaping a fist wedge was design *avant la lettre*.

Products as such have been with human development since its first day (for a long time, using tools has even been considered a key criterion distinguishing humans from animals). With industrialisation, however, a new mode of production took over. Design was no longer an individual, experience-based skill, products were no longer manufactured by handicraft workers in the neighbourhood and exchanged against farmers' goods. Instead, major facilities produced high volumes of more and more standardised products on their assembly belts, plus the pollution typical for the industrial age. Design, formerly a part of the production process, was now responsible for the blueprints of products – recognising responsibility for the social and environmental impacts of production was still a far way off.

Thus since the 19th century, mass production of objects transformed design from an art into a stakeholder co-shaping the future of industrial, and later service/knowledge, societies. Today, answering to the responsibility this implies must include efforts to overcome designs which through their application in mass production have generated negative social, environmental or institutional aspects ('mess production' by mass production). Tomorrow's sustainable consumption and production requires a massive redesign of consumer goods and industrial practices, of services and infrastructures. Unfortunately, so far sustainability plays a minor role in design education and practice, and design is not recognised as a relevant factor in the sustainability discourse. The DEEDS project[1] was designed to provide one step forward on both fronts.

* Corresponding author. Tel.: +49 221 2168 95; fax: +49 221 2168 94.
E-mail address: Joachim.Spangenberg@seri.de (J.H. Spangenberg).

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Design is a code of communication in product information, a function of growing importance with the transition from an industrial to an information society. It should not create false, untruthful, misguiding meanings, nor use unsustainable means or support unsustainable ends. On the contrary, it should provide people with tools to express their (chosen) identities in a sustainable fashion. Doing so requires the skills to recognise, frame, re-structure and solve problems by providing better alternatives. These are the kind of skills the DEEDS project has promoted (Blincoe et al., 2009). They build on a knowledge base in sustainability and sustainable consumption research and on proven design methodologies, but go beyond a focus on details.

The main claims resulting from the project are that

- it is necessary to expand the scope of design education and practice beyond style and fashion, economic issues (mainstream design) and environmental concerns (Ecodesign) to include social and institutional issues whenever possible,
- it is possible to do so in a comprehensive fashion, using a coherent, non-eclectic approach as described in the SCALES principles developed by DEEDS,
- it pays out to apply such an ambitious approach since it indicates a way towards future-proof design, thus offering support and not representing a threat to designers.

1.2. The challenge

Sustainable development does not provide an ideological blueprint for a future society: nobody knows what the future will look like, although we are all involved in creating it. However, sustainability encounters a set of guiding principles and key objectives, in particular the acceptance of limits, and the priority for overcoming poverty. If we accept these overriding priorities and the two normative assumptions of intra- and inter-generational distributional justice, i.e. the need for

(1) equivalent services from the environment for future generations (inter-generational justice), and
(2) equitable access to the world's resources as a kind of human right to resource use (resources as a common heritage of humankind, intra-generational justice),

we have to broaden the set of design criteria. On the environmental side, we must not only avoid toxics (a standard condition) and enhance eco-efficiency (a usual intention in ecodesign), but need to limit and indeed to reduce, given the damages already visible, the entropy generation stemming from the resource throughput of our economies (Fig. 1).

As a first, directionally safe target for criterion (1), a 50% reduction of global resource consumption has been proposed (Schmidt-Bleek, 1994). Implementing the second criterion results in a dramatic redistribution of resource use, resulting in a reduction need of more than 9/10 (a factor ten) for both energy and material in industrialised countries by the end of the century (Stern, 2006; IPCC Intergovernmental Panel on Climate Change, 2007). For the South, however, this means in average a doubling of resource availability compared to current levels, and still being within the permissible consumption limits. This is what "dematerialisation strategies" in Fig. 1 refers to, demonstrating how they complement chemicals and efficiency strategies. Each of the strategies will require a specific design approach.

Even more complex is the social challenge of sustainability (2): overcoming poverty implies enhancing the access to those goods and services needed to lead a dignified life in the respective society.

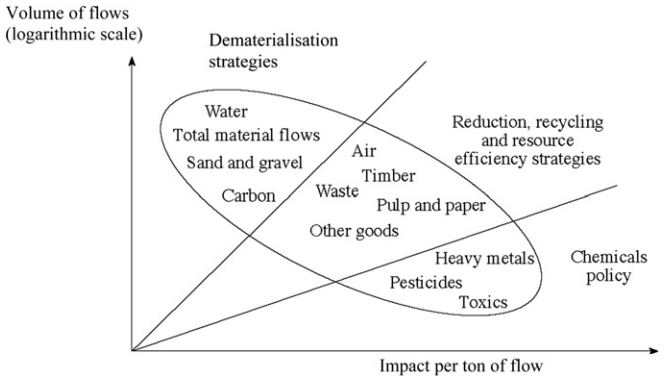

Fig. 1. Environmental impacts of resource consumption and mitigation strategies. Hazards are dealt with by chemicals policy, traditional non-toxic pollution issues by environmental policy including reduction of pollution at the source, closed loops to prevent emissions and to enhance resource efficiency, and recycling in the case of open loops. They are complemented by dematerialisation strategies for those material flows where not the chemical characteristics of the respective substances, but the sheer volume of the material flow causes the problems. Source: Palm (2002), there adapted from Fischer-Kowalski and Hüttler (1999).

