Wuppertal Institute designguide: background information & tools

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Wuppertal Institute
for Climate, Environment
and Energy

WUPPERTAL SPEZIAL 46

Wuppertal Institute Designguide

BACKGROUND INFORMATION & TOOLS

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Imprint

Publisher:
Wuppertal Institute for Climate, Environment and Energy
Doeppersberg 19
42103 Wuppertal
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Print: Druckerei Lokay e.k. , Umschlag Munken Lynx 300g/m^2 Paper, Inhalt Munken Print white, 1,5 fach Volumen 115 g/m^2

ISBN: 978-3-929944-90-7

Wuppertal Institute
Designguide

Foreword

In a century marked by a growing world population, increasing purchasing power, and rising material needs, our use of energy, land, and natural resources necessary to meet those needs will continue to grow. By 2030 it will be double that of today's status quo (Bringezu/Bleischwitz 2009). In order to sufficiently meet human needs without irreversibly overburdening global ecosystems, we require a producer and consumer culture that has learned to differentiate between the essential and the expendable combined with an economy that is under much less pressure to grow as well as new products and services. Taking a holistic approach to products, we are made aware that the engineer alone is incapable of developing products with a perspective for transitioning toward sustainability. In the preface of the first book to deal with the topic of sustainable product development (Schmidt-Bleek, F. and Tischner, U. (1995): Produktentwicklung – Nutzen gestalten – Natur schonen, p. 5.), published by the Wuppertal Institute, Ernst Ulrich von Weizsäcker posed the following question: "Are designers part of the ecological solution or part of the ecological problem?" He answered his own question as follows: "Typically they are rather part of the problem." But why? Then as well as now, designers are asked by their clients to develop products that are either meant to be sold as mass-produced articles or intended to ultimately generate economic welfare. By looking at the task of the designer from an eco- and resource-friendly perspective, one can explore new ways and possibilities for the designer can become part of the solution (Ibid. p. 5.).

The designers focusing on related behavioural issues of products and services will thus play a new and crucial role as change agents for sustainable development in the 21st century. Since the decisions made during the product planning stage define 80% of the production costs as well as 80% of the environmental impacts (Tischner et al., 2000), designers no longer will focus solely on aesthetic, functional, and promotional considerations, but also on aspects facilitating sustainable development.

For more than twenty years, the Wuppertal Institute has been engaged in designing sustainable product-service systems. Today the development of affordable products and services which improve quality of life and protect the environment is more relevant than ever. Society's transformation towards sustainability will only be successful if it is possible to launch ecologically-smart product-service systems, and this is where the designer can make a crucial contribution. Designers are thus a fundamental part of transition research aimed at sustainability, which includes the realisation of society's inter- and transdisciplinary potentials in order to elaborate and practice new approaches. In this spirit, the Wuppertal Institute has advanced its research program by integrating so called LivingLabs. These events are the equivalent of think tanks – laboratories in which innovative approaches for sustainability are being devised and tested in experiments. Also of great importance is the integration of outcomes of sustainability research into design theory and teachings.

This edition of Wuppertal Spezial describes a new approach to sustainability. Its concept is based on the idea that design development and human behaviour patterns (in production and consumption) are closely interlinked and that designers can translate the different needs of all the related actors into concepts, products, or services that support a sustainable future. Only cooperation will allow us to complete this tremendous task. And it is only when designers are supported by specialists in the field of sustainable development with their competencies and tools – and it is certainly a two-way street, for these specialists will also learn from designers on how to best apply their methods – that this ambitious aim can be achieved.

Over the course of the 20th century, hardly any products were designed with re-use or recycling in mind, and marketing and the underlying economic system were developed in order to enhance the sustainable consumption of products and/or services. The consequence of this was a throwaway society with products with short life spans. Thus we now require transformed collective behaviour patterns to emerge from a new concept of design.

For this reason, and because design includes companies' crucial decision-making activities, a set of rules derived from the three major strategies for a sustainable development – efficiency, consistency, and sufficiency – will have to be considered by designers in the coming decades. These will include the preferred use of environmentally friendly and easily recyclable materials, modular construction methods, longevity, collective forms of utilization, and innovative services supporting the use of goods instead of mere ownership.

This DesignGuide is an example of co-operation with universities, design schools, and the Wuppertal Institute. Its scientific analysis and methodological development was carried out at the Wuppertal Institute. Since it was first created in 2008, the guide has been applied, evaluated, and revised in many classes and at the international Sustainable Summer Schools. It was created with the aim of fostering the education of a new generation of designers which realises that the 21st century may never be allowed to become just a sequel to the 20th.

Prof. Dr. Uwe Schneidewind
President and Chief Research Executive

I. BACKGROUND INFORMATION

II. TOOLS

Sustainable Products and Services:
Your Designguide

BACKGROUND INFORMATION

1. Abstract

Our perception of design is changing, for design today is no longer concerned only with aesthetics. Now the key factors are interdisciplinary competence and approaches to problem solving. Both politicians as well as businesses recognise design's hybridity and increasingly implement it as a driver of sustainable development (see Chap. 2: Design as a Key Management Factor for Sustainability).

But what exactly does "sustainability" mean? What does it mean in this specific context? People must make use of natural resources to meet their basic needs. In this process, resources are transferred into commercial circulation and usually transformed into products with a particular function. Yet the environment is limited and humanity uses more resources than the Earth can sustainably provide. It is time to rethink and generate the same usage while consuming fewer resources (see Chap. 3: Environmental Space – Challenging Transitions).

Most countries have incorporated sustainability strategies into their political agendas in order to counteract the threats of climate change caused by the overuse of natural resources, high CO2 emissions, and other factors. The indicators for these strategies vary greatly from country to country (see Chap. 4: Sustainability – Challenges, Politics, Indicators).

These indicators need to be taken into account if we are to successfully implement a product or service within a specific context. A concept can only be successful when country-specific indicators are taken into account and the societal context is incorporated into the plan right from the start. The goal is to develop services that support national sustainability targets in production and consumption systems (see Chap. 5: Managing Sustainable Development).

When it comes to companies, these changes can simply be introduced in the form of services or products. In the end, it is the users who decide on the success or failure of innovative solutions by either integrating them into their daily lives or ignoring them. Solutions will only be integrated into users' lives when their role within the social framework remains unchallenged by behavioural transformations caused by use of the solution. In order for users to be able to adopt innovations, sustainable development must take place simultaneously on many different levels. These multi-levelled transitions allow for the transformation of society as a whole. Designers can act as agents of change by providing the needed innovations (see Chap. 6: Transition Requires Change Agents for Sustainability).

If we are to develop suitable solutions and new approaches, the real needs have to be analysed at the beginning of the development process. New physical products, which frequently result in auxiliary products, are often developed without taking into account the overall context, whereas the development of service-orientated solutions is ignored. A physical product is not absolutely necessary. A service (which is naturally dependent on physical products) can usually fulfil the need just as well – or perhaps even better and at a lower cost – while using fewer or no resources (see Chap. 7: Needs & Services – An Approach).

There are a variety of possible approaches to integrating sustainability into the design process (see Chap. 8: Design Process).

Precisely which solution is "most or more sustainable" (this is dependent on the defined targets and the indicators used) is often not immediately obvious, and we must turn to a set of methods for a transparent and tangible assessment (see Chap. 9: Sustainability Assessment in Design – Overview and Integration of Methods).

Conclusion

The aim of this design guide is to provide background information, an assessment catalogue, and a toolset for the integration of aspects of sustainability into the design process.

It enables designers to integrate these factors into their workflow through methods which support and accompany the design process without restricting creativity. This background information enables a broader look at relevant topics. The tools can easily be implemented in the design process through combinations (MODULE) of tasks (JOB). The toolset is composed of different steps (TASK) that change depending on whether a concrete product, concept, or a sustainability vision is to be developed. The different tools are based on a common, modular system made up of the following elements: background information (with references to background papers), the aims of the tools (the expected result), the purpose (start situation and use), and proposals for work steps which could be strategically effective both before and after the use of the tool.

In order to successfully change the normal design process into one oriented towards aspects of sustainability, it is important to understand the relevance of the decisions made during the process have for sustainability strategies, aspects, and topics.

The modular construction of the tools allows them to be used individually or in a step-by-step process. This ensures that the design guide remains a universal catalogue of methods for designers.

2. Design as a Key Management Factor for Sustainability

“Design is a process, an activity, and not only the results of that activity.” (EU Commission, 2009)

“This statement does not exactly make it easy to clearly differentiate the discipline of design from a company’s other activities – but this is design’s strength! Design is extremely diverse, which allows it to be a driving force and play a key role in the anchoring of sustainable thinking and actions in corporate culture. It is a broad field with docking points in various other disciplines. Design “is considered as the bridge between for example creativity and innovation, technology and the user, scientific and commercial disciplines.” (EU Commission, 2009) This gives companies the possibility of interdisciplinary work, as “Design allows a broad range of considerations to be taken into account.” (EU Commission, 2009)

Design is about products, services, systems, environments, and communication. Beyond the traditional approach to industrial design, it can also be applied to services – private and public – as well as systems such as urban planning and even experiences (EU Commission, 2009). It allows for a wide range of considerations to be taken into account and is a holistic approach to problem solving allowing for factors extending well beyond only aesthetics. These include functionality, ergonomics, usability, accessibility, safety, sustainability, cost, and intangibles such as brand and culture (EU Commission, 2009). These features illustrate how design is a key management factor for sustainability.

INFORMATION

Design has no commonly agreed definition and the word is given different meanings in different contexts. Very often, design is associated with the aesthetic aspect of objects only, whereas in reality its application is much broader. A review of definitions by design professionals and policy makers highlights the broad nature of design and its potential to integrate aesthetic and functional as well as, for example, environmental, safety, cost and intangible considerations into products, services, and systems (EU Commission, 2009).

Reference

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3. Environmental Space – Challenging transitions

The need for dematerialisation stems from the limited amount of "environmental space" (Opschoor/Costanza, 1995) available on our "Spaceship Earth" (Boulding, 1966). In general, environmental space refers to the amount of resources we can use without comprising future generations' access. These resources provide fundamental life services such as energy and raw materials, the absorption of wastes, climatic regulation, and biological diversity. Services provide utility for us directly in the form of fresh air and water or recreational values, such as hiking in the mountains, or indirectly when transformed through technology into products. The notion of sustainability stipulates that environmental services (and the corresponding related spaces) must be equitably distributed per capita (over generations). Western lifestyles generate wealth for less than 20% of the world population, but they consume 80% of all resources globally. We therefore must find ways to generate wealth using around 10% of resources we currently consume (or ten times less – the "Factor 10") in order to let the people who now use less claim their fair share of resources (Schmidt-Bleek, 2000). This is why the concept of "environmental space" promotes reduced resource consumption in high-intensity areas. Such a reduction is indeed possible, as a comparison between households in Finland has shown.

Here the difference between the highest and lowest backpacks was shown to differ by more than a factor of ten (Lähteenoja et al., 2008:9).

Countries with diverse consumption patterns (from highest to lowest levels of resource consumption such as India, China, Brazil, etc.) and "poorer" countries with high regional poverty rates may still grow materially. Resource extraction thus needs to be reduced globally by a factor of two (i.e. reduced by half) (Schmidt-Bleek, 2009).

But how can countries with proportionally lower levels of environmental space usage still grow when there is no space left? According to the notion of a sustainable development, this is not only a matter of environmental reconciliation but also entails a path by which these countries can escape poverty and hunger while fostering health and social equality (see Millennium Development Goals at www.un.org/millenniumgoals). In order to guarantee these basic needs within the constraints of environmental space, saturated and affluent societies need to use much less in order to benefit countries that use much less environmental space.

For example, modern Western lifestyles in Germany or the United States all carry an ecological backpack in the range of seventy–ninety tonnes per capita per year (Schmidt-Bleek, 2007: 44, Bringezu/Bleischwitz, 2009: 61). According to the Factor 10 concept, there is a need to create a sustainable ways of living, sustainable consumption of household goods, food and beverages, transportation and tourism, electricity, heating, and housing that does not exceed eight tonnes per capita by 2050. However, the composition of this footprint is not the same for everyone. The share of consumption represented by a material footprint of eight tonnes can differ according to the values, needs, and aspirations of each individual's unique lifestyle (Lettenmeier et al., 2012:8). It is true that we need to reduce our consumption patterns dramatically, but there is still space to maintain individual welfare by designing this pattern according to individual needs that relate to quality of life. In this respect, designers are able to both support and design the search and the individual transition of the society or peer group. For example, some people may accumulate more of their footprint through mobility, whereas others require less transportation but instead live in a larger apartment. Not everyone needs to live the same way, but – at least on average – everyone must live within the boundaries of our planetary system in order to realise our sustainable future.

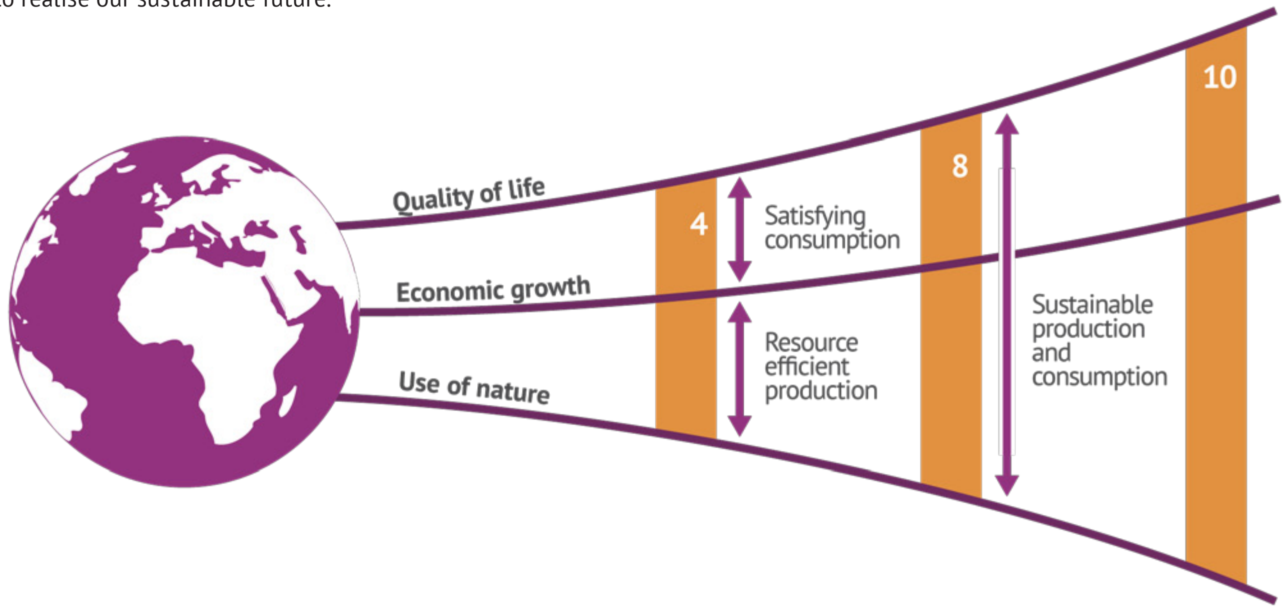
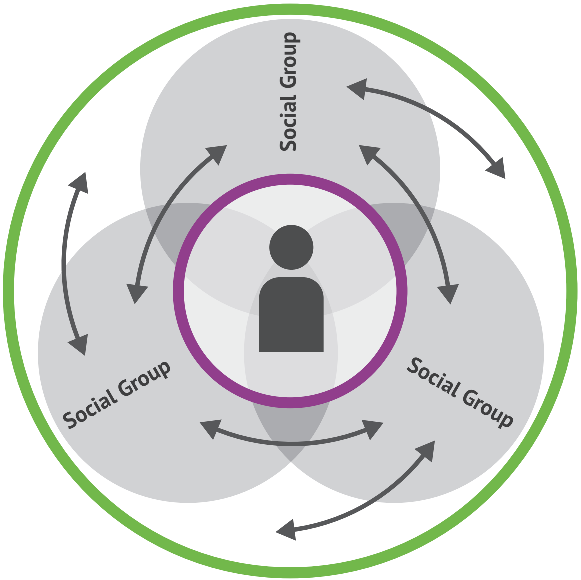


Figure 1: Factor 10 – Wuppertal Institute

APPROACHING A SUSTAINABILITY PERSPECTIVE



Individual: Individuals are embedded in social groups with their norms and values. The individual's choice on what to consume depends to a varying extent on the peer group's norms.

Social groups: Individuals and social groups want to maintain or increase their social status, well-being and welfare, reflecting the norms and values of their peer group.