This is a challenge for design, a problem to be solved. Affordable products, accessible services, public infrastructures and caring for the common goods may be part of the answers to be found; they will vary with the social context.

2. Design for Sustainability: embedding design in sustainability

Delimitation

In the sustainability and sustainable consumption discourses, design was traditionally and still is either ignored as a relevant factor (Miljövern Departementet, Norwegian Ministry of the Environment, 1995; SCORE, 2009) or even considered to be part of the problem rather than a possible contribution to the solution (Packard, 1958; EEA, 2005). Progress has been made on other fronts: design is increasingly recognised as a relevant factor in business competition, and ecodesign acknowledged to be a crucial element in the race for green technology/green growth leadership. Today Japan is trying to recapture lost ground in energy efficiency, the US government – after the crisis – has made green technology leadership an investment priority, and China is determined to achieve global leadership in green technologies: this is one focus of the next five years plan (Stigsson, 2009). In Europe, besides a variety of national initiatives, the EU Commission has established technology platforms, published the 2020 strategy focussing on information and resource efficiency technologies, and issued a Communication highlighting the contribution of ecodesign.

Such developments are not to be underestimated, but they fall short of addressing the broader sustainable development agenda (see Section 3). Thus we distinguish Design for Sustainability DfS from ecodesign, chosing amongst the wide range of definitions of ecodesign the one prevailing in the political arena. Thus we understand ecodesign as an approach dealing mainly with environmental and economic effects (and thus with eco-efficiency), based on a life cycle analysis of cost and impacts (life cycle analysis LCA, life cycle costing). As opposed to that, DfS is understood to address all dimensions of sustainability, looking at bigger systems and asking more fundamental questions about consumption and production.

$$\text{Consumption efficiency} = \frac{\text{Consumer satisfaction}}{\text{Resources activated}} =$$

$$\frac{\text{Consumer satisfaction}}{\text{Services consumed}} \times \frac{\text{Services consumed}}{\text{Services generated}} \times \frac{\text{Services generated}}{\text{Products produced}} \times \frac{\text{Products produced}}{\text{Physical input}} \times \frac{\text{Physical input}}{\text{Resources activated}}$$

$$\underbrace{\text{Satisfier efficiency}}_{\text{DfS}} \times \underbrace{\text{supply/use efficiency}}_{\text{Consumption patterns}} \times \underbrace{\text{product efficiency}}_{\text{Product-Service Systems PSS}} \times \underbrace{\text{production efficiency}}_{\text{Eco-efficiency}} \times \underbrace{\text{provision efficiency}}_{\text{Ecological Backpack}}$$

Fig. 2. Consumption efficiency disaggregated. Physical input is measured as material flows, products are tools made (designed, engineered and produced) to fulfil a function, the fulfilment of that function is the service (humans provide services mostly by using products as service-delivery-machines), and satisfaction is a subjective term, the "psychic income" (Fisher, 1906). Source: J.H. Spangenberg, author's design.

Products

In between production and consumption are the products (including services) and the ways they are used. The volume of annual purchases constitutes the main component of the GDP, and household consumption is often misinterpreted a measure of welfare (Stieglitz et al., 2009). However, much of this expenditures is not voluntary: Tischner (2001) estimates (for household appliances) that although 90% of the life cycle wide energy consumption takes place in the use phase, this consumption is up to 90% determined in the design phase. Here the decision lays in the hands of business managers and their 'useful dwarfs', designers and engineers with profits, not the satisfaction of human needs, the main driver.

Unlike the impression given in much of the consumption debate, not only short-lived goods are a reason for environmental and economic concern: the accumulation of durables is problematic as well. The mere maintenance of long-lived goods and infrastructures requires an increasing volume of monetary and resource expenditures, without providing additional welfare. They need to be cleaned, upgraded, repaired or renovated to continue providing the same service, while acting as a restriction to behavioural options other than those foreseen at the time of their construction. Being aware of the need to once buy but then maintain durables in order to continuously yield the services they provide, already in 1906 Fisher suggested not to count the purchases as the basis for welfare estimates, but the volume of services yielded from the products, while purchases would be written off over their life time (Fisher, 1906)[2] Stockpiling new products on top of old ones does not enhance the efficiency – thus as much as innovation we need ex-novation, ways to get rid of outdated, unsustainable artefacts and habits.

2.1. The eco-efficiency of production: an established field

The domain of production is the better understood one in terms of the innovations needed for a transition towards sustainability. For the environmental dimension, it is well known that all along the product chain improvements are possible (and from a sustainability point of view, necessary). The social and institutional dimensions are usually represented by health and safety (H&S) and workers rights (job security, co-decision, etc.) while profitability is the core of the economic dimension. It is the profit motive, and not the desire to satisfy human needs which drives the production system.

Provision and production efficiency (see Fig. 2) are at the heart of the environmental dimension of sustainable production. In the most narrow sense, eco-efficiency refers to *production efficiency*. It can be significantly increased by process, product and organisational innovations (the latter are often underestimated but crucial) in the secondary sector. This is where increased processing efficiency, in-house reuse and recycling, upstream product chain management, life cycle analysis and costing are well established ways not only to reduce resource consumption, but also to reduce expenditures and enhance competitiveness, a typical win–win situation.

In a broader sense, the *provision* efficiency, reducing the amount of activated but unused material, the "ecological backpack", is part of eco-efficiency. As it can be improved, for instance, by more efficient technologies, or by finding use options for by-products so far considered waste, it is mainly in the hand of the resource extraction industry (primary sector plus mining).

The *product* efficiency increases with engineering and design improvements (ecodesign), and with product service systems PSS providing not the products as such but the services they generate. This kind of rethinking products offers significant improvements and thus provides new business opportunities.

2.2. The eco-efficiency of consumption

Max-Neef et al. (1989) distinguish human needs like subsistence, protection, affection, creation, identity and freedom from the means by which humans satisfy them, the satisfiers. Whereas human needs can be considered an anthropological constant, satisfier choice varies with factors like culture, wealth and the products on offer. Rather obviously, many needs are best satisfied by non-commercial services, such as care in a family or amongst friends, and not by products. However, for the reminder of this paper we focus on commercial products and services as they are objects of professional design. *Sustainable consumption is about choosing true satisfiers, not about neglecting needs.*

Less frequently discussed than the efficiency of production is *supply/use efficiency,* closely related to the standard of living. Even if a product is efficient in offering its services day and night, the *use* efficiency can be extremely low if most of the time the product is not used (for instance, in Germany a car is used in average 29 min per day; the accumulated use time of a 12 years product life is less than 3 months (BUND/Misereor, 1996)). Seen this way, it is easy to detect possibilities for improvement, socio-cultural rather than technical, like improving the use intensity e.g. by sharing instead of owning the "autostabile" ("mobile" it isn't most of the time).

The disaggregation in Fig. 2 is also helpful to understand the difference between wealth, standard of living/affluence, and well-being/quality of life (Fig. 3). Since medieval ages, the term wealth is used to describe a stock of assets sufficient to live a decent life on them; not only the volume, but the ownership is decisive. As

[2] Long before the concept of GDP was developed during WW II as a means of describing the combatants' potentials of generating economic output, he offered a kind of accounting that much resembles the current discussion on sustainable consumption. It shares the strengths of the current debate (count as positive what is increasing well-being) and its problem: the difficulty of quantifying the results. Nonetheless his concept of "psychic income" could serve as the theoretical backbone of a more elaborated theory of sustainable consumption.

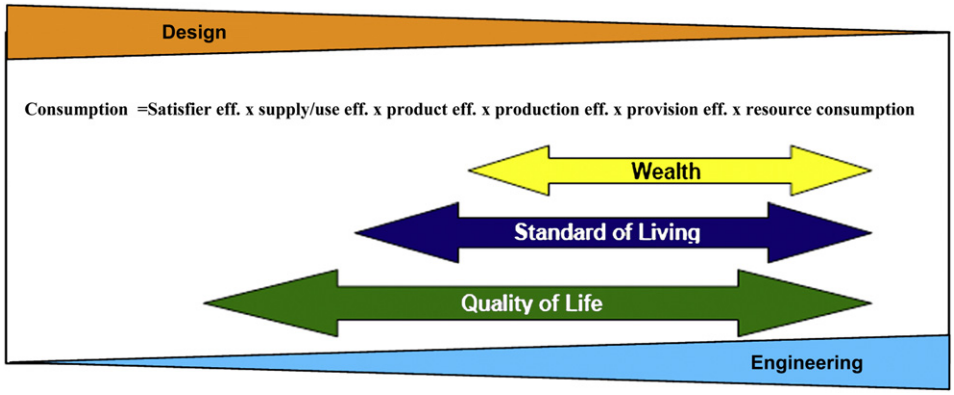

Fig. 3. Efficiencies, their contribution to Quality of Life, and the contribution of design. The influence of design is stronger closer to the consumer side, as it shapes not only the product but also the consumption behaviour. Engineering is crucial for the development, functionality and efficiency of products, including the provision efficiency. Product ownership has often been described as material wealth, whereas the standard of living refers to the services enjoyed and can include non-market services. Its environmental impact is determined by the production and product efficiency, a focus of ecodesign. Design for Sustainability particularly addresses satisfier and the use efficiency, adding the qualitative component and with it social and institutional criteria. Source: J.H. Spangenberg, author's design, based on Naturwissenschaftler Inneninitiative Verantwortung für Frieden und Zukunftsfähigkeit e.V., DEEDS (Design, Education and Sustainability) Project (2008).

opposed to that, the standard of living is a more recent term, a notion pointing at flows of services (income, rent, interest) derived from a stocks of wealth. What counts is the access to the flows, the right to use them at one's own discretion, not the ownership as such. A focus on the standard of living requires a consumer identity based on access to and command over services – the insistence on ownership is then somewhat anachronistic. Today such a shift from ownership to access is visible, but it is far from sure that it will indeed transform consumption behaviour: such trends flourish with confidence and optimism towards the future, and tend to be undermined by social insecurity and precarisation leading to a re-traditionalisation of behavioural routines in times of crises (Kraemer, 2002).