Economy: The economic construct is the means societies use the environment to meet their needs and desires.

Environment: Provides resources and nature services to all other layers. This not only includes economic use but for example also contributions to human well being through recreation, for example taking a walk in the forest.

Figure 2: Approaching a Sustainability Perspective – Wuppertal Institute

How can we approach sustainability in a consistent and comprehensive fashion? First, it is important to remember the principle of environmental space. We are individuals who are organised into social groups and work in companies that follow certain economic rationales. These rationales have to be revised according to the principle of environmental space (see Fig. 2). Needs and desires are satisfied by materialised products and are incorporated into preferences for social justice or meaningful work which are themselves the results of social norms and values. We also have to consider this when we talk about sustainable design. Sustainability is not just about materials alone, for it also has to take social needs into account in order to support individual quality of life.

Conclusion

In summary, sustainable design it is all about establishing or maintaining the individual's quality of life without limiting the potential well-being of other people or future generations, and this includes the promotion of a sustainable use of environmental space. Sustainable design therefore needs to provide socio-technical solutions that didactically foster appropriate transition processes (Liedtke et al., 2012).

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4. Sustainability – Challenges, Politics, Indicators

Managing Sustainability and Environmental Space Challenges

When it comes to politics and policies enacted within national or institutional boundaries such as within the European Union or the Organisation for Economic Cooperation and Development (OECD), for example, the specific strategies differ. Eventually we have to deal with a diverse range of strategies and apply at the core the common and vast idea of sustainability proposed by Brundtland (1987): "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition is quite vague, however, and leads to ambiguous and diverse policy recommendations.

Similarly, a patchwork of indicators underlies the specific pattern of these strategies. Industrialised societies may focus more on ecological and economic aspects of sustainability, whereas developing countries tend to favour economic or social progress. The mainstream concept reports social, economic and ecological aspects separately. Therefore, strategies are classified analytically into the commonly known arrays of economic, ecological, and social sustainability.

In this respect the question arises as to how we can measure and make sustainability visible. How can we measure sustainable development? Do we do so in economic or in social terms? In ecological terms? Is it even possible to combine them into socio-economic or socio-ecological factors? Sustainable development in economic terms is often reported in terms of GDP per capita, i.e. the growth of a national economy in material terms. By comparison, sustainable development in ecological terms may be monitored by emissions (output oriented) or material requirements (input oriented), while social sustainability may be reported by the distributional equality of national income (see Chaps. 14 and 15: National Sustainability Indicators/Strategy Wheel). When dividing sustainability into formulated categories, one sector may dominate (economic aspects may take precedence over ecological or social factors, for example). Furthermore, indicators may report contradictory and ambivalent developments. An economic development that is measured by growth in material terms (such as per-capita GDP) will never lead to a dematerialised economy. Developments intended to grow physically can hardly reduce their material requirements in absolute terms. Sets of indicators are always selective, and in some cases they are even misguiding, as only that which can be measured quantitatively is featured in an indicator set. In this respect, we must remain cautious and carefully select our set of indicators.

That means indicators are always works in progress – they require dynamic adjustment and sometimes must be reformulated. Nevertheless, indicators are essential tools for monitoring progress. They help us to choose appropriate strategies, remedies, and designs. Setting goals does not make any sense if we cannot see where we are going. Yet without goals we are blind, so to speak. In general, sets of indicators are sophisticated tools for social learning.

Conclusion

A set of indicators should monitor progress in terms of individual well-being within environmental space. Which indicators appear inadequate for this task, and what indicators must then be established? What are the corresponding sustainability goals? How much environmental space may be assigned to my country or society (and people)? Should socio-economic progress be favoured? Should reduced environmental destruction be a goal? Eventually, sustainable design has to consider these questions in order to select the indicators relevant to the focused design concept (see Chap. 5: Managing Sustainable Development). In this respect, sustainability strategies are tools for reflection, a tool around which change agents such as designers can orientate themselves.

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5. Managing Sustainable Development

Chapter 4 introduced the complexity as well as the problems that arise when measuring sustainability. In a nutshell, it is all concerned with the dilemma posed by socioeconomic progress within ecological boundaries. One way to solve the problem is to focus on one specific area in sustainable development. For example, the set of indicators in Canada focuses on environmental issues, whereas the Indian and Tanzanian indicators focus in particular on attaining minimum living standard for the majority of these countries' citizens. This is all well and good, for the global "environmental space" must be distributed equitably, meaning that according to Factor 10, developing countries may continue to grow economically while industrialised countries need to dematerialise their economies by a factor of ten.

On the other hand, there are efforts to overcome or replace some antiquated measurements such as GDP for measuring economic (a synonym for societal) progress with new indicators measuring happiness (Bhutan) or quality of life. For example, the German sustainable strategy points out that the

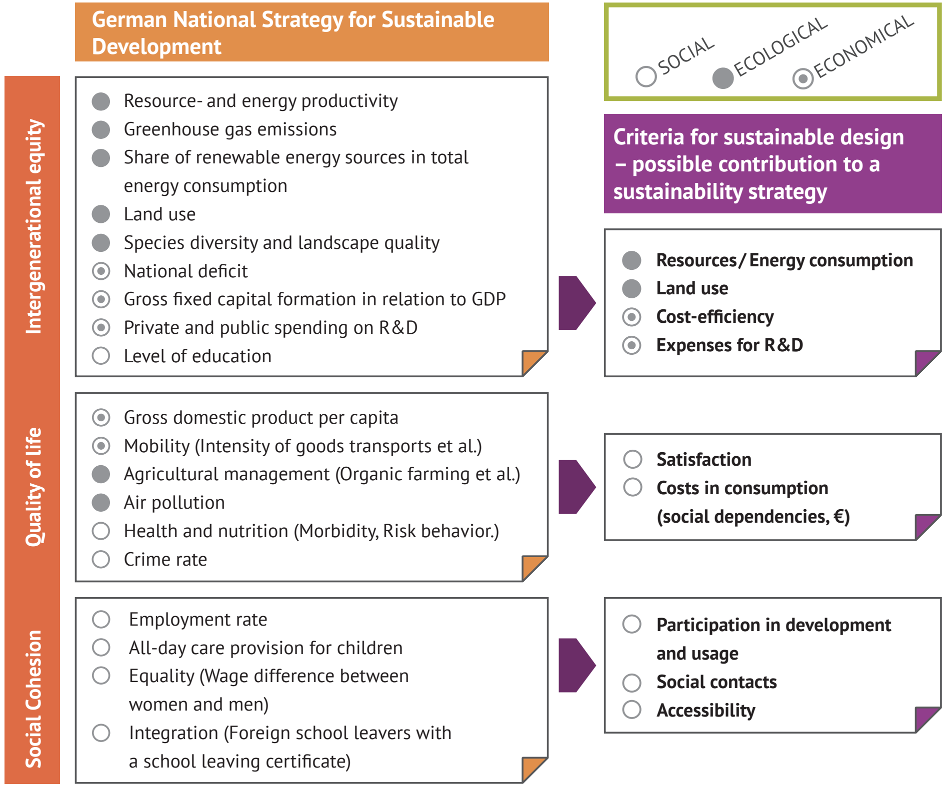

Figure 3: Strategies for Sustainability - Wuppertal Institute

most important factor is not only economic progress, but also quality of life. At the same time, however, Germany includes per-capita GDP as a means of measuring quality of life. In other words, it employs GDP as a proxy for well-being, which is still insufficient. The concept behind the national strategy in Germany is thus quite forward-thinking, but the indicators are still lacking, for only factors which can be measured (and compared!) are featured in this set of indicators. Fig. 3 introduces the German strategy in order to provide us with an idea of how sustainability can be managed nationally on the basis of certain indicators according to constructed categories. However, the realisation of sustainability strategies relies on their actors – designers, in particular – implementing them into the production and consumption system.

For this reason, the European Topic Centre (2011), on behalf of European Environmental Agency (EEA), calls for a reassessment of the notion that goals follow indicators. Goals need to be defined first and only then can we conduct an analysis to determine whether the indicators exist that can adequately measure and report on the fulfilment of set goals. Resource consumption should not neglect hidden material flows, and that is why the EEA (2008, 2012) is currently revising the Total Material Requirement as a sufficient indicator for resource use in production and consumption systems. If it is not, data has to be generated and new indicators created (see current efforts to revise economic growth as a proxy for social well-being). Only when appropriate assessment tools are used can national strategies manage sustainability issues in favour of their transition processes. Therefore, the assessment tools themselves have to be developed and adjusted to present this knowledge. They need to relate to future scenarios and appropriately describe them.

Conclusion

(Inter)national strategies must be capable of reflecting and creating individual welfare in a sustainable manner. Sustainability is not a matter of economic, ecological, and social abstracts but about striving for individual well-being at a social and ecological level. The management of a sustainable development is without doubt a complex and contested process by actors from the areas of politics, economy, and other social spheres that all articulate their own interests. Taking this into consideration, (inter)national sustainability strategies together with their indicators and policies mirror this complex and long-term process. Nevertheless, strategies are only effective when they become relevant and tangible for people. Strategies remain mere paperwork unless the ideas are implemented in everyday life. This is why it is important for designers to incorporate strategies as well as their indicators and ideas into their work and make them visible and integrable into individuals' lifestyles.

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6. Transition Requires Change Agents for Sustainability

"If design is to contribute to human culture in a more meaningful way then it has to move beyond the often shallow, style-based notions of product design that have become so prevalent over the last fifty years" (Walker, 2008). The question then arises as to how design can contribute to sustainable transition processes as well as societal transformation that can promote sustainable development.

The task of design and the societal concepts of how design is defined or understood are deeply connected with societal development. Design is an extremely complex and diverse discipline which has a direct effect on societal development and is in turn influenced and characterised by society's actions and decisions. The areas of focus for design can vary greatly. Sometimes the focus is on form and aesthetics – the artistic aspects of design – whereas at other times it deals with the pragmatic and the functional. Design and the related societal interpretation regarding its role in society are a reflection of societal development and innovation processes. It is therefore hardly surprising that sustainability

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"Transitions are defined in the mainly Dutch transition research as the radical structural change of a societal system as a result of co-evolution of economic, cultural, technological, ecological and institutional develepments on different levels. (Rotmans et al. 2000)" In contrast to transformation, a sustainable transition refers to deep changes at the regime level of societal sub-systems (see below) such as the energy sector, for example. Such transitions can thus represent individual steps towards the transformation of society.

researchers and politicians who seek solutions for the transformation of societal patterns of behaviour in production and consumption consider design to be a mediator and formative element in these necessary transition processes. Transition processes can be promoted or even triggered by what are known as change agents (Kristof, 2010; see glossary). Such competent actors are a key aspect of facilitating change processes. By integrating sustainability aspects into the design process, designers can act as a kind of change agent – something that only accommodates the activity of design, since it avoids acting arbitrarily with the possible consequence of negative rebound effects (see Chap.16: Hot Spot Analysis).

In order to understand the connections between societal processes and products and/or services, it helps to approach socio-technical system innovations using a "Multi-Level Perspective". The Multi-Level Perspective consists of three different levels. The level "socio-technical regime" corresponds to the core of a socio-technical system. Essential elements include markets, user-preferences, industry/business, science, technology, as well as fundamental cultural elements such as values and norms, which find expression in the respective market, technology, or industrial structure. The level of the "socio-technical landscape" considers general global trends that impact regimes and niches (war and

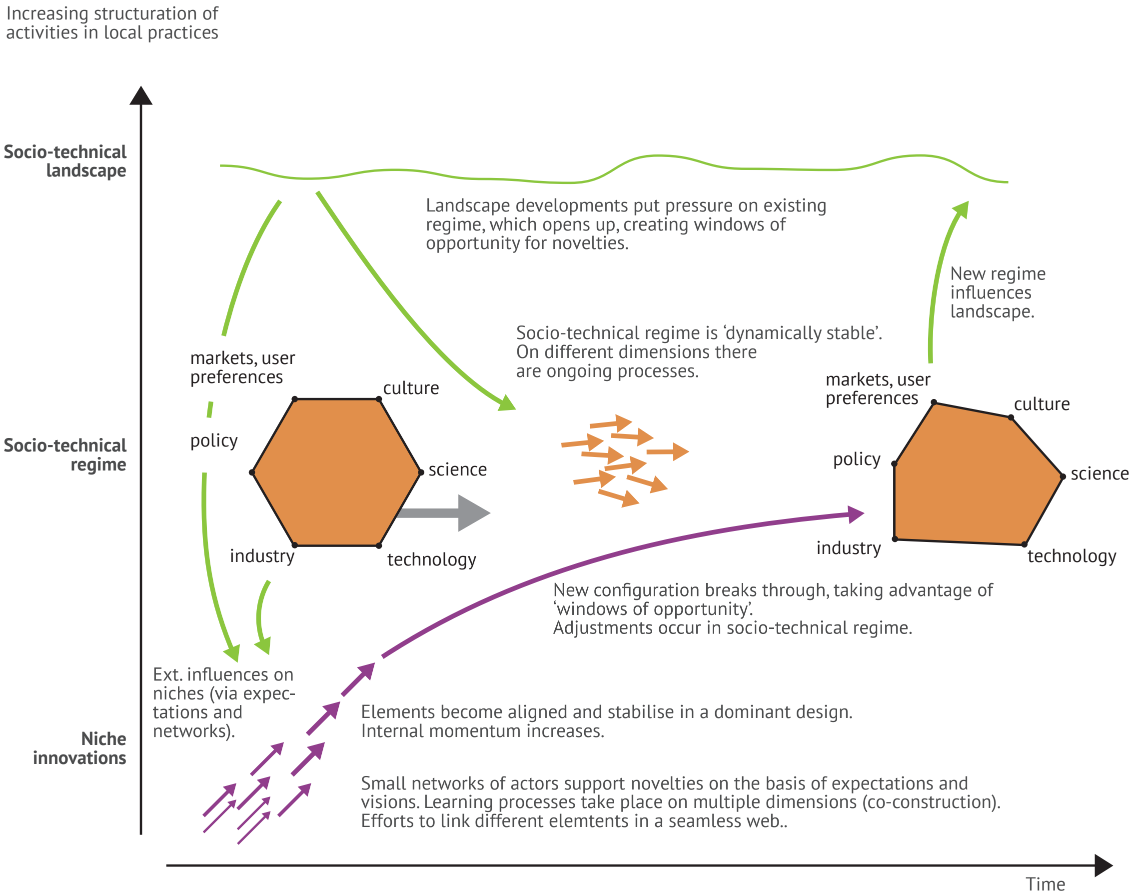

Figure 4: Multi-level perspective on transitions - Interaction between landscape, regime and niches (source: Geels and Schot 2010: 25, based on Geels 2002) – Adopted by Wuppertal Institute

peace, globalisation, urbanisation, climate change). At the level of “niche innovations” it is possible to develop something truly new. These innovations can only be adapted in the form of a transition process when the pressure from either the “niche-innovation-levels” or the “socio-technical landscape” is significant enough – or are exerted by the regime – due to learning processes which enable the penetration of the innovation. Only then can the innovation cause fundamental changes in the regime configuration. Change agents can promote niche innovations and their diffusion.

Nevertheless these factors make it difficult to clearly define how broad the designer’s duties actually are. The design of societal processes (products and services) is already intrinsically diverse: socio-technological development processes take place permanently in all areas of society. Design tasks can always be found wherever material and immaterial changes are needed.

In their role in developing product-service systems, designers can act as change agents and are themselves part of transition processes, as they can actively influence the drivers of sustainable development. In order for designers to be able to orient themselves in their area of activity, it is important to define both the possibilities and limits of design.

To date, the creation of new products actually continues to represent a part of the problem rather than a part of the solution. It would at first appear as if the designer no longer has a contribution to make within the conventional parameters of product design (Walker, 2008). Here it is important to remember that the idea of design is in a state which invites us to proactively look for possibilities and limits (Park, 2010). Once the designer has studied the concept of “good form”, it is possible to characterise design according to the following three characteristics: design as aesthetic design, design as rational planning, and design as idea creation (Park, 2010). Above all, as object of the design process in the later characteristic, not only products but also processes and systems should be considered. The future will show whether the designer is able to deal with this changing task. This requires a different or widened understanding of design and as well as completely new approaches and tools (Park, 2010). Instead of focusing on objects (the product), the subject (the individual) should be in the foreground. Not only products, but entire lifestyles need to be designed to be sustainable. This is why use-management thinking and service design need to be a part of the process (Schmidt-Bleek and Tischner, 1995; Tischner, 2000). Design no longer merely means creating new products, for we must also search for new (system-)solutions that provide sustainable product and service arrangements. Sustainability research also seeks to more clearly define this requirement in the area of product and service development (Liedtke et al., 2012; Green and Vergragt, 2002).

In his November 2011 speech “Design for a More Human Environment”, Dieter Rams stated: “The demands on our surroundings are as fundamentally ‘human’ as they always were. They are not changing at a faster and faster pace. On the contrary, these human demands on life are astoundingly constant: love, security, friendship, self-fulfilment and success, as well as the potential for adventure – and to fail. It is only the conditions that change constantly – and that is where the designers come in” (Rams, 2011). The goal of the designer must be to instruct the user with easily accessible products and services in order to prevent incorrect use and possible negative effects, but not to limit the user to such an extent that individual strategic actions become impossible. The user will only use the product or service over a longer period of time and in the intended fashion, but this does not rule out the possibility of a reusing products and services or using them differently than intended – along the lines of non-intentional design (Brandes, 2008) – if he or she enjoys doing so.

Calls for designers to emancipate themselves from material dependency and become more than mere "stylists" are growing louder. In order to meet these demands, designers have to start thinking outside the existing box and begin to look at design in terms of service units instead of material products. When this is the case, not only is the user's satisfaction ensured, but we can also achieve "dematerialisation".

Conclusion

Design can make an important contribution to transition processes on the path towards the sustainable transformation of society. In order for this to occur, we need the appropriate instruments and ensure the interdisciplinary and transdisciplinary integration of these processes.

The DesignGuide is an instrument for this purpose. It shows designers where concrete integration of sustainability aspects into the design process is possible and which problems require interdisciplinary or transdisciplinary work. It also seeks to focus on the problems in the system which need to be solved and determines whether the developed concepts can help solve problems in socioeconomic and socio-ecological systems.

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7. Needs & Services

Needs are shaped by the society you live in
By their very nature humans are essentially dependant on living together in groups and social communities. This is expressed, for example, in our efforts to act according to rules, norms, and values or in accordance with our own peer group. Only by following certain types of behaviour and social routines can the individual expect to be accepted within a social group. This means the individual is influenced in his or her actions by the societal context. When performing these actions and forming routines, he or she forms the context – the society. In the course of performing these routines, the individual consumer seldom enters into a situation in which they must reflect upon their (consumption) behaviour. He or she tends to automatically reduce the psycho-social costs that are caused by acting against norms and expectations within a peer group (Matthies, 2005). Engaging in social practises requires the appropriate consumption of goods and services (Warde, 2005). Depending on social status, cultural background, and the region at issue, such expectations can vary substantially. Therefore design has to saturate different cultural approaches and/or needs. In industrialised nations, most people can easily satisfy their basic needs. In most cases, purchases are not essential for survival but serve the purpose of self-fulfilment or entertainment. People living below the respective poverty levels usually seek to satisfy basic needs such as food, clothing, housing, basic commodities, and other requirements.

In this context, at issue is a decent standard of living rather than the development of a personality. A need to show social status using material goods can be seen among the emerging educated middle classes in many developing nations. This is also reflected in the fact that use of resources is expected to more than quadruple by the year 2050 (Bringezu et al., 2009:72), as the worldwide adoption of wealthier lifestyles by the educated middle class in developing nations leads to a rapid rise in resource and space consumption. Climate change and its effects can therefore hardly be stopped. Eco-intelligent solutions for service systems leading to a lifestyle change are needed. These need to not only consider the fair distribution of resources for worldwide prosperity, but also the need for social status.

If we are to take “Factor 10” (see Chap. 3: Environmental Space – Challenging Transitions) seriously, each person must plan their lives so that he or she only uses a set amount of water, raw materials, and land. This is what is known as the sufficiency aspect (see Chap. 9: Sustainability Assessment in Design – Overview and Integration of Methods) of this concept. Following the ideas put forth by Sachs (1993), lifestyles and consumption patterns need to be slowed down, unbundled, cleaned up, and de-commercialised. These four terms do not conflict with individual welfare. On the contrary – they highlight the development of sustainable lifestyles.

Goods offer function, status, identification, emotion, and much more ...
At this point in the discussion, a short digression into the world of brands is necessary. Products and goods always have an immaterial added value in the form of a brand image. Since a minimum quality standard is guaranteed by law in many countries, the only way for companies to differentiate themselves from competitors is in terms of brand image (Baltes, 2004). A product does not only fulfil a certain function, it also identifies the user as a part of a particular social group and its associated lifestyle. The brand tells much of who and what the user represents in a social con-

text. There is a pattern through which the user tells a story. Appearance or reality is difficult for outsiders to identify, but it is possible to express that which the user wants to communicate.

At a minimum, consumer goods include the added value of a brand that accompanies their function as a "service fulfilment machine" (Schmidt-Bleek, 1999). But what else? In order to answer this question it is important to consider the need that is satisfied. How do the users use the existing product? When and why do they use it? What do they expect from it? Pure functionality, status, luxury, enjoyment, freedom, or self-development? What happens when they use it? What do they buy along with the physical product? What value does it have for them? Goods are usually not only purely functional, but they have an added value which allows the user to be identified with a social group and communicate a rise in status. It is an evolutionary biological fact that people strive to become a member of a group with higher social standing.

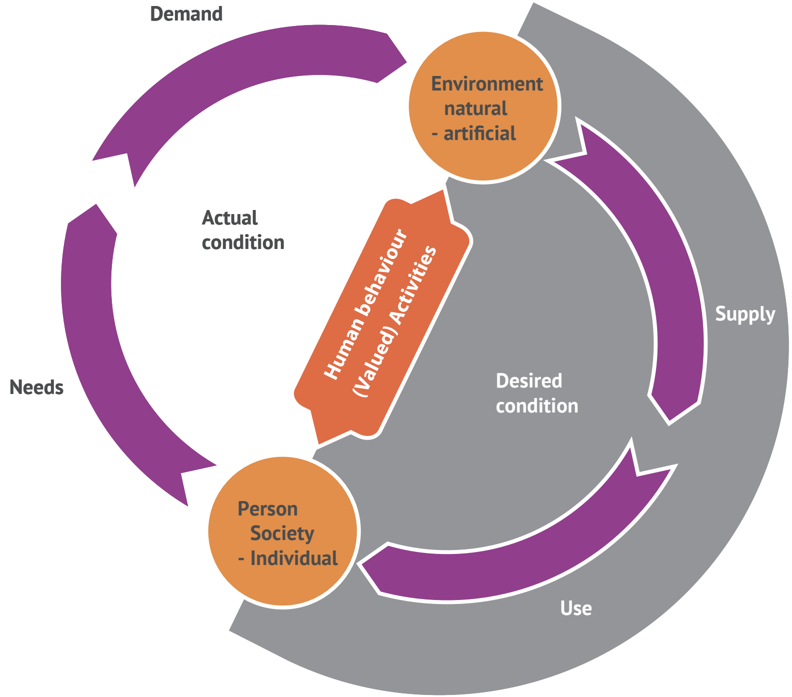

Figure 5: Maser, S.: "Mensch und Umwelt als System von Prozessen zur Bedürfnisbefriedigung (Maser, S. (1993): Zur Planung gestalterischer Projekte. Essen. S. 73.) redrawn by Wuppertal Institute

What is a service and can it satisfy a need?

"Do we really always need new things?" (Rams, 2011) We need a design approach that foes far beyond superficial and cosmetic consumption, beyond an exclusively consumer-oriented society. "The only way out of this dilemma requires a change in outlook." (Rams, 2011)

With these words, Dieter Rams assigned designers responsibilities which go far beyond the design of form. Carlo Vezzoli was even more concrete when he stated: "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 while 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." (Vezzoli, 2006)

To arrive at a "resource-light fulfilment of a need", the designer must define the core needs and the surrounding system and include them in the following considerations. In order to develop practical strategies for the future, it is crucial to come to solutions which are not based on today's strategies (see chapter 13: Taking Stock).

When it comes to determining the core focus of a need before using it to develop a service definition, the theories of Siegfried Maser (See Fig. 5), who sees people and the environment as a system of need-fulfilment processes, are quite helpful.

Once core needs have been clearly defined, the service definition can be determined. You may recall the "bundle of service" concept which defines the end-user's expected utility for the product. This means thinking in terms of the need a product satisfies (such as enjoying tasty coffee) instead of the physical product itself (such as a coffee machine). Such an approach comes to the conclusion that the user essentially wants clean laundry (service unit) and the washing machine (physical product) is only a means to this end. Thinking in this manner leads to creative and innovative product service systems (PSS).

Even though services seem less materially intense than physical products, they are not immaterial. For example, car sharing, which provides the essential service of getting from point A to point B (service unit), still requires a fleet of cars, buses, trains (physical product), fuel to run them, and support networks dependent on communication technology, energy, etc. Here it is important to be aware that categorical "quick fix" solutions are rare.

INFORMATION

Eco-design begins with the definition of the utility or the bundle of services which the end-user expects of a product. This utility must then be generated with the least possible quantity of natural resources in a process reaching all the way from its cradle (creation phase) to its grave (reuse life phase) or back to the cradle (Schmidt-Bleek, 1994).

Conclusion

"We still have the opportunity to change our unsustainable habits, but we can no longer afford to take our current consumption patterns for granted. A consumer demanding cleanly-produced products might feel good about his or her lifestyle choice, but it will take more than just consuming such products to initiate a change – it will require a decrease in consumption as well in order to realise any gains." (Clark et al., 2009)

If current trends of population growth and rising consumption persist, the consumption of resource-light products alone will not result in a sustainable society. Only when the societal context as well as the patterns of consumption are gradually changed can we become a sustainable society.

Truly sustainable products are distinguished not only by efficient use of resources, but also by the integration of sufficiency and consistency into the products that results in the consumer consuming less (e.g. transformative products) without forfeiting quality of life (see Chap. 3: Environmental Space – Challenging Transitions).

INFORMATION

Eco-intelligent goods are objects, devices, machines, buildings, and infrastructures which provide as many benefits as possible (differing and measured according to the needs of the individual) at competitive prices. Moreover, this entails a minimisation of materials, energy, land use, waste, transport, packaging, and dangerous materials throughout the whole lifecycle, beginning with the excavation of the raw materials and ending with recycling (Schmidt-Bleek, 2000: 4).

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8. Design Process

Human needs can be separated into two basic categories: individual needs and social needs. Given this fact, the economic system or the technosphere should only exist in order to satisfy such needs, but they can in fact also create wants. This is not possible without nature's services, such as pollination of food crops by bees, for example. The concept of sustainability integrates the challenges of deciding between individual and social needs while conserving nature's services without which we cannot exist.

Environmental and social or ethical considerations should be introduced into product planning as early as possible, as the decisions with the greatest impact are made at the very beginning of a new product's or service's development (during the product planning phase, not only are 80% of the production costs defined but so are 80% of its environmental impact [Tischner et al. 2000]).

The earlier environmental concerns are integrated into these decisions, the greater the potential for cost savings, increasing profits, and reducing the environmental impact. This responsibility starts with the first actors in the production process: the designer, the engineer, or other change agents.

The eco-design approach focuses on integrating environmental aspects without compromising functionality for the user. In terms of the design process, this means a holistic review of the product lifecycle in terms of raw material input. Environmental, social, and economic aspects need to be considered simultaneously and be assessed in an integrated manner. First and foremost, however, the environmental space perspective, the target of eight tonnes of resources per person per annum is the first target for the following decision processes. The aim is to create products with a higher level of service delivery while maintaining their quality or even improving it (Schmidt-Bleek, 2009). This is a pathway out of our current ecological and economic dilemmas.

An important feature of eco-design is that it considers the environmental impact of a product or service over its entire lifecycle.

It endeavours to determine possible environmental impacts (material consumption, energy input, toxic materials, waste, etc.) of a given product or service, starting

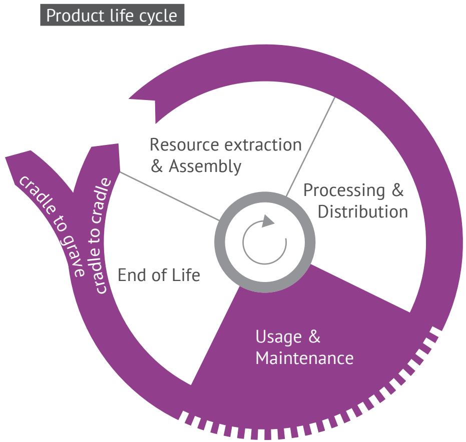

Figure 6: Product Life Cycle - Wuppertal Institut

Figure 7: based on http://bit.ly/olnbek - redrawn by Wuppertal Institut

from the supply of raw materials through manufacturing to final disposal or recycling.

This thinking in terms of lifecycles is also highlighted in terms such as "from cradle to grave" or "from cradle to cradle" (Schmidt-Bleek, 1994). The latter emphasises recycling and the concept of a "closed-loop" recycling economy embedded in European and other national regulations (producer responsibility) (Bringezu/ Bleischwitz, 2010).

Given the high target and the recognised threats posed by current and projected material use, solutions to enable dematerialisation are required. In order to dematerialise production, the most logical approach is to start at the source: the design process. Here the classic slogan of the three R's (Reduce, Reuse, Recycle) serves as a basic signpost. Designers can help reduce the material needed in production and use phases of a product or service – a step that would have the greatest environmental impact. A reduction in consumerism is of course related to reuse, for if we begin reducing we have to think about reusing what we already have (Walker, 2008). Designers can help to REUSE products either in its originally intended manner or by giving the user enough leeway to interpret the product in a new way (see "non-intentional design" in the Glossary). Designing products with recycling in mind is another valuable contribution. Such approaches come under the umbrella term of eco-design (Schmidt-Bleek et al., 1997).

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9. Sustainability assessment in design – overview and integration of methods

Introduction

By now everyone should be aware of the fact that lifestyles in industrialised countries are changing the ecosphere (see Chap. 3: Environmental Space – Challenging Transitions), something that is clearly visible in our changing climate, for example. Once stable systems become unstable due to the influence of both materials extraction and the emissions and wastes that are the result of human economy on natural material flows and cycles (see Lettenmeier et al., 2009; SchmidtBleek, 2009).

Over the course of the last few decades, the technosphere's demand for resources has increased dramatically. At present the human economy consumes a level of resources as if we had two planets at our disposal. Nevertheless, 90% of the non-renewable materials we use are wasted in the process of creating products for the end-user. We simply do not handle natural resources in an efficient manner.

Mankind must recognise that all human use of materials is changing natural material flows and ecosystems.

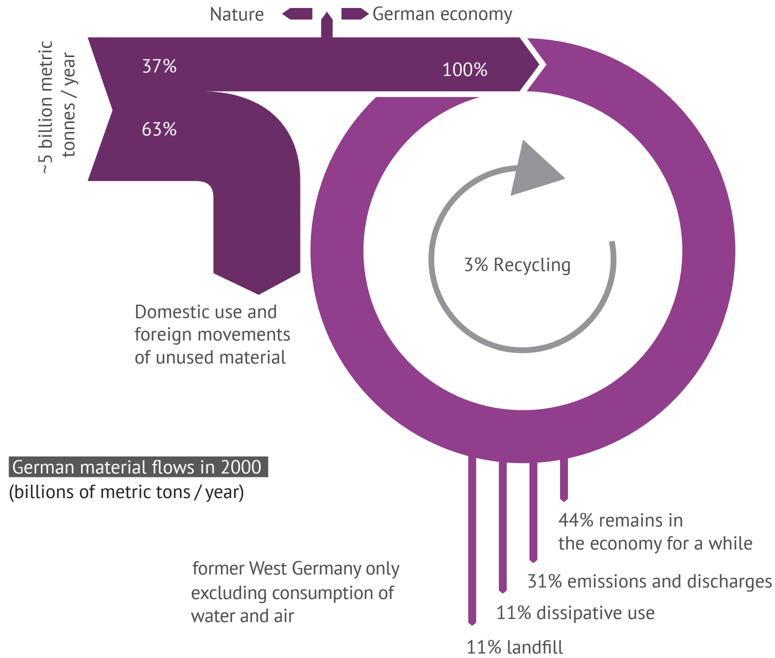

Figure 8: Schmidt-Bleek 2007, p.13 - redrawn by Wuppertal Institute

If we wish to guarantee the same quality of life for all of the Earth's inhabitants, we must dematerialise our economy (see Chap. 3: Environmental Space – Challenging Transitions). At present, 20% of the planet's people use 80% of all of its natural resources (Schmidt-Bleek, 2000). Global levels of natural resource consumption must be reduced by half, and consumption rights have to be evenly distributed among the world's rising population. This strategy will reduce occurrences of ecological disasters, resource-based social conflicts and civil wars, and increase the financial stability of our economies, companies, and households (Meyer, 2009).