Finally, a point rarely discussed in efficiency terms, is *satisfier* efficiency: not products or services as such, but satisfaction is the key to quality of life (this concept of subjective life satisfaction is the most recent one, dating back to the second half of the 20th century). The level of life satisfaction (equivalent to the quality of life, the psychic income or happiness, see (Veenhoven, 1983) as an early example) is dependent on a number of object functions, including functionality, usability, synesthesic sense functions, and the symbolic functions of a product or service (including non-market goods and services, such as mutuality-based or altruistic social relations, and the public goods provided by the environment). Satisfaction in general is growing with access to goods and services which are in line with consumers' needs and support their individual and social identity – such products are satisfiers. Symbolic functions often play a major role in the formation, expression and communication of the given, chosen or aspired identities. Status products, distinction and identity functions are important drivers of current consumption. So the reputation of a certain good with the relevant peer groups plays a decisive role.

2.2.1. The role of Design for Sustainability

Design for Sustainability, addressing all dimensions of sustainability and asking more fundamental questions, plays its most important role in combining the effects of satisfier efficiency with the supply and product 'efficiencies'. For engineering, the focus is rather opposite and thus both disciplines seem to be complementary – a fact most often overlooked by the stakeholders involved, as due to different mentalities their mutual dependency is often not recognised (NaturwissenschaftlerInneninitiative Verantwortung für Frieden und Zukunftsfähigkeit e.V. and DEEDS (Design, Education and Sustainability) Project, 2008).

It is a characteristic (and an irony) of our consumer society that the command over certain products and services from mass production has become the mean to express individualistic identities. Here design and marketing are the key agents, and all too often it is pseudo-satisfiers (or even inhibitors) which are advertised. Design for Sustainability DfS must offer an alternative, providing sustainable satisfiers and improving satisfaction effectiveness.

2.3. Sustainable consumption: consumers' choice?

Unfortunately, so far, sustainability policies are based on preciously little insight what it takes to change consumer behaviour towards sustainable consumption of (real) material and (mediated) symbolic resources (Jackson, 2006). Life styles are shaped by context and habit, and changes require at least three conditions to be given:

(1) the personal motivation and information,
(2) the ability to change given the restrictions of the social context (acceptance, image, peer group identity etc.) and
(3) the opportunity, i.e. the availability of alternatives at competitive prices., i.e. personal, social and economic desirability.

Only with social desirability and opportunity, changes of demand can be expected, making *satisfier* efficiency with its reference to social context a crucial but undervalued element of the overall eco-efficiency. Different social agents dominate each of the conditions, although their spheres of influence and thus responsibility overlap (Spangenberg and Lorek, 2002). Design plays a significant role in regulating both material and symbolic resources through 'form-giving', raising awareness, changing perceptions of value and integrating these elements (Wood, 2003) (Table 1).

Unlike in economic theory, in reality there is no absolute "consumer sovereignty" – preferences are formed in a complex interaction process involving social, psychological, cognitive and economic factors. Consumer research has generated many insights concerning the intrinsic motivations and driving forces for household consumption (see for example SCORE, 2009; Jackson, 2006; Reisch and Røpke, 2004 and for a psychoanalytical analysis Kumar and Kumar, 2008), but much less is known regarding the institutional setting necessary for or at least supportive to sustainable consumption of state and households.

Table 1
Preconditions for sustainable household consumption.

Decisive factor	Agent	Design implications
Motivation and information	Consumers, suppliers	Reliable and understandable signals, no fake
Social acceptance and desirability	Peer groups, society	Projection screen function maintained (adaptable to diverse identities)
Availability of sustainable alternatives	Business, state	Added value: for consumers, providing freedom for choice without regret. The business case: dematerialisation saves costs, DfS addresses multiple customers

Source: own compilation.

The symbolic value of consumer goods is frequently more important for the willingness to consume (Røpke, 1999) than their initial function as 'service-delivery-machines'. It provides an important contribution to the subjective quality of life, but also fuels competitive consumption ('keeping up with the Joneses') and private debt (see Fig. 4: life enjoyment by a group from a low income neighborhood, facilitated by clothing of entirely symbolic value). The individuals and institutions that control the mediation of symbolic resources potentially hold significant sway over individual consumers and organisations, and their spending patterns.

Across Europe condition (1) is regularly covered by information campaigns, but condition (3) is mostly addressed by labelling to make existing products more easily recognisable (reducing transaction cost), but not by pressuring business to provide more affordable sustainable products (even opportunities to do so via public procurement are rarely exploited). The biggest deficit, however, lies in the limited attention paid to criterion (2), the social acceptance and desirability.

2.3.1. Social acceptance and desirability

While extrinsic factors (purchasing power, professional status, resource endowment) and social relations (respect, admiration leading to imitation, peer pressure, fashion, family bargaining) determine the availability of consumption *options*, it is intrinsic factors that shape the *choice* between the alternatives available. Intrinsic factors comprise cognitive capacities, psychological factors, spontaneous emotions, individual interests, time use preferences and philosophical, moral or ethical norms. As both overlap (for example, individual preferences are shaped by social norms and relations and vice versa) no quantitative determination of the relative importance of each one for the resulting behaviour is possible; they co-evolve. Indeed, Vihma (2002) proposed a new semantic sign, the aesthetic sign function, to indicate the umbilical connection between emotive cognition and cognitive emotion. For instance, the need for food is a constant, but with societal change, eating habits, time patterns etc. have changed rapidly, a development made possible by increasing income and available technology. As a result, access to a refrigerator was no option in 1900, no immediate need in the 1950s (buying fresh products from the markets was a widespread habit), but 2000 it was.

One key factor determining consumption decisions is the individual assessment if existing alternatives are supporting the desire to maintain or improve self-esteem, social status and acceptability (Cogoy, 1999)[3] Exposing a certain good (privately or collectively owned, or borrowed) can symbolise the membership of a certain group (or the aspiration to be a member), support for a certain idea, and so on: products do not create identity, but they are indispensable

Fig. 4. Group membership expressed, identity created by specific goods: a carnival association exhibiting identity creating design, Cologne 2008. Source: Photo by J.H. Spangenberg.

tools to express it (goods as a 'projection screen' for otherwise defined identities). Figure 4 demonstrates an occasional collective identity, with impacts for and roots in everyday life, expressed by shape and colour standards of otherwise rather useless clothing, bought or borrowed. The obvious uselessness highlights the symbolic function of the costumes as means for identity creation and expression. Identical costumes – like uniforms – also create an illusion of equity. In the mean time, the multiple messages products can carry (about the product, user and company) are pretty well understood (Vihma, 2002; Gotzsch, 2006).

A specific form of distinction is the ownership and exhibition of positional or oligarchic, mostly paid goods. The less people can afford a certain artefact at a given time, the smaller the group of potential owners, the higher its positional value, and the higher the incentive for all others to strive for future ownership as well. Then the good will be no longer positional, rendering the intended positional gain unattainable, which is subsequently promised by another good. Although positional goods need not be monetary, tradable or material – status is a clear positional good, time can be one – Mainwaring (2001) suspects that as a rule of thumb more positional goods will be more environmentally damaging than less positional goods, as status is most frequently advertised by exhibiting material goods.[4] Indeed, house, car and dining are status symbols, and for centuries extremely resource intensive satisfaction of these demands has been the privilege first of aristocrats, then of the rich: power was always demonstrated by squandering scarce resources. It is a major challenge to DfS to design low-impact positional goods, i.e. to make consumption efficiency a positional value.

As societies and economies change, altering the patterns of scarcity and the relation of capital, labour and the environment, a failure of consumers to adapt to changing circumstances can lead to a lock-in, to sclerotic, outdated but quasi-sacred consumption patterns.[5] Such sclerotic consumption patterns inhibit the adaptation of consumption to ever-changing extrinsic conditions and thus the evolution of societies. DfS can smoothen the way out of this trap by offering solutions which appeal to traditional habits but satisfy demands in an innovative, more sustainable fashion.

[3] Similar criteria apply to goods not traded on markets, but exchanged with or without equivalent compensation, like all services from unpaid work (caring and supply, housekeeping and education, voluntary and community activities, and so on).

[4] This does not rule out the possibility that cheap mass produced products, due to inefficiencies and low quality resulting in a shorter life span, can be even more expensive and damaging in the long run.

[5] One example is the 'American way of life' which was maintained even after neoliberal politics and the burst of the dot.com bubble undermined its economic basis. Financing it with loans, mortgages and credit cards contributed to the high level of private debt, and was one key factor for the melt down of the financial system in the USA.

3. Design for Sustainability: embedding sustainability in design

With its over-lapping design foci on all four dimensions of sustainability (Fig. 6), DfS could and should play an important role in the transition towards sustainable production and consumption as key components of the quality of life. As a practice and a problem solving process in which designers include considerations and impact assessment of the four dimensions, from the process of resource mining to the final product and its consumption (in particular regarding product, use and in particular satisfaction efficiency), it asks fundamental questions about consumption and production (Spangenberg, 2009; Design Council, 2007). This encompasses the use of the most appropriate technology, materials and production processes to achieve zero-carbon emissions and minimal non-renewable resource use whilst paying due attention to the impacts on human well-being (mental, physical and emotional). In other words, DfS aims to provide real satisfiers, to achieve the human satisfaction the consumptions process is motivated by while minimising the negative and maximising the positive impacts on nature, humans and society. For instance, questions of product usefulness, i.e. their value as satisfiers and their supply and use efficiency, are typical DfS challenges (although they have in the past also been mentioned as elements of ecodesign).

Unfortunately so far, DfS has made few inroads into the design profession, but is mostly still lingering on its outer boundaries. Despite the broad discourse amongst the public, experts and decision, the design profession at large remains disengaged, if not ignorant.

3.1. Obstacles: preoccupations and institutional difficulties

Why is this the case? The reasons are manifold. First of all, DfS broadens the horizon and is perceived as a challenge to established practice (including hierarchies and reputations), and rightly so. DfS requires rethinking established practice, and the inclusion of additional criteria into the design process. It creates an additional level of complexity and makes solutions less clear-cut and more "blurred". The additional challenge of DfS as compared to ecodesign is illustrated in Fig. 5. It demonstrates that DfS also includes taking risks (which are inevitable linked to leapfrogging solutions, as compared to incremental improvements).