The use of natural resources by industrialised western countries therefore needs to be reduced on average to approximately one-tenth of its present level (Schmidt-Bleek, 1994; Schmidt-Bleek, 2009). This is also known as the “Factor 10” goal (see Chap. 3: Environmental Space – Challenging Transitions). In order to implement Factor 10, it is important to benchmark the ecoefficiency, or resource productivity, of technologies, products, and services to determine resource efficiency potentials (see Rohn et al., 2009).

In creating this unit of measurement, Friedrich Schmidt-Bleek developed the concepts of the “ecological backpack” and MIPS (Material Input per Service Unit, see below), which visualise the invisible material burden posed by products or services in order to then compare their potential environmental impacts. As any input from nature into the technosphere eventually becomes an output impacting the environment, measuring input can provide an estimation of the potential for environmental impact.

INFORMATION

“If we want to guarantee everybody on this planet the same lifestyle we have to dematerialise our economy.” (Lettenmeier et al., 2009)

Ecological backpack or material footprint

The ecological backpack, also known as the material footprint, represents this invisible material burden. It is represented by the total input of natural resources (material input, MI) – minus the weight of the product itself – required by a given product “from the cradle to cradle/grave.” It is measured in mass unit such as kilograms or tonnes. The ecological backpack provides a summary of resource use in the production of goods (Schmidt-Bleek, 2009) and is an important measurement for comparing functionally equivalent goods from competing producers at the point of sale (Lettenmeier et al., 2009).

The ecological backpack describes a product’s invisible material burden. However, most products would provide no benefit if additional materials, energy, and/or water are not added to the equation. This additional input is what is needed to create a unit of service or benefit. MIPS can thus be seen as a means or measuring the “ecological backpack of a service”.

MIPS stands for “material input per unit of service” over the entire lifecycle of a product or service. It allows us to estimate a product’s inputoriented environmental impact potential (Schmidt-Bleek, 1994, 2008; Lettenmeier et al., 2009).

INFORMATION

MIPS = material input per service unit = MI/S

RECIPROCAL of MIPS = S/MI = resource productivity

MI is given in terms of tonnes, kilograms, or grams. In contrast, the service(s) is case specific and must be defined as the specific performance offered by a product, e.g. one kg of clean clothes or a 10km journey (Schmidt-Bleek, 2009). The service must be rigorously defined in each individual case. Focusing on a product’s benefits instead of the actual ownership of a product opens up a whole new dimension of development options. This shift corresponds to growing market trends of renting, sharing, and leasing goods instead of merely owning them. (Schmidt-Bleek, 2008; Lettenmeier et al., 2009)

INFORMATION

According to the ecological backpack and MIPS, all material consumption over a product's entire lifecycle (beginning with the point of the extraction in nature, over the course of manufacturing and use, and ending with its recycling or disposal) is calculated as natural resource consumption. The following categories of resources are counted separately:

» biotic (or renewable) raw materials
» abiotic (or non-renewable) raw materials
» earth movements in agriculture and forestry (including erosion)
» air (mainly the oxygen used in combustion processes)
» water

The MI factors are expressed in kg/kg (kg of resources per kg of the material used), kg/kwh (kg of resources per kilowatthour of energy consumed), or kg/tkm (kg of resources to transport one tonne over one kilometre). In this manner, the use of MIPS is at the same time practicable, comprehensible, and harmonised. (Schmidt-Bleek, 1994, 2008; Lettenmeier et al., 2009).

INFORMATION

Practical indicators for determining relevant potential of environmental impact must satisfy the following requirements:
They must be scientifically founded.
They must guarantee transparent and reproducible estimates of the potential environmental impact of processes, goods, and services from cradle to grave.
They must be easy to apply in practical use and be time and cost efficient.
They must give targeted answers.
They must be relevant to the economy and to profitability in terms of practise and concept.
They must be applicable on local, regional, and global levels.
MIPS and the ecological backpack are one option for an indicator meeting these requirements.
(Schmidt-Bleek, 1994, 2009)

Resource productivity
By turning around the MIPS formula (MI/S), one can derive the amount of benefit provided by a given cradletocradle quantity of material. S/MI thus becomes an expression for resource productivity.

This means we can compare the degree of service that can be created by "investing" a certain amount of natural resources. Resource productivity can be improved by technical decisions as well as by the consumer's personal decisions.

What makes MIPS unique?
MIPS can be applied at different levels, such as at the company level as well as industry-wide. By interlocking the processes at all of these levels, the optimisation of all material inputs contributes to an increase in resource productivity over the entire lifecycle or in terms of the overall economy (see for example Schmidt-Bleek, 2009; Schmidt-Bleek et al., 1998).

MIPS is a robust and reliable indicator for the comparison and estimation of functionally comparable products and services in terms of their material and energy requirements over their entire lifecycles (Lettenmeier et al., 2009).

A further strength of the MIPS concept is that it reflects the general sustainability strategies, efficiency, consistency, and sufficiency. Improvements in efficiency and consistency are directly shown in the material input, the MI-value from MIPS. It is important to keep in mind that in MIPS concepts, social as well as technical energy innovations have to be taken into consideration. A car motor could use only 3l/100km instead of 6l/100km and be twice as efficient. However, the same effect is possible when twice as many people use the same car (car sharing), for example.

Consistency, better known as the "cradle-to-cradle" principle (Schmidt-Bleek, 1994: 108), can be expanded by not only considering the quality of the material used, but also the quantity and/or the hidden material flows. The consistency principle emphasises the meaning of material quality (when a T-shirt is 100% compostable, for example), but it neglects hidden or unused resource extraction. Only 3% of all material flows are currently produced within a cycle, which is precisely where cradle-to-cradle can be applicable. When for example the seats in an airplane are produced in an eco-effective fashion, the question still remains as to the rest of the plane's degradability as well as the remaining necessary infrastructure, such as airports.

According to the MIPS concept, the principle of sufficiency is hidden behind the service unit and accounts for the opportunity to change the system in favour of reduced resource use. Do I need the service? Do I see an improvement in quality of life? The design task at hand is to make more using less. Understanding design as use management instead of products and service creation using as few materials as possible is the overriding principle.

Hot Spot Analysis – an instrument for determining the most important criteria

In order to establish an appropriate basis for making decisions, it is important to have the right tools and background information at hand. One quite interesting method available to designers is known as Hot Spot Analysis. As it was initially developed for companies to help them improve the sustainability indicators of their products and services, this method can support the interaction between company needs and the developmental work of designers or scientists in the R&D process (Liedtke et al., 2010).

Hot Spots are aspects in a specific phase of a lifecycle that assume a high degree of relevance within the entire chain. One can either use several different indicators or focus on a large number of aspects related to the target or strategy. In order to simplify the approach, we can focus on a manageable number of different indicators in the design process. The following aspects could be among those considered:

» environmental aspects: resource efficiency, water use/backpacks, land use, and energy efficiency/CO2 emissions

» social aspects: consumer satisfaction, health and safety, hazardous substances

» economic aspects: cost efficiency in production and consumption, cost of research and development.

Once identified, Hot Spots can be the leverage points that can allow designers to make a product more sustainable in terms of ecodesign. Additional aspects could be added to the evaluation if necessary (see Chap. 16: Hot Spot Analysis).

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Tischner, U. et al. (2000): Was ist EcoDesign?: Ein Handbuch für ökologische und ökonomische Gestaltung Frankfurt, Verlag form praxis.

Sustainable Products and Services:

Your Designguide TOOLS

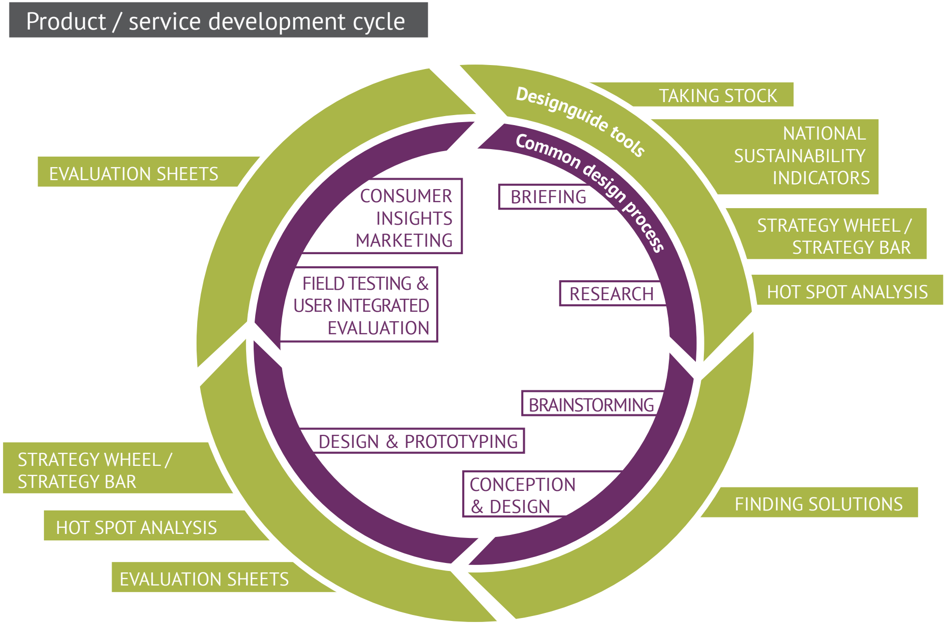
10. General Information

The practical part of the DesignGuide provides tools which allow for the integration of a sustainability rating into the design process. It is structured so that the tools can be used for many different design tasks.

For this purpose, different jobs have been defined which allow the user to define a design task. Once designers have found their job, they can integrate the tools into the design process in the order indicated. They are always to be seen as extras tools that compliment the normal design process.

The figure to the right shows how the design process takes place and where each tool (Taking Stock, National Sustainability Indicators, Strategy Wheel/Strategy Bar, Hot Spot Analysis, Evaluation Sheets) can be used. Depending on the job, different combinations of tools can be used in various orders alongside the normal design process.

Within this DesignGuide, the "Finding Solutions" step is included in the jobs but it is not aided with a method as it is a part of the normal design process. Here the designer can apply his or her own methods. In order to smoothly integrate the tools into the design process, the tool "Finding Solutions" is used as a transition between the two creative processes, thus allowing all solutions to be rated.



11. Tools - a Short Description and a Classification

Taking Stock
- » Which system is considered?
- » What should be included in the considerations and/or ratings?
- » What is the (product's) desired service?
- » Is it really needed?
- » If yes, what aspect of it is needed?

National Sustainability Indicators
- » What are the necessary goals for change in the systems under consideration?
- » Which social- and target-group-orientated sustainability strategies and/or goals have already been developed and are in use within society?
- » What role can my development play within the system?

Strategy Wheel/Strategy Bar
- » How can the evaluation of an established or developed product system or service most accurately be used to compare different approaches or to show a change or rework?

Hot Spot Analysis
- » How can I rate the contribution the product system or service?
- » How can I determine where it can be improved?

Finding Solutions
- » What is the core need?
- » Which service is desired?

Evaluation Sheets
- » How can I show or rate this process at the end?
- » Which criteria catalogue can I use to compare different approaches?

12. Jobs - Possibilities of application

New Design Concept

- Taking Stock
- National Sustainability Indicators (optional)
- Strategy Wheel/Bar
- Finding Solutions
- Evaluation Sheets
- Strategy Wheel

New Product/Service

- Taking Stock
- National Sustainability Indicators
- Strategy Wheel/Bar
- Hot Spot Analysis
- Finding Solutions
- Evaluation Sheets
- Strategy Wheel
- Hot Spot Analysis

Redesign

- Taking Stock
- National Sustainability Indicators
- Strategy Wheel/Bar
- Hot Spot Analysis
- Finding Solutions
- Evaluation Sheets
- Strategy Wheel
- Hot Spot Analysis

Comparison of two Existing Concepts

- National Sustainability Indicators (optional)
- Strategy Wheel (optional)
- Hot Spot Analysis (optional)
- Evaluation Sheets

Comparison or Evaluation of one Concept in Different Situations

- National Sustainability Indicators
- Strategy Wheel
- Hot Spot Analysis (optional)
- Evaluation Sheets
- Strategy Wheel
- Hot Spot Analysis

Evaluation of one Concept

- National Sustainability Indicators (optional)
- Strategy Wheel (optional)
- Evaluation Sheets
- Strategy Wheel (optional)

13.1 Taking Stock

Introduction

Before designing a product or service, it is important to first consider the following questions: What is the product or service? What makes it special? In which context will it be placed? Lucius Burckhardt's interpretation of Pattern Language (Alexander, 1977) in his book *Design ist Unsichtbar* (Design is invisible) is of particular interest when it comes to considering these points. He proposes a new classification of the world into different types of objects. Rather than the conventional distribution of the world of objects (house, kiosk, street, traffic light, bus, etc.), the integrated unit (such as the street corner as part of the urban system) should be used. The kiosk lives from the bus running late, which gives the passenger has time to buy a newspaper, for example (Burckhardt, 1995). Whereas until now the context of a design has been seen as a restriction, the context is now incorporated into the design process. The system limits can be questioned and moved.

It is also important to consider that a product or service not only has a functional dimension, but also an aesthetic dimension. This dimension, when examining the design process as a whole, flows into the individual, social, economic, political, and cultural aspects of production and reception (Wagner, 2008).

To design a product or service which stands up to such a wide design process concept, it is important for the designer to be able to break down the process into the most important elements. The works of Siegfried Maser, who "described the most elementary form of the design process" (Bürdek, 2005), are helpful here. The basis is formed by the change in real states. With help from the terminology of cybernetics it can be described as follows:

1. Current states (ontic) are (linguistically) descriptive, as precise as possible, and can be fully understood.

2. A target state should be determined using this knowledge, as well as at least a plan describing how the current state can be changed into the target state.

3. Effective change in reality due to the plan. (adapted from Maser, 1972)

When to use it

At the beginning of the design process in order to understand the central problem that has to be addressed. Only if you know what (target state) you wish to achieve and where you have come from (current state) can you really think about how to achieve it (service).

How to use it

Either alone or as a part of a group, try to break down your design task into its principal elements. Follow the four steps (described in detail below) and first describe the current situation. Then think about the target situation you want to achieve. In the third step you will present the differences in detail in order to then summarise your findings.

References

Alexander, C. et al. (1977): A Pattern Language. Towns, Buildings, Construction.

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Burckhardt, L. (1995): Design ist unsichtbar.

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Norman, D.A.; Verganti, R. (2012): Incremental and radical innovation: Design research versus technology and meaning change. In: Design Issues.

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Taking stock of your mission

Current State – Target State

Now that we know there are many different ways to view systems, it is now time to take the first steps towards describing the situation (the system and the most important aspects involved) to be changed. In order to capture all the relevant criteria later in the design process, every aspect needs to be described as precisely as possible. The objective is precisely and thoroughly described in a second step. The basis for the following design process is created with these descriptions of the situation. It helps to hang these "principles" that show where you are coming from and where you are going somewhere where you can see them. This way, you can see if you are on the right track and whether or not you following the set goals.

Change of Reality

In order to come up with answers for how to get from the beginning situation to the target situation, it helps to show connections between the two positions. A change can be triggered through targeted questioning: asking how, why and when, for example. Try to formulate different questions that arise from your described situations. The answers indicate the starting point for the development of a solution.

Summary

Finally, try to summarise these answers in a single sentence. This is the starting point for your service definition. It will allow uncommon approaches, and here you will need a clear idea of what you wish to achieve.

1 Mindmap

a. Current state

These days I talk a lot on my mobile phone, seeing as how my contract is not at all that bad. It's easier for me to write a text message, though, and I do that a lot as well. Since my contract allows me to have a new free phone every two years, I just take it. I know that it's not really free and that I'm somehow paying for it monthly. But to be honest, I'm just too lazy to change my cell phone provider. I already have a lot of phones lying around in a drawer at home. I'm afraid there might be sensitive data hidden away on them, so I don't want to throw them away – although I recently did get rid of the oldest one.

b. Target state

I want to be able to communicate on the road in a sustainable manner, concentrate on my ten most important contacts, and have the time to deepen the relationships.

c. Where does change take place?

All of the users have to make a change in their consumption behaviour and stop thinking "I will get a new one after two years, so who cares?" They should learn to appreciate their old products again.

When does change happen?

Change happens as soon as the consumer starts acting differently and as soon as the provider starts offering different solutions. The question is how to start the process.

Who is involved?