However, defensive motivations (defending habits and status) are not the only ones. According to empirical work analysed in the course of the DEEDS project, others exist, and they are manifold:

- DfS is tangential to rather than embedded in mainstream design education and practice. DfS is still only taught in few design institutions in the EU.
- Design educational culture tends in most cases to encourage the expression of the ego and the aesthetic as well as functionality through formal design under the primacy of economic restrictions, whereas for sustainability more emphasis should be placed on societal and global needs.
- Design tutors tend to have a defensive attitude towards sustainability, especially in areas where they do not have the capability, due to overcrowded curricula, limited staff awareness/expertise or even perceived irrelevance by academic staff, and limited institutional drive and commitment.
- Some professional bodies, for example ARB/RIBA, UK and The Association of Danish Designers in Denmark, acknowledge sustainability in their validation criteria but it is compartmentalised and relegated to technology subjects, rather than integrated into professional practice and/or a cultural context. The Danish Designers' Association does, however, include responsibility for environmental and social issues in their membership criteria, and BEDA the Bureau of European Design Associations participated in the DEEDS project.

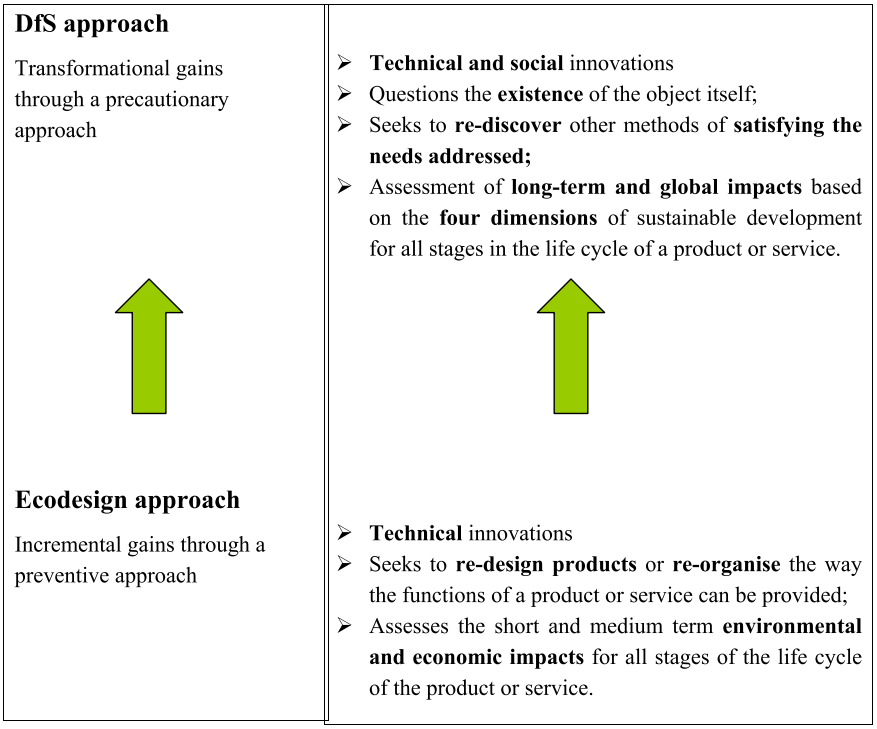

Fig. 5. The challenge – from ecodesign to Design for Sustainability: Some definitions of ecodesign, derived to distinguish it from mainstream design, go beyond incremental gains. However, these definitions were made in the absence of DfS as an additional category. Distinguishing it from ecodesign we draw the dividing line in this paper as suggested e.g. by Cucuzzella and De Coninck (2008).

A first analysis of the motivations behind the perceived obstacles has revealed three basic suspicions which must be addressed in order to mainstream sustainability in the design professions:

1. Sustainability will not be accepted by designer's clients (economic partners) as it does not pay in the market (yet).
2. Sustainability is value-laden and thus perfectly fine for a specific niche, but not acceptable for the public at large, and hence for designers in general.
3. Sustainability is restrictive, a barrier to creativity.

3.2. Opportunities

Fortunately, on closer scrutiny, all three arguments can be proven wrong: With broad public debates on climate issues all over European consumer societies, the demand for personal response options, in particular in consumption, is increasing significantly, opening the mass market to "green" and/or low-carbon products. A multi-dimensional life cycle analysis covering also social and institutional aspects as it should be usual in the framework of DfS whenever suitable can help providing reliable decision support at a largely reduced effort for performing the assessment.

Furthermore, as sustainability is broader than environmentalism, product DfS also responds to issues of justice and equity as illustrated in Table 2, which are also prominent in any opinion poll (thus policies promoting sustainable consumption seem to find more support amongst consumers than amongst decision makers, resulting in limited but significant voluntary actions such as the fair trade movement). DfS could help mainstreaming such approaches.

Sustainability is indeed normative, not ideological but (re-) presenting some rather general ethical values (like the responsibility for distant neighbours and future generations) on which most citizens might, but do not have to, agree. However, although re-introducing values into science and design education contradicts the self-perception and habits of scientific/academic thinking, it brings design closer to its end users: moral and ethics are an indispensable element of any social fabric.

Finally, experience gained by ICIS, the DEEDS project leader, demonstrates that substituting traditional design briefs for sustainability-oriented instructions broadened the horizon of students and led to an outburst of creativity and originality. DfS requires "thinking out of the box", overcoming traditional habits, and this is a significant creativity stimulus.

Even more challenging, this creativity stimulating function of DfS is not restricted to designers, but involves consumers as well (Fig. 5). Products are to be 'fertile', having development and adaptation potentials, involve consumers in designing the final shape and function. They emphasise 'buy-in' over 'buy it', psychological ownership feelings (identification) over legal and economic ownership. While being effective satisfiers, they provide choices for and less determination of consumer behaviour (consumer empowerment). They offer new opportunities to express identities – and their change over time and (social) context.

Table 2
Design for Sustainability: from functional to experiential.

Objects: form & function	Beyond the object: experience, emotion, relationship, awareness
Product ownership	Sharing, pooling, leasing, renting Pay-per-use/-result/-time/-experience
Products	Product Service Systems PSS, services, experiences Dematerialised services
Buying products	Making them
Short product lives	Extended product lives
Sterile products	Fertile products
Materialised products	Intangible goods

Source: Fuad-Luke (2008b), modified.

4. DEEDS

Against this conceptual background, the DEEDS project was initiated in order to

- meet the increasing demand by consumers, producers and governments for new design thinking and practice by training educationalists and professionals in DfS,
- introduce new thinking in the process of designing to further design innovation, and
- develop new thinking in the field of Low Carbon Design.

Thus DEEDS has been conducted with the key objective to seize the chance to demonstrate the superiority of DfS in future-proofing designers, education and industry (Blincoe et al., 2009). It did so by demonstrating the potential and usefulness of integrating sustainability into mainstream design practice and design education, and thereby *providing the missing link between sustainable production and consumption*. This was achieved by means of case studies (education experiments) in Brighton and Poznan. As a result, theoretically well-founded and empirically tested modules have been developed, offering educational material to design education institutions and the design profession in the EU countries. The educational modules developed will be offered to mainstream design education institutions to equip the next generation of designers with the necessary tools and skills in designing more sustainably. In this case, target group are design teachers and design students.

A second target group are practicing designers. Based on questionnaire analysis, DEEDS identified their information needs (for more details on the results see Blincoe et al., 2009) and provides knowledge, tools and skills for DfS via the project website.

To reach its objectives, DEEDS has defined elements of education and training which contribute to overcome the obstacles found in the literature survey and illustrated by interviews undertaken as part of the project. The result is a list of principles called SCALES which should form the basis of sustainable design and education (Table 3). They are grouped, three each, constituting a structure of themes which we consider to be generic, i.e. which would apply in diverse cultural and economic contexts. The principles, however, are more specific (although not extremely concrete and operational) and might thus be fitting more or less in different contexts; they are open to adjustment according to the prevailing circumstances. The current formulation (future improvements, in particular by users, are expected and welcome) offers a 'representative diversity' (O'Connor and Spangenberg, 2008), a stand-in for the options to be selected.

Nearly a third of the principles refer to skills (three sub-themes with three principles each) – may be not too surprising for a project dealing with education. Some of the principles are well known to any designer as they are part of their professional qualification, but others are rather new. A literature survey on ecodesign and DfS principles published so far revealed that earlier suggestions are most comprehensively covered by SCALES, while it offers an inspiring but challenging range of new approaches, derived from our multi-dimensional approach to sustainable development.

5. Outlook

The working mode of "normal science" is exploring ever more details on all levels, from the cosmic to the sub-atomic level (Kuhn,

Table 3
SCALES core principles (from Blincoe et al., 2009).

Special skills – holistic approach
S 1 **Develop new skills** for recognising, framing (looking for systemic connections) and solving problems
S 2 **Define problems holistically** by systems & Life Cycle Thinking (LCT), combined with appropriate technical and social innovation
S 3 **Analyse problems from multiple perspectives**, including the four sustainability dimensions – economic, human/social, societal/institutional and environmental – including the full richness of the human dimensions (mental, physical, emotional and spiritual)

Special skills – eco-efficient production & resource usage
S 4 **Develop LCT, LCA and 'cradle to cradle' skills**, be familiar with technology know-how and appropriate application of lightweighting (materials reduction), renewables/new materials, extended product lives, reusability and recyclability (designing 'quality waste'), waste avoidance, energy issues, and dematerialisation (moving from products to dematerialised services)
S 5 **Integrate efficient service provision** in design solutions, by designing product – service – systems PSS, products suitable for sharing and pooling, pay-per-use or -per-experience
S 6 **Maximise consumer satisfaction** per service enjoyed by addressing human needs; consider different material and immaterial options to do so and choose the most sustainable one; design fertile products offering users experience, emotion, relation, pride, self-esteem and awareness

Special skills – communication & leadership
S 7 **Lead the agenda** – develop **leadership** skills
S 8 **Tell engaging stories** – develop presentation, narrative and scenario setting skills
S 9 **Forge new visions of enterprise** – understand economic thinking without adopting it (know the language, but don't have the mindset of business)

Creating change agents
C 1 **Expand your context** – be aware that the sustainability context expands the design context in thinking and practice
C 2 **Change perceptions** – by making use of the diversity of 'value-added' outcomes of DfS
C 3 **Set new aspirations** – practice DfS approaches that provide significant, immediate and visible benefits to encourage consumers to aspire to a new, sustainable cultural representation of the "good life"