Every consumer as well as every provider and producer. Even politicians play a part thanks to their role in defining the rules for designing products.

Why do you have to invent something?

Modern lifestyles mean we are all "online 24/7" so that we can stay in touch with our surroundings. It's certainly a question of lifestyle, but it is also a social demand.

d. Summary

I want to have a sustainable means of communicating within a communication infrastructure according to my needs in both an analog as well as in a digital manner.

13.2 National Sustainability Indicators

Introduction

This worksheet is based on the introductory chapter which discussed the connections between dematerialisation, the "Factor 10" concept, its strategies, and associated indicators. Please refer to the introductory chapter for background information. The following paragraph will provide you with a detailed summary of sustainability strategies and indicators which may be of help during the design process.

According to the "Factor 10" concept, the strategies of well-developed countries such as Canada and Germany are more focused on ecological aspects, whereas less developed countries (in material terms) place their focus on social and economical development. The Indian and Tanzanian indicators focus in particular attaining a minimum standard of living for the majority of their citizens. When discussing national indicators in general terms, it does not make much sense to categorise certain national strategies into the typical poles of ecological and socio-economic clusters. For example, the German strategy attempts to divide its indicators into aspects of intergenerational justice or quality of life by employing well-developed ecological indicators. This lends the German strategy a generally ecological focus. The figures can help you decide which indicators to take into account during the design process.

When to use it

If you are confused by the concept of sustainability, this worksheet can provide you with insight and rough overview of the main indicators for sustainable development as well as the respective strategies. If you are not sure which sustainability attributes to include in your concept, you can use this worksheet to get your bearings, approach the concept of sustainability, and select indicators which can form the basis of your concept.

How to use it

You can orientate yourself towards the indicators of the country for which you will design your concept. Sustainability is an all-encompassing idea that may include indicators from other areas (ecological or socio-economic indicators, for example) which you might also consider.

References

Overviews

http://www.iisd.org/measure/gov/sd_strategies/national.asp

http://www.un.org/esa/dsd/dsd_aofw_ni/ni_index.shtml

http://www.oecdbetterlifeindex.org

http://www.ssfindex.com/

Direct links to sustainability indicators

Australia: http://www.environment.gov.au/about/international/wssd/publications/assessment/overview.htmwl

Brazil: http://www.iisd.org/ measure/capacity/sdsip.asp

Canada: http://www.ec.gc.ca/dd-sd/default.asp?lang=en&n=917F8B09-1

China: http://en.ndrc.gov.cn/newsrelease/t20070205_115702.htm

Finland: http://www.ymparisto.fi/default.asp?node=15131&lan=en

France: http://www.developpement-durable.gouv.fr/IMG/pdf/RevueCGDD_idd_1_.pdf

Germany: http://www.nachhaltigkeit.info/artikel/statistisches_bundesamt_nachhaltige_entwicklung_i_1439.htm

India: http://www.iisd.org/pdf/2004/measure_sdsip_india.pdf

Japan: http://www.environment-health.asia/userfiles/file/Basic%20Environment%20Plan_Japan.pdf

New Zealand: http://www.mfe.govt.nz/issues/sustainability/programme.html

Tanzania: http://www.helio-international.org/uploads/Tanzania-EN.pdf

USA: http://www.whitehouse.gov/the-press-office/2010/09/22/fact-sheet-us-global-development-policy

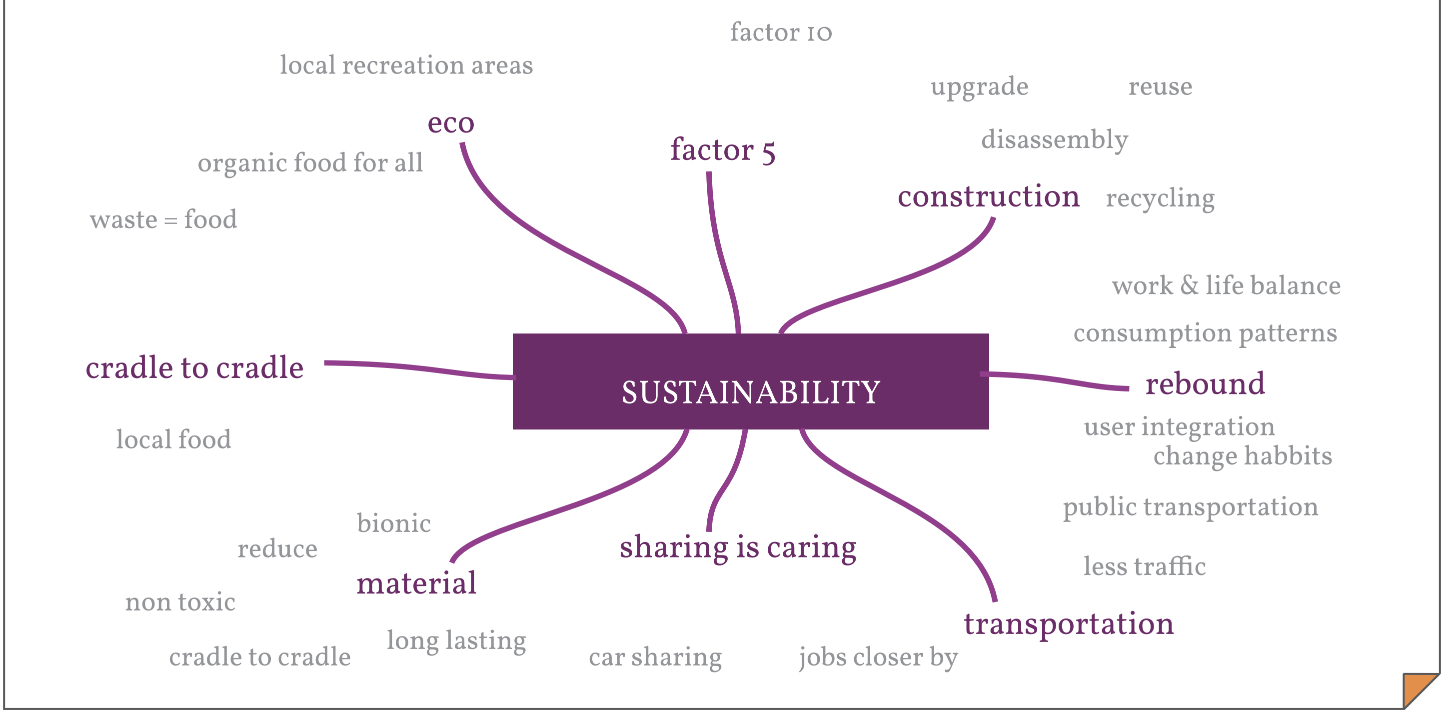
Example

Defining your Sustainability Indicators

Sustainability Indicators - Mindmap

What does sustainability mean to you? Which aspects of sustainability do you find important? Record your thoughts using a mind map and cluster your ideas. If you are not comfortable with listing your own ideas or you cannot think of any further sustainability aspects, you can jump to the next steps that will guide you towards a set of indicators you can use.

2a Mindmap



2b Research, 2c Analysis

GERMANY SUSTAINABILITY INDICATOR

quality of life

strengthen civil society

climate and energy

social cohesion

international responsibility

renewables

food for the world

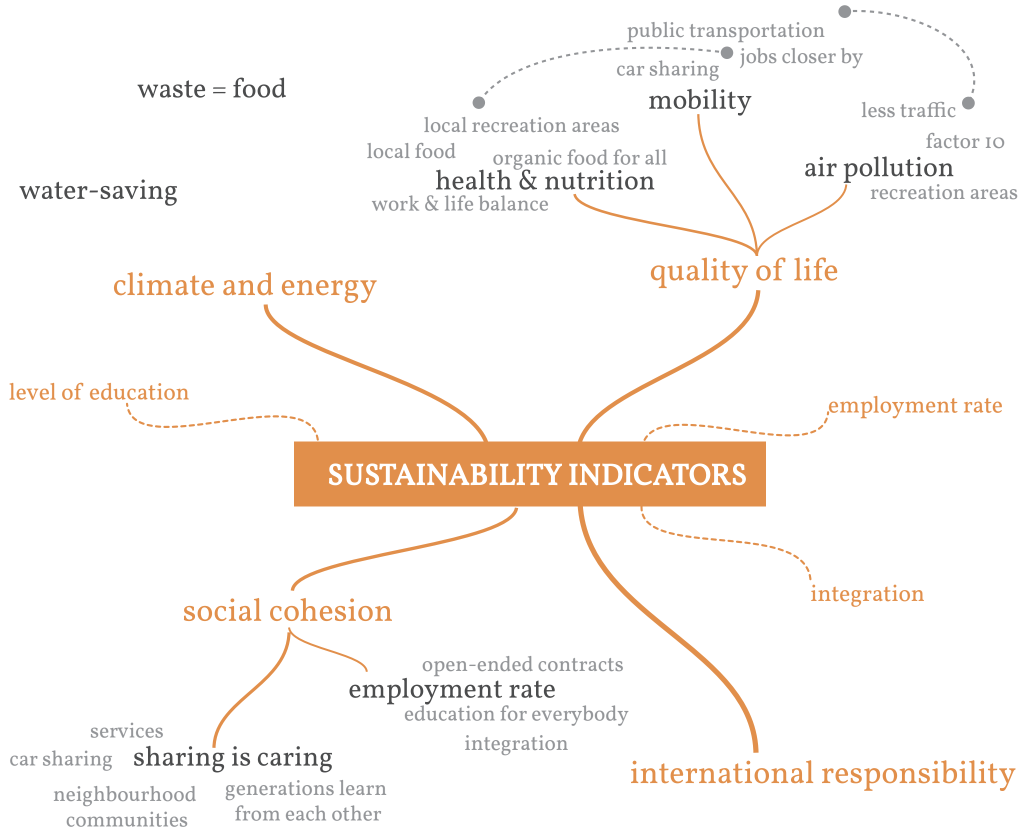
intergenerational equity

National Sustainability Indicators - Research
Taking into account the notion of equitable distribution of environmental space, it is important to consider the specific national environmental requirements. Where do you plan to implement your concept? Is it an industrialised or developing nation? Is it in need of economic or ecological progress? Look at the overviews in the graphics and research the specific sustainability indicators used in the country where you plan to implement your concept. A good starting point for research are the UN, DSD, and IISD websites (see links on page 1).

National Sustainability Indicators - Analysis
Write down the indicators that are important for this country. It may be helpful to carry out the steps using some form of mind map. Analyse these indicators. Describe the main aspects of each indicator. What is used to measure the indicator? What is the ultimate goal of your country? Is it striving for economic progress or ecological health? Which steps need to be taken to reach the goal described by the indicators?

National Indicators - Selection
Using the analysis, select and define several indicators that are relevant for the design of your concept. List the indicators that are most important to you. Think about, define, and record your goal/goals in the implementation of your concept. Most importantly, does your concept provide a service that fosters individual and social quality of life for present and future generations without moving beyond the envisaged environmental space (refer to introduction for explanation)?

Sustainability Indicators - National Indicators
Once you have completed the first step, compare your results from step 1 with the analysis from steps 2 and 3. In which respects do they overlap? Are there any indicators from step 2 and 3 which you would now include in your personal set of indicators from step 1?


public transportation
jobs closer by
car sharing
mobility
waste = food
less traffic
local recreation areas
local food
organic food for all
factor 10
health & nutrition
air pollution
water-saving
work & life balance
recreation areas
climate and energy
quality of life
level of education
employment rate
SUSTAINABILITY INDICATORS
integration
social cohesion
open-ended contracts
employment rate
education for everybody
services
integration
car sharing
sharing is caring
international responsibility
neighbourhood communities
generations learn from each other

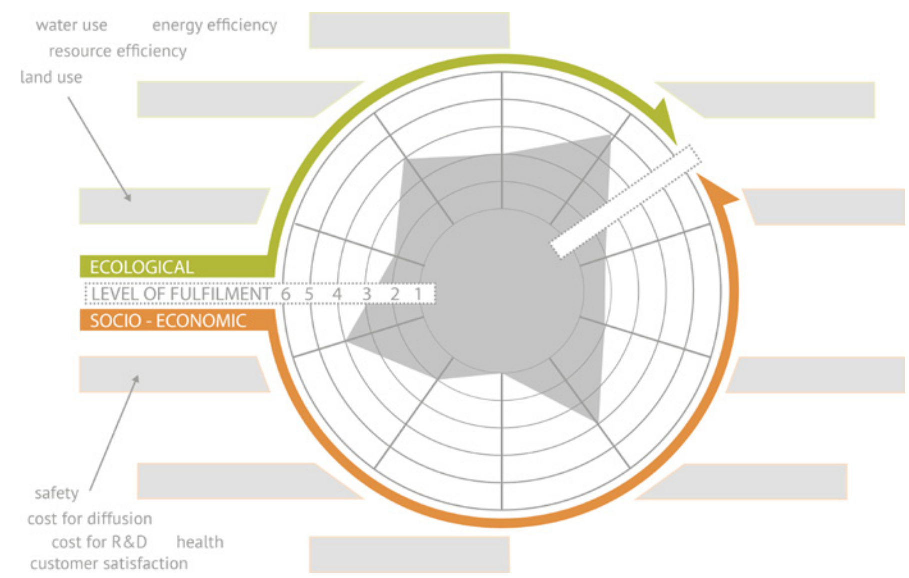
13.3 Strategy Wheel/ Strategy Bar

Introduction

The EcoDesign Strategy Wheel (also known as Lifecycle Design Strategies – LiDS) and the Strategy Bar show whether the goals (described by the chosen indicator set) are addressed during the design process which is intended to focus on these indicators. They show both the improvements and downturns respective to the specific indicator set chosen by the designer (Brezet; van Hemel, 1997). It is also used to describe and communicate design decisions. It is a goal-oriented tool used to steer the development process of products and services. It can be considered as a tool ready for use at every stage of the design process. It shows the designer and other stakeholders which effects can or cannot be achieved. The strategies shown here are mainly used during the product lifecycle. Nevertheless, you can also use the tool for more focused areas (such as the consumption phase, for example) or divide the whole lifecycle into separate steps and examine each individually.

The goal of this Strategy Wheel/Strategy Bar is to create an indicator set or criteria catalogue with which the different socio-economic and ecological conditions in the target area can be rated, taking into account the preset goals and the inferred indicators for the project. This is a common process in companies, which also makes it a good tool to present to stakeholders. It helps when the "National Sustainability Indicators" tool has already been used, as this will allow the important indicators to be

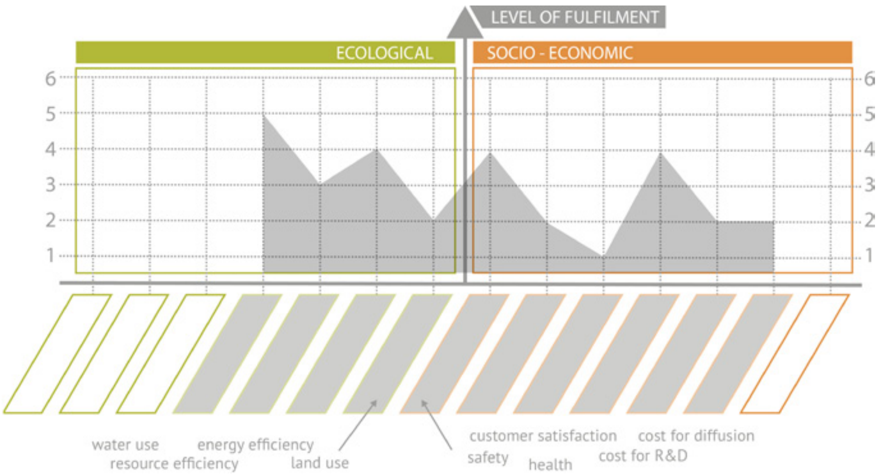
3a Example Strategy Wheel



sorted into a set. This makes it possible to measure and visualise how well the project is tailored to the context and requirements, thus creating the highest acceptance rate possible.

In order to be able to compare the starting situation and the finished project, the starting situation and goal are rated using the same indicator set and/or criteria catalogue.

3b Example Strategy Bar



When to use it

After you have worked with the indicators at the beginning of a project. This tool helps to structure the subsequent work process. If you are not yet sure what the requirements for your project are, this tool helps to create a context and define the framework around which the project will be developed.

How to use it

By creating an indicator set against which the project can be measured, you can create a guideline which can then be used to see if the concept matches the sustainability needs of the target environment throughout the development process. The indicator set is used to evaluate the concept on an ongoing basis and to maintain focus on the goals. In this manner, decisions can be made or revised.

Two presentation methods are shown here: the Strategy Wheel and the Strategy Bar. Use the tool that you find more appropriate and with which you can better show your indicators.

References

Brezet, H. and van Hemel, C. (1997): EcoDesign: A Promising Approach to Sustainable Production and Consumption. France: UNEP.

13.4 Hot Spot Analysis

Identifying Points for Improvement:
This section will show you how to identify Hot Spots within an existing product chain or service system. A "Hot Spot" is an environmental, economic, or social aspect in a specific lifecycle phase that assumes high relevance in the context of the entire chain. The steps below will guide you to a better understanding of where products and services can be improved.

Before following the practical steps, it is important to understand what the environmental, social, or economic aspects identified by Hot Spots entail:

Environmental Aspects/ Ecological Backpacks

Resource Efficiency
All the raw materials (abiotic and biotic) used during the different phases of the whole lifecycle (resource extraction, production, use, disposal/recycling)

Example
The ecological backpack denotes the invisible material burden (the "subsidy by nature"), or the total input of natural resources required by any product "from cradle to cradle/grave". In a sense, the ecological backpack parallels the monetary price of products in physical terms. It is an important measure for comparing functionally equivalent goods from competitors at the point of sale (e.g. tools or cars).
(http://www.wupperinst.org/uploads/tx_wibeitrag/ ws41.pdf)

Water Use
The amount of water used, including water used for the related phase and the entire life cycle.

Example
While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold. Yet more than one in six people lack access to safe drinking water.
(http://www.worldwatercouncil.org)

Land Use
The area of land used. This aspect also includes the biodiversity loss and soil degradation that can lead to desertification.

Example
Land degradation costs an estimated US $40 billion annually worldwide, without taking into account the hidden costs of increased fertiliser use, loss of biodiversity and loss of unique landscapes. (http://www.fao.org/nr/land/degradation/en/) Every day, biodiversity is lost at up to 1,000 times the natural rate. The abundance of species has declined by 40% between 1970 and 2000. Species living in and around rivers, lakes, and marshlands have declined by 50%. Since 2000, 6 million hectares of primary forest have been lost each year.
(http://www.iucnredlist.org)

Energy Efficiency / CO2 Emissions
The energy used along the life cycle of the product and green house gas emissions during the whole process.

Example
Warming of the climate system in unequivocal and can now be firmly attributed to human activity. The century-long linear warming trend (1906–2005) was 0.740°C with most of the warming occurring in the past 50 years. The warming for the next 20 years is projected to be about 0.20°C per decade.
(http://unfccc.int)

Continued increases in greenhouse gas emissions and associated global warming could well cause a rise in the sea level of between 1m and 3m this century. Hundreds of millions of people are likely to be displaced by a rise in sea levels.

(http://www.wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2007/02/09/000016406_20070209161430/Rendered/PDF/wps4136.pdf)

Social Aspects

Consumer Satisfaction

Degree of satisfaction felt by users and consumers (estimation, survey, user-integrated evaluation)

Health

Health standards of a given product, product safety, information and transparency regarding health issues (allergens, nutritional values)

Example

In 2004 the FDA and EDA issued a warning about mercury levels in fish. This heavy metal causes neurological and heart problems. It accumulates in the food chain and is often found in older and larger fish.

(http://www.eufic.org/)

Safety

Warnings if some type of use is restricted or hazardous, declaration of control mechanisms for health and safety.

Example

In California, some rubber ducks are sold with the disclaimer: "This product contains chemicals known by the State of California to cause cancer or birth defects", to warn consumers of the risks associated with its use.

(http://www.ted.com/talks/lang/eng/william_mcdonough_on_cradle_to_cradle_design.html)

Economic Aspects

Cost Efficiency

The cost for the user and the producer should be economically optimal and offer the best possible price-quality ratio.

Cost of Research and Development

The price paid for the R&D process must be reasonable and suitable. Consider the necessary steps for the manufacturer's development and marketing processes.

Cost of Diffusion

This aspect considers the necessary steps for the implementation of the product or service in the market.

When to use it

A simplified Hot Spot Analysis will help you identify the aspects of the product or service that most need improving. A full Hot Spot Analysis involves extensive fact finding, calculations, and is more complex overall. It is often used by different companies (e.g. Liedtke et al., 2010; ProPlanet). For the design process, it is enough to use a simplified version to obtain an idea of the crucial aspects.

How to use it

The complete Hot Spot Analysis procedure is comprised of three different steps: two different ratings, a multiplication, and a summary.

1. Look at the lifecycle phases and gauge these against one another.
2. Rate in the first instance the lifecycle phases referring to the different aspects of sustainability (as mentioned above). In the second instance multiply the latter rating with the rating above.
3. Note the highest scores – known as Hot Spots – showing the lifecycle phase and the Sustainability Aspect.

The grading scale

1 stands for low relative significance,
2 for medium relative significance and
3 for high relative significance.
If you cannot rely on sources, the ratings should be estimated as accurately as possible.

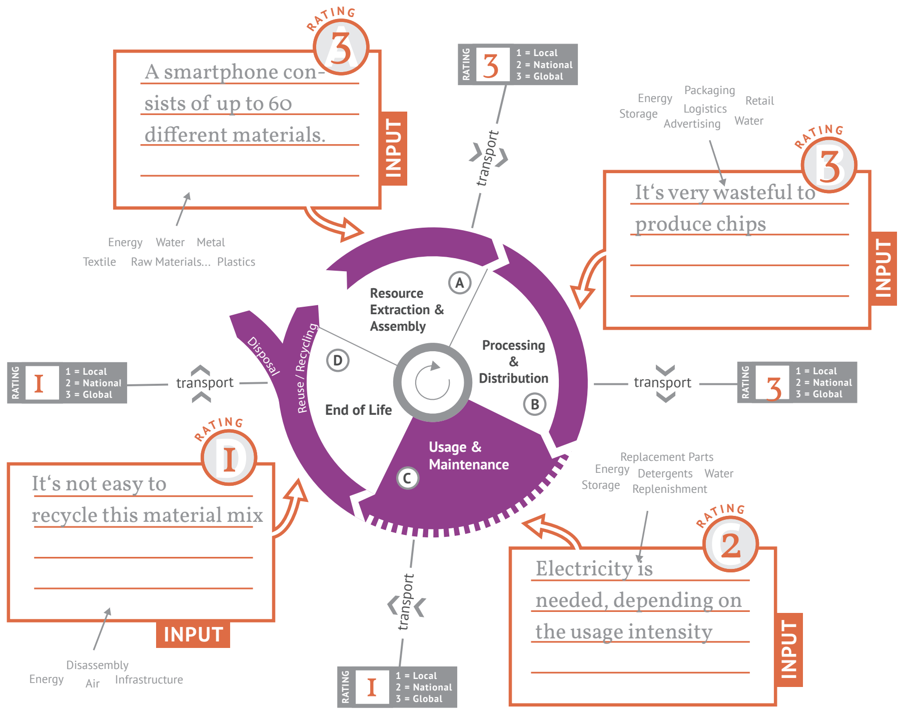
Rating a Material Product. Getting Started

Rating the Phases - Product

First, you have to grade each lifecycle phase to reflect the contribution to the overall environmental impact of the product lifecycle. Compare the phases with one another (if possible, get some information from the producer or scientists.). This way, you are taking the whole lifecycle into account in order to get an impression of where the highest impacts are. Think of the whole supply chain of the product. This will illustrate the vast and complex impacts of producing a product. By taking into account when the resource input is used, you will get an impression of each phase's emphasis. Do not forget the "invisible things" such as transport within the whole lifecycle. Rate it separately and take it into account once you make the final evaluation.

If possible discuss it with experts or do your own research. Estimate the grade for each phase and rate them. Note your grades and write down your arguments for your rating.

4a Example Rating a Material Product



Rating a Service. Getting Started

Rating the Phases - Service

If you want to analyse a service you first have to define its boundaries. Only then you can start thinking about all the real material products that have to be considered when analysing an immaterial service.

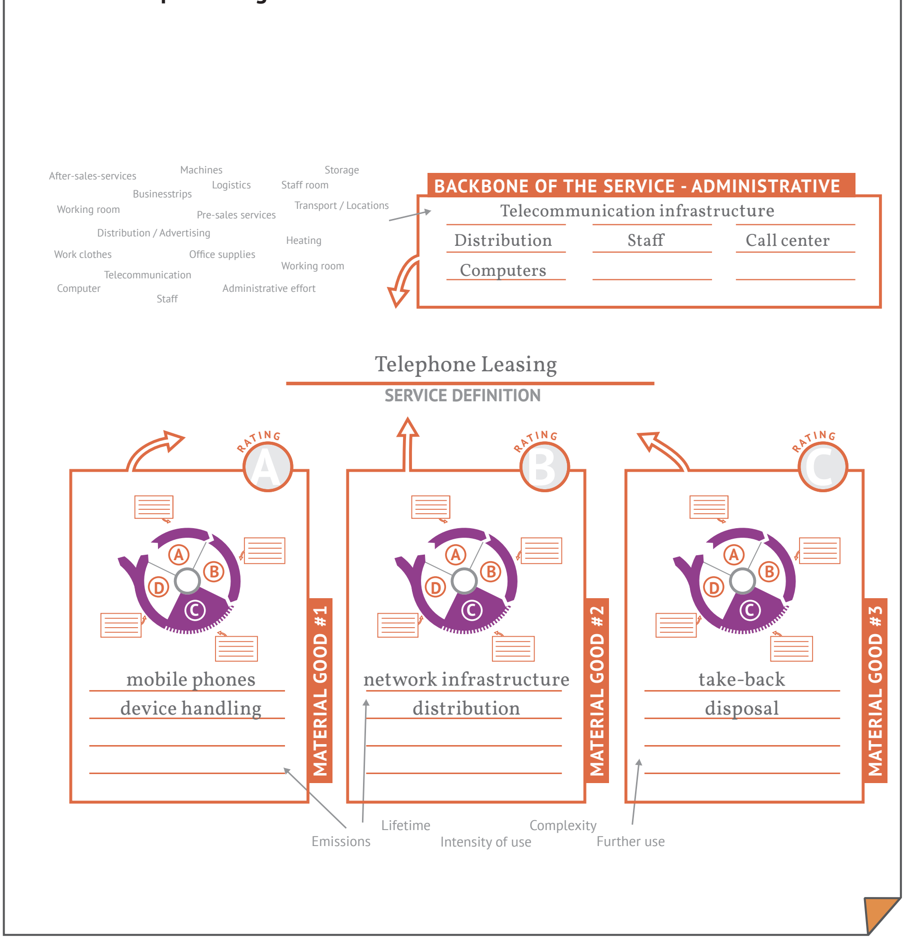
Once you have carved out the systems setting you have to take all elements into consideration and start the rating on several levels.

At the product level you must grade each lifecycle phase, reflecting their different contributions to the overall environmental impact of the product chain. Compare the phases with one another (If possible, get some information from the producer or scientists.). In this manner you are taking the whole lifecycle into account in order to get an impression of where the highest impacts are.

Think about the whole supply chain of the service. This will illustrate the vast and complex impacts of producing a service. Asking questions about the origin and delivery of the material inputs for the service will prepare you for improving the sustainability of the design. By taking into account when the resource input is used, you will get an impression of each phase's emphasis.

If possible discuss it with experts or do your own research. Estimate the grade for each phase and rate them. Note your grades and write down your arguments for your rating.

4b Example Rating a Service



Getting the Hot Spots

This worksheet will help you to identify the Hot Spots, the lifecycle phases with the highest impact in the respective columns pertaining to aspects of sustainability.

Enter the rating you gave for every life-cycle phase in the first step, and then assign a level of importance for every aspect (environmental, social, economic).

The grading scale: 1 stands for low relative significance, 2 for medium relative significance, and 3 for high relative significance. If you cannot rely on sources, the ratings should be estimated as accurately as possible. Multiply these two ratings to obtain the overall rating of each aspect. The ones with the highest score are the Hot Spots of the existing product or service.

The higher the rating, the higher the priority of this phase. A high priority means that this phase needs to be examined and addressed. For example, a high rating for land use means that land use is of a high priority and therefore a Hot Spot. A high rating for the consumer translates to a low level of satisfaction among consumers, another Hot Spot.

4c Example Getting the Hot Spots

Rating: 1= low significance, 2= medium significance, 3= high significance

Life cycle phase / Sustainability Aspects		Resource Extraction & Assembly (Rating 3)	Processing & Distribution (Rating 3)	Usage & Maintenance (Rating 2)	End of Life (Rating 1)
Environmental Aspects	Resource Efficiency	A x 3 = 9	B x 3 = 9	C x 3 = 6	D x 2 = 2
	Water Use	A x 3 = 9	B x 3 = 9	C x 1 = 2	D x 1 = 1
	Land Use	A x 2 = 6	B x 3 = 9	C x – = –	D x 2 = 2
Socio-Economic Aspects	Regionality	A x – = –	B x – = –	C x 2 = 4	D x 1 = 1
	Durability	A x 3 = 9	B x 2 = 6	C x 1 = 2	D x 2 2
	Repairability	A x 3 = 9	B x 2 = 6	C x 1 = 2	D x 2 = 2
	Product Safety	A x 1 = 3	B x 1 = 3	C x 3 = 6	D x 3 = 3
	Health	A x 1 = 3	B x 2 = 6	C x 1 = 2	D x – = –
	Human Rights	A x 1 = 3	B x 1 = 3	C x 3 = 6	D x – = –

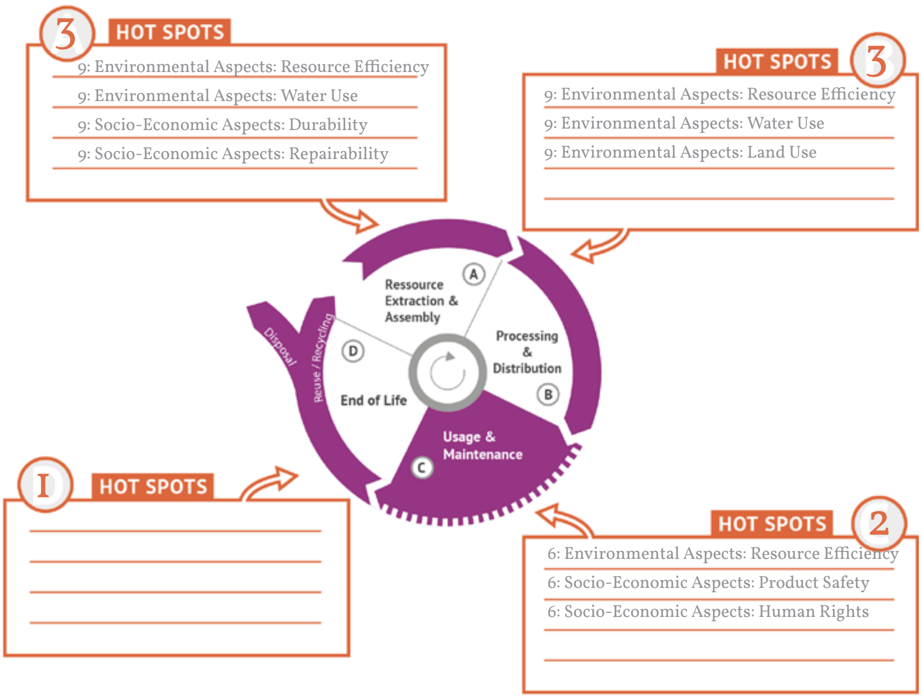
Summarizing the Hot Spots

Where are the relevant Hot Spots that need improving during your design process?

Map the result in the graphic to the right. Please discuss the results from Step 1 and Step 2 at the workshop: Which Hot Spots did you identify? Insert the results in the following graphic.

After you have identified the aspects in need of drastic improvement, the next step is to design a better product. During this process keep in mind that the optimisation of one aspect can negatively influence other product characteristics. Ask yourself the following: Can the demand be satisfied without products, without the existing number of products, or without additional products? Can a service concept fulfil the demand? Think of a service concept using as little material as possible throughout its entire lifecycle. If service concepts are not possible, search for new solutions such as products or infrastructures. The solution you design should be the least possible materially intensive option.

4d Example Summarizing the Hot Spots



References and Literature

Further Information about Hot Spot Analysis / Examples

Liedtke, C. et al. (2010): "Resource intensity in global food chains: the Hot Spot Analysis." In: British Food Journal.

Links

http://www.proplanet-label.com/de/pro-planet

Resource Efficiency

http://wupperinst.org/uploads/tx_wibeitrag/ws41.pdf

Water Use

http://www.worldwatercouncil.org

Land use

http://www.fao.org/mr/land/degredation/en/

http://unccd.int

http://www.isric.org/UK/About+ISRIC/Projects/Track+Record/Glasod.htm

http://www.globalchange.umich.edu/globalchange2/current/lectures/land_deg/land_deg.html

http://www.luckredlist.org

Energy efficiency /CO2 emissions

http://econ.worldbank.org; Dangupta et al. (2009): The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis. World Bank Policy Research Working Paper no. WPS4136

Health

Redman, N. (2007): Food Safety: A Reference Handbook. California.

http://www.utopia.de/produktcheck

European Food Information Council: http://www.eufic.org

Safety

http://www.ted.com/talks/lang/eng/william_mcdonough_on_cradle_to_cradle_design.html

US Consumer Product Safety Commission: http://www.cpsc.gov/

13.5 Finding Solutions

Searching for possible product-service solutions and selecting options by scrutinizing sustainability aspects.

Design new solutions for a product or service!

Techniques such as brainstorming, morphological analysis, or analogies may be helpful at this stage. Select the most promising of the solutions from a sustainability point of view (resource efficiency).

Fill out the table and describe your solutions and their advantages.

5 Example Finding Solutions Summary

Short description
(5–10 sentences or keywords)

SOLUTION A	SOLUTION B	SOLUTION C
Establishment of a smartphone-sharing service system. This system will allow anyone to lease a suitable smartphone with full support including maintenance and repair. A leasing concept ensures there will not be any leftover, old-fashioned phones. The used phones are designed to be very long-lasting, and their aesthetic is timeless.	Design of a smartphone without using harmful substances. Due to a technological breakthrough it is now possible to have a device that helps me to communicate without using either "bad energy" or "bad materials". It might be unbelievable from today's point of view, but it is worth a try, isn't it!?	Change in the social structures resulting in less talking on the phone. A slow down of today's lifestyle and a change in everyday ways of life will help get by without a smartphone – and without missing anything.

13.6 Evaluation Sheets

General Information

Evaluating Solutions: These sheets can be used as many times as you see fit.

Assess your solution with the detailed environmental criteria below using the following scores:

(+3)	(+2)	(+1)	(-1)	(-2)	(-3)
completely met					not met at all

If a certain criteria is not relevant for any particular aspect of the solution, please mark the field with "n/a", meaning "not applicable". If there are a great many "n/a" fields for a certain product, this does not mean the solution is not worth realising. Please keep in mind that some solutions are visionary and cannot be scrutinised in as detailed a fashion as "mature solutions" over the shorter term.

Add up the total scores in each phase per solution by adding together the plusses and minuses (for example, +3 and -2 makes +1). Doing so you will get an estimate per solution for each phase, which then makes it possible to compare the solutions with each other. If your total score is positive, it means that you have found a better solution and your product or service is more eco-efficient. If the sum is negative, you can look back over the worksheet to find the reasons. Feel free to evaluate the existing solution and try to find out whether your solutions really are an improvement.

Estimate a sustainability score for the aspects based on your own estimates. This helps illustrate your level of knowledge and what you think of the product or service. This promotes awareness of what and how you already automatically evaluate and make unconscious decisions conscious. It also shows you what you have not yet thought about and do not yet know how to evaluate. Highlight these scores, note your questions, and organise other possible aspects that are important for the sustainability score. With these results you are ready to discuss questions and estimations with your teachers and relevant experts.

When on the job and working on projects with companies, evaluation results can help pinpoint where expert help is needed. You can then consult with these experts and use them as an option in calculating of your proposal.

6 Example Evaluation Sheets

ECOLOGICAL ASPECTS

PRODUCTION PHASE

	Solution A	Solution B	Solution C
Low material or energy input	+3	-2	+2
Low waste intensity	-1	+1	0
Low scrap rate	n/a	0	+2
Low material diversity	+2	+1	-1
Low transport intensity	+1	+3	0
Low packaging intensity	0	-2	-1
Minimised appropriation of land area	+2	-1	n/a
Minimised use of harmful substances	+1	+1	+2
TOTAL PHASE SCORE	**+8**	**+1**	**+4**
Not applicable			

USE OR CONSUMPTION PHASE

	Solution A	Solution B	Solution C
Low material or energy input	-2	-1	+2
Minimised size & weight/easy storage	+3	-2	-1
Low cleaning effort	+2	+1	+3
High functionality/variability	+1	0	-2
High opportunity for repeated use	0	+1	-1
High opportunity for joint use	n/a	+2	-1
Low waste intensity	+2	0	+2
Minimised use of harmful substances	-1	+3	+3
Non-fashion-oriented design	+3	+2	-1
High value estimation	+2	-2	0
Low maintenance effort	0	-1	-1
Easy repairability	-2	-3	+1
High reliability	0	+2	+1
Modular construction & high degree of standardisation	+2	+1	+3
Upgradability	+3	-1	-2
TOTAL PHASE SCORE	**+13**	**+2**	**+6**
Not applicable			

RECYCLINGPHASE

	Solution A	Solution B	Solution C
Easy disassembly or seperability, possibility of collecting & sorting	+1	+3	-2
Low cleaning effort	+2	-1	+3
Clear material labeling	0	+1	+1
High possibility of disposal	+2	-1	-3
Continued use, re-use	+2	n/a	+2
Recycling of component parts, secondary utilisation of materials	-1	0	+1
Low material or energy input	0	+3	+2
TOTAL PHASE SCORE	**+6**	**+5**	**+4**
Not applicable			

DISPOSAL PHASE

	Solution A	Solution B	Solution C
High compostability or fermentability	+3	+3	+1
Positive combustion characteristics	-1	+2	-3
Low environmental consequences of land filling	-2	+1	n/a
TOTAL PHASE SCORE	**0**	**+6**	**-2**
Not applicable			

FINAL TOTAL SCORE

	Solution A	Solution B	Solution C
Production Phase	+8	+1	+4
Use or Consumption Phase	+13	+2	+6
Recycling Phase	+6	+5	+4
Disposal Phase	0	+6	-2
TOTAL SCORE	**+27**	**+14**	**+12**

Decision making

Having scrutinised the possible solutions in terms of their detailed environmental, social, and economic aspects, it is now time to choose which solution to pursue further.

This table will assist you in your decision making. Fill in the main benefits of each to gain an overview. Here it is necessary to check back to the detailed tables for the strengths of each solution. Under additional benefit(s), brainstorm other advantages of the solution you think are important. Indicate your preference in the last row: this is the product-service solution to design!

7 Decision making

	SOLUTION A	SOLUTION B	SOLUTION C
Short description	Developing a smart-phone-sharing system.	Designing a smart-phone without using harmful substances.	Slowing down of now-adays lifestyles in order to not using the smartphone.
Main benefit(s)	reduction of material consumption smartphones used more frequently fostening social inter-action	fewer health risk for wor-kers producing the pone and also for users reduced environmental impact	improve the quality of life through more conscious living reduction of nervous ten-sion and deseases caused by stress
Additional benefit(s)		facilication of recycling, reuse alternative materials can also be used for designing other electronic items	reduction of material consumption
Total score	+ 27	+ 14	+ 12
Not applicable Best possible solution (tick and briefly explain your choice)	Best solution because it´s a combination of reduced resource use and encoura-ging social interaction.		

14. Glossary

Abiotic materials are all materials taken directly and unprocessed from nature and are not renewable in hundreds of years, e.g. ores in a mine, “unused extraction of raw materials”, excavation of earth and sediment etc.

Air is accounted for in the MIPS concept, as long as it is changed chemically or physically (aggregate state). Most of the air consumption calculated in the MIPS concept is oxygen used in combustion processes.

Biotic materials are all organic materials taken directly from nature, before processing, (e.g. trees, fish, fruits, cotton).

Change agents are competent actors working as a kind of (internal or external) consultant i.e. in change or innovation processes in a company and can facilitate diffusion. They support and promote change processes by developing a bearing idea and suggestions for solution. They can successfully integrate other relevant actors and professionally design change processes, while adequately taking aspects of timing into account. To do so, they should be able to develop a vision, be enthusiastic to change things, communicative, confident of their own capability to act, and have considerable specialist knowledge and processes expertise (Kristof, 2010).

Cycles: A series of natural, but also technical substance flows can occur in cycles. A typical example is the natural water cycle.

Dematerialization is the radical reduction of natural material resources for satisfying human needs by technical means. Neither environmental nor economic sustainability can be attained without dematerialization.

Earth movement encompasses all movements of earth in agriculture and forestry, all ploughed land and erosion.

Eco-efficiency means the delivery of competitively priced goods and services which satisfy human needs and produce quality of life while progressively reducing ecological impacts and resource intensity, through the life cycle, to a level at least in line with the earth‘s estimated carrying capacity (Frank Bosshardt, Business Council for Sustainable Development, 1991).

Eco-innovation means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic substances. (Reid, Miedzinski, 2008).

Ecological backpack (Ecological rucksack) denotes the invisible material burden (the “subsidy by nature”), or the total input of natural resources required by any product “from the cradle to the point of sale”. In a sense, the eco-logical rucksack parallels the monetary price of products in physical terms. It is an important measure for comparing functionally equivalent goods from different competitors at the point of sale (e.g. tools or cars).

Ecosphere is the natural environment of human beings.

Efficiency: The effectiveness, with which means are introduced into an existing process in order to attain a defined output (see, in contrast: productivity).

Emissions are material contaminations of the air, noises, vibrations, light, heat, radiation, and similar energetic or material phenomena, which come from a facility, a vehicle or piece of equipment.

Factor 10 is the strategic economic goal of generating human well-being in industrialized countries with (on average) ten times less natural material resources by the middle of the 21st century than was the case at the turn of the century.

Factor 4 is the global goal of achieving a fourfold increase in global resource efficiency by the middle of the 21st century by halfing resource use and doubling welfare. This requires at least Factor 10 in the industrialized countries. Factor 4 can also be seen as an interim step on the way to Factor 10.

Factor X and **Factor Y** are variations on Factor 10, with the purpose of indicating the unavoidable uncertainty in individual cases regarding how far dematerialization can and must go.

Goods are machines, products, equipment, objects, means of transport, buildings, infrastructures (including works of art and musical instruments).

Greenhouse effect: Sunlight falls on the earth's surface, where it is transformed into warmth and partly reflected towards outer space. Some constituent parts of the earth‘s atmosphere, especially water vapor and carbon dioxide, are involved in the process of capturing part of this warmth. If this natural greenhouse effect did not exist, the earth‘s average temperature would not be fifteen degrees Centigrade, but as cold as minus eighteen or nineteen degrees Centigrade. Mankind is currently changing the relative amounts of important greenhouse gases in the atmosphere. As a result, the man-made greenhouse effect is added to the natural greenhouse effect, changing the earth‘s climate.

Industrial products are machine-processed foods, medicines, infrastructures, machines, equipment, tools, instruments, vehicles, and buildings produced with technical means in the technosphere.

Input includes everything that is employed in a process. In the MIPS concept, the inputs are materials (including energy), measured in kg or tonnes.

Intermediary products are products that are manufactured in the process chain, but that, for the moment, do not yet perform a service, or, are not yet of use, (e.g. a car battery, in regard of a car).

Life-cycle-wide: encompasses all life phases, i.e. from the extraction of raw materials, through the production and use, application, to the recycling and disposal of a product.

Material Input (MI) encompasses all material inputs, which are necessary for the manufacture of goods or for the provision of a service, expressed in mass units (kg or t).

Material Intensity (MIT) is the material input in relation to a unit of measurement. MI factors are used to express material intensity of production inputs (materials or energy), expressed in mass unit of resources per unit of input (e.g. kg/kg or kg/kWh).

MI factors are called the material intensity values for the single/individual materials or modules, expressed in mass unit of resources per unit of input (e.g. kg/kg or kg/kWh).

MIPS is the abbreviation for Material Input Per Service unit. It is the life-cycle-wide input of natural resources (MI) which is required to fulfill a human desire or need

(S) by technical means. The material input is expressed in mass units, the unit of the services depends on the case. MIPS = MI/S

Output encompasses everything that results from a process, a procedure or a behavior. Output need not be material, enjoyment and pleasure can also be outputs. Emissions and waste are also called undesired outputs.

Process is the procedure (machine, method, use), during which the inputs are converted into outputs, by means of an action. By which, at least one intended output is produced, (e.g. shaped metal sheet, a chemical or the transport of goods).

Process chain is the representation of the process system, with the individual processes and their links.

Production intensive are products, whose manufacture causes greater resource consumption than their use.

Production technologies are machinery, plants and tools etc., which are necessary for the execution of a process, but are not used in the process, itself.

Productivity: yield of production of goods or services. While efficiency describes the effectiveness of the use of the available means, productivity measures the result, in other words, the yield of products and services, regardless of which means were employed to obtain the result.

Rebound Effect: The rebound effect is the 'increased demand due to an improvement in productivity'. This increased demand is an unwanted side effect, which is contrary to the goal of saving energy.

Resource productivity is the amount of goods and services which can be produced per unit of input of resources (materials, water, surface area, energy). The reciprocal of MIPS (service per material input = S/MI) is a measure for resource productivity.

Service (technically provided service) is the purpose-oriented fulfillment of a need by technical means. All man-made services require the use of technical infrastructures, equipment, vehicles, and buildings. Services can be rendered by humans or by machines. From the end consumers' point of view, a provided service is the ability of goods to satisfy needs or provide utility.

Serviceable products are goods that were produced for use or consumption and that can provide utility by being used (for example, robots, sundials, automobiles, mousetraps, spoons, oil paintings). There are also non-serviceable goods, such as bars of gold or aluminum profiles.

Sustainability has several fundamental dimensions: economic, social, ecologic, and institutional. The ecological dimension determines the corridors for economic and social developments because the availability of natural resources is limited and the vital services of the ecosphere can be diminished or annihilated, but not replaced, by human activity. Sustainability is the capacity of the economic system to provide prosperity for all and, at the same time, to secure the natural, social, and economic foundations that this capacity depends on for the future. Achieving sustainability necessitates overcoming current challenges today and not shifting the burden to the shoulders of future generations.

Sustainable economic activity is service-oriented and knowledge-intensive. It can be approximated but not necessarily fully reached. It creates prosperity comparable to the level attained in industrialized countries at the beginning of the twenty-first century with extremely little use of natural resources (material, water, space). Dematerialization is a necessary, but not sufficient condition for approaching sustainability.

Technosphere: the part of the ecosphere, which is directly affected by mankind.

Total Material Flow (TMF): see Total Material Requirement (TMR).

Total Material Requirement (TMR) is the sum of the abiotic and biotic raw materials and of erosion used for a certain purpose. An an economy level, it is a robust economic indicator to measure the annual total amount of natural materials – including rucksacks – which are processed through an economic area by technical means. The term TMR is also used on the product level when the abiotic and biotic material input and the erosion are summed up to one value.

Transition (Transformation): These terms refer to the form and progression of a transition or a change; however, they are viewed and defined differently in different scientific disciplines (including genetics, mathematics, linguistics, technology). In this report, the WBGU uses these terms pri marily in the sense they are used in socio-scientific transition research focusing on the analysis of political system changes. As transition research is a branch of comparative politics studies, it usually refers to the transition from authoritarian regimes to democracies. The term transition is here often used synonymously with the term transformation, amongst others. The far reaching processes of social, economic, cultural and political change are always the research subject (WBGU, 2011).

References

German Advisory Council on Global Change (WBGU) (2011): World in Transition. A Social Contract for Sustainability. Flagship Report. Berlin.

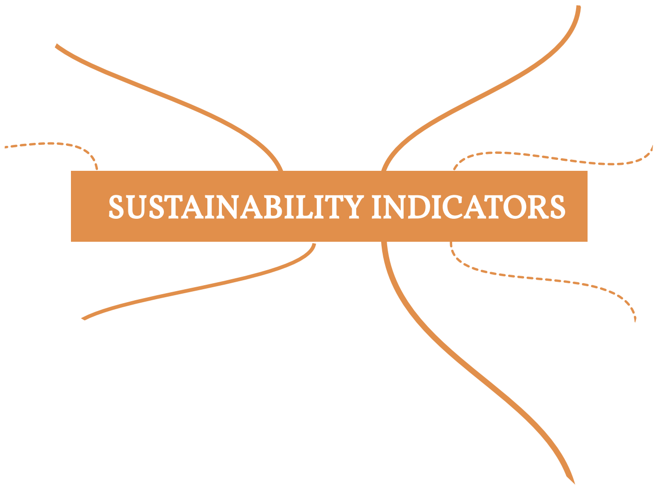
Kristof, K. (2010): Models of Change. Einführung und Verbreitung sozialer Innovationen und gesellschaftlicher Veränderungen in transdisziplinärer Perspektive. Vdf Hochschulverlag.

Lettenmeier, M., et al. (2009): Resource productivity in 7 steps. Wuppertal Institute, Wuppertal Spezial.

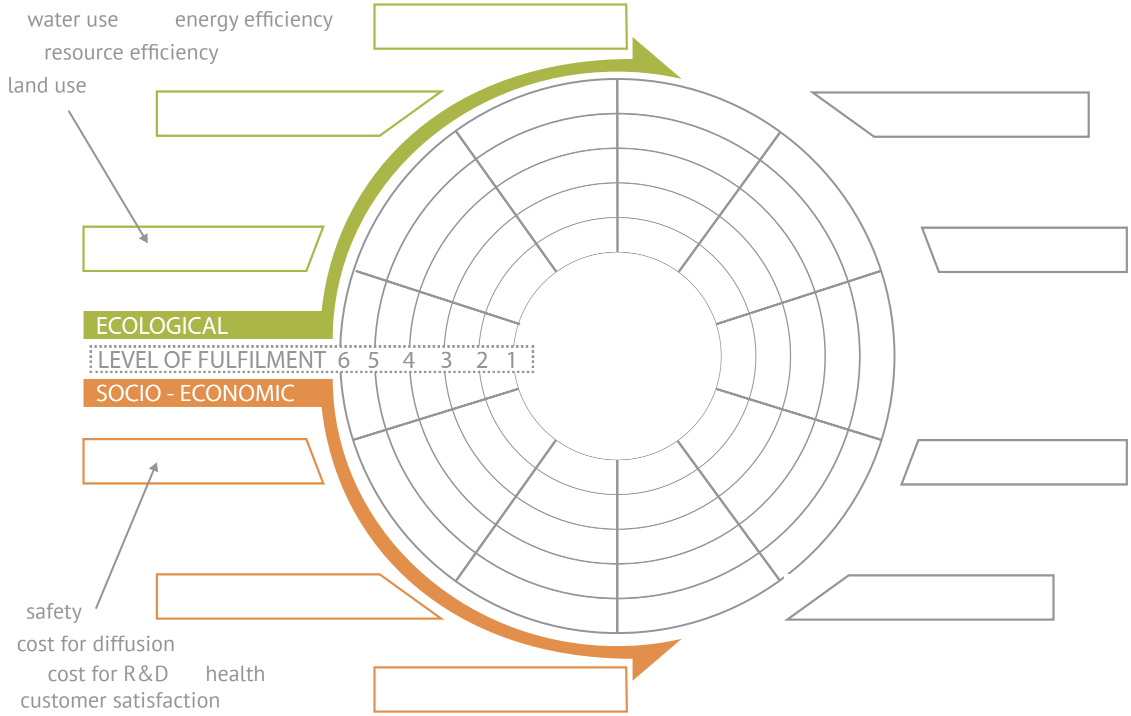
15. Master Copies

1 Mindmap

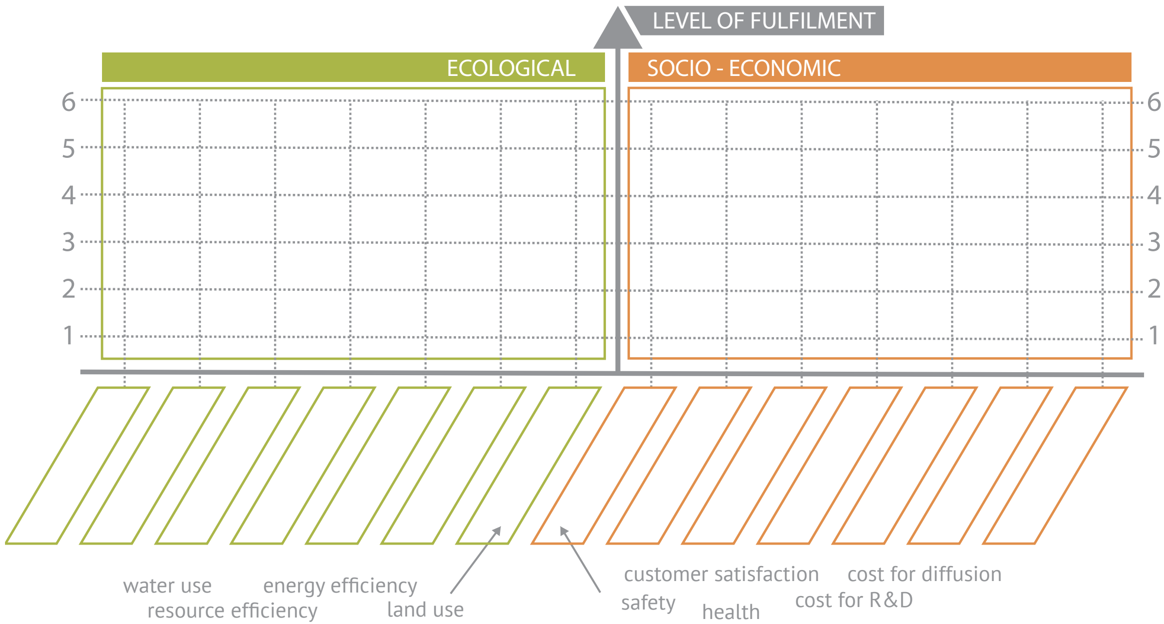
2a Mindmap


SUSTAINABILITY INDICATORS

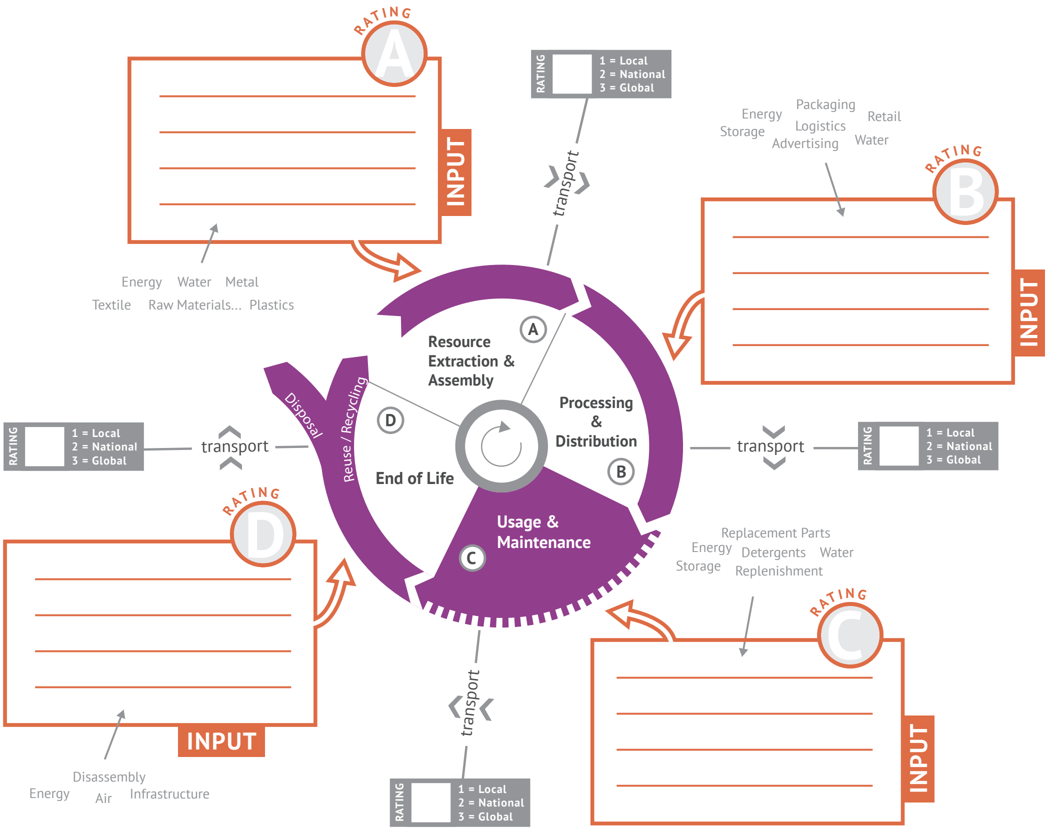
3a Example Strategy Wheel



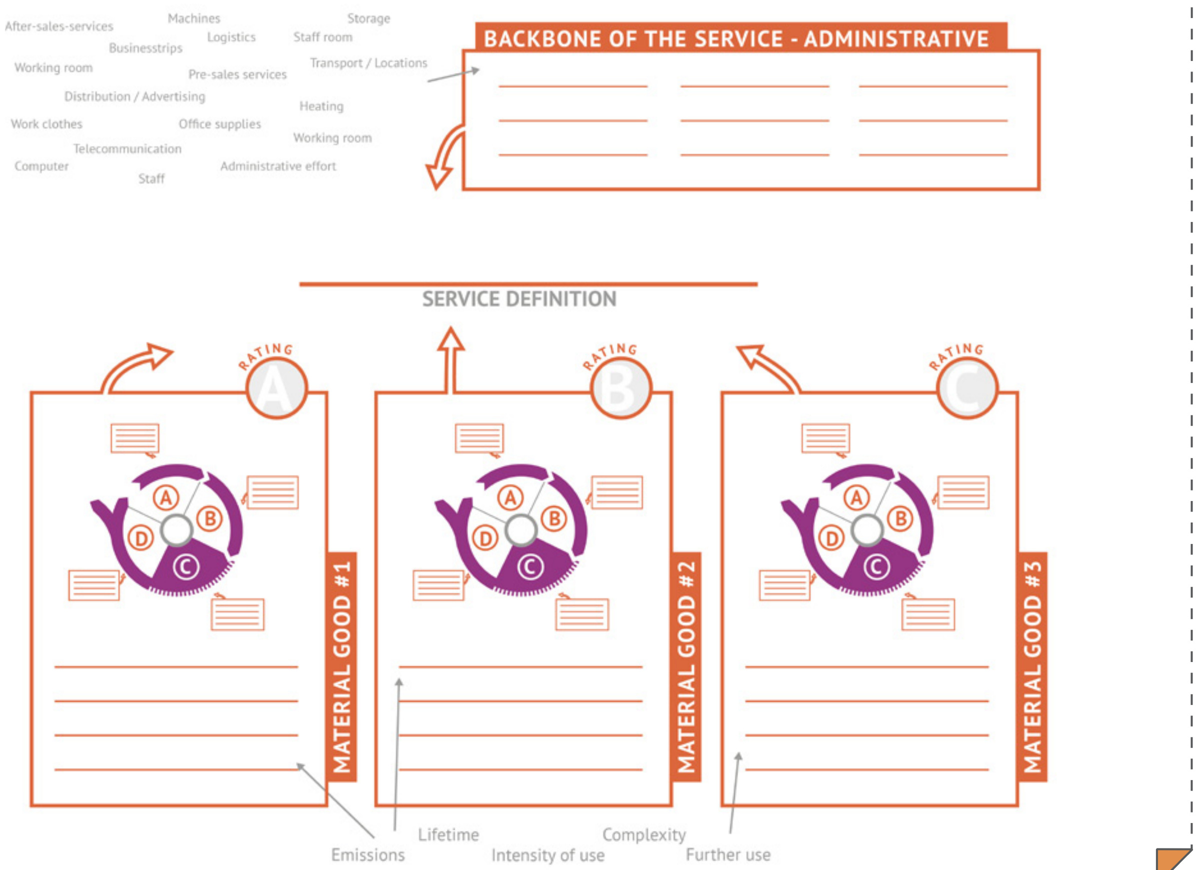
3b Example Strategy Bar



4a Example Rating a Material Product



4b Example Rating a Service

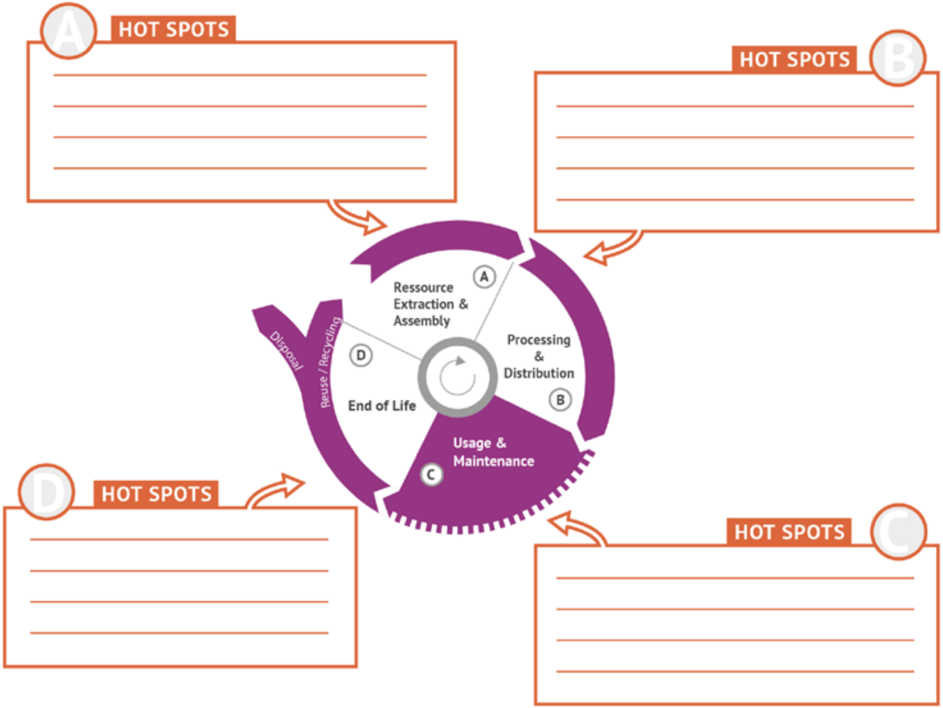


4c Example Getting the Hot Spots

Rating: 1= low significance, 2= medium significance, 3= high significance

Life cycle phase / Sustainability Aspects		Resource Extraction & Assembly (RATING A)	Processing & Distribution (RATING B)	Usage & Maintenance (RATING C)	End of Life (RATING D)
Environmental Aspects	Resource Efficiency	A x =	B x =	C x =	D x =
	Water Use	A x =	B x =	C x =	D x =
	Land Use	A x =	B x =	C x =	D x =
Socio-Economic Aspects	Regionality	A x =	B x =	C x =	D x =
	Durability	A x =	B x =	C x =	D x
	Repairability	A x =	B x =	C x =	D x =
	Product Safety	A x =	B x =	C x =	D x =
	Health	A x =	B x =	C x =	D x =
	Human Rights	A x =	B x =	C x =	D x =

4d Example Summarizing the Hot Spots



5 Example Finding Solutions Summary

Short description
(5-10 sentences or keywords)

SOLUTION A	SOLUTION B	SOLUTION C

6a Evaluation Sheet ecological aspects

ECOLOGICAL ASPECTS

PRODUCTION PHASE

	Solution A	Solution B	Solution C
Low material or energy input			
Low waste intensity			
Low scrap rate			
Low material diversity			
Low transport intensity			
Low packaging intensity			
Minimised appropriation of land area			
Minimised use of harmful substances			
TOTAL PHASE SCORE			
Not applicable			

USE OR CONSUMPTION PHASE

	Solution A	Solution B	Solution C
Low material or energy input			
Minimised size & weight/easy storage			
Low cleaning effort			
High functionality/variability			
High opportunity for repeated use			
High opportunity for joint use			
Low waste intensity			
Minimised use of harmful substances			
Non-fashion-oriented design			
High value estimation			
Low maintenance effort			
Easy repairability			
High reliability			
Modular construction & high degree of standardisation			
Upgradability			
TOTAL PHASE SCORE			
Not applicable			

RECYCLINGPHASE

	Solution A	Solution B	Solution C
Easy disassembly or seperability, possibility of collecting & sorting			
Low cleaning effort			
Clear material labeling			
High possibility of disposal			
Continued use, re-use			
Recycling of component parts, secondary utilisation of materials			
Low material or energy input			
TOTAL PHASE SCORE			
Not applicable			

DISPOSAL PHASE

	Solution A	Solution B	Solution C
High compostability or fermentability			
Positive combustion characteristics			
Low environmental consequences of land filling			
TOTAL PHASE SCORE			
Not applicable			

FINAL TOTAL SCORE

	Solution A	Solution B	Solution C
Production Phase			
Use or Consumption Phase			
Recycling Phase			
Disposal Phase			
TOTAL SCORE			

6b Evaluation Sheets: Socio-Economical Aspects

LEGEND

P/S — Product/Service

(person icon) — how the design criteria contributes to my well-being

PRODUCTION PHASE