Awareness – systemic & context
A 1 **Be aware of context and connections** (people, planet, prosperity; key drivers and timeframes)
A 2 **Be aware of positive and negative impacts**, feedback loops and side effects in this context
A 3 **Be aware of choice and responsibility** under these circumstances

Learning together
L 1 **Seek to work with other disciplines** – practice inter- and trans-disciplinary thinking and practice
L 2 **Be a teacher–learner** – practice mutual learning, creativity and team working, understand sharing ideas as a way to stimulate creativity
L 3 **Participate with your peers** – practice teaching and learning through participation, involving an extended peer community of relevant stakeholders

Ethical responsibilities
E 1 **Develop design that does no harm** (responsible design, with integrity), but contributes to a sustainable way of a "good life", long term and globally, also if applied in mass production
E 2 **Create genuine consumer empowerment** – offer design that enhances personal standing and acceptance, and thus social sustainability and encourages user involvement (consumer empowerment)
E 3 **Focus on experiences not objects** – develop practical, functional and *fun* design that deepens life experiences and strengthens personal and social cohesion

Synergy & co-creating
S 1 **Activate through participation** – promote the development of teams, communities and networks
S 2 **Engage in synergistic clusters of competence**
S 3 **Practice collaboration, sharing and partnering**, and the involvement of stakeholders in the problem definition and the solution design process.

1962). Sustainability science and research, as opposed to that, focuses on a systems view as illustrated in Fig. 6, exploring the interactions of system elements and the emerging properties of

Fig. 6. The Prism of Sustainability.

systems. This integrated (sometimes called 'holistic') view is achieved by means of inter-disciplinary overview, integrative methodology and trans-disciplinary project conduct. Inter-disciplinarity implies a joint definition of research questions, trans-disciplinarity goes one step further by involving stakeholders, for instance consumers or other final users of the design results, as an "extended peer community" (co-design as an element of post-normal science, see Funtowicz and Ravetz, 1993; co-design as a design approach, see Fuad-Luke, 2008a).

Design for Sustainability must be able to draw on the detailed knowledge of science (and produce its own), but must go beyond it to provide comprehensive solutions by involving actors, stakeholders and consumers in the process. Selective, decontextualised perception of tasks and challenges is not future proofed, as the objects of design cut across all spheres of life and all components of eco-efficiency. Thus design(ers) need a vision of a better life in tomorrow's society and a clear understanding of their role, their possible contribution to and responsibilities in the transition towards sustainable development.

Without the contribution of design, the full potential of sustainable production and consumption, and thus sustainability, cannot be realised. Similarly, only in a sustainability perspective, can the full potential of design can be released.

However, activating this potential will (like all sustainability policy) require ethical/sustainable management and suitable political framework setting.

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Joachim H. Spangenberg is a Macroeconomist with previous education in Biology and Ecology. He is the Vice Chairman of SERI Germany e.V. and Professeur invite at the University of Versailles. He was a Senior Researcher and Co-coordinator of several international sustainability research projects, including DEEDS. Other current activities include moderating the sustainability strategy process in Luxembourg, a membership in IUCN CEM and having been a Review Author for IPCC ar4. In all these activities, he tries to bridge the gaps between disciplines and between scientific analysis and application. The scientific basis of this work is his research experience with SERI, in the Helmholtz Centre for Environmental Research, the Wuppertal Institute and the Institute for European Environmental Policy, but also the experience from work as an International Expert for UNDESA, UNDP and UNEP. For 20 years, his work has focused on developing integrated approaches towards sustainable development. He considers design as an underestimated agent in the process of future-proofing our societies.

Karen Blincoe is an Educator, Designer and Environmentalist. She is a Fellow of the RSA and CSD in the UK and a member of Danish Design in Denmark. She was the Director of the Schumacher College, Dartington, UK, a unique centre for studies in sustainability issues based on Ghandian teaching and learning principles. She was the Founder/Director of the International Centre for Innovation & Sustainability (ICIS), Denmark. She was educated in Graphic Design in the UK, established and ran a graphic design consultancy in London (1984–1992) and became the Head of the Institute for Communication at the Danish Design College (1992–1998). She is a visiting Professor at Brighton University, UK, and has held honorary positions both in Denmark and the UK. She lectures in sustainability, design and education around the world and is privately interested in personal development, leadership and conflict solving.

Alastair Fuad-Luke is a Sustainable Design Consultant, Facilitator, Educator, Writer and Activist. He works with diverse clients in the design and educational sectors in the European Union and internationally. He managed the Design Education and Sustainability (DEEDS) project from November 2006 to June 2008. He is a Visiting Lecturer at a number of UK universities, serving as a Senior Lecturer for the MA Sustainable Product Design at University College for the Creative Arts, Farnham, UK, between 2004 and 2007. He is the author of *The Eco-Design Handbook*, *The Eco-Travel Handbook and Design Activism*. He founded SLow, a website exploring 'slow design' (www.slowdesign.org) and is the Vice-President of the Board of New York and Amsterdam-based SlowLab (www.slowlab.org). He is passionate about society-wide engagement with design as a means to live a more fulfilling, sustainable life and for exploring more reflective, meaningful forms of production and consumption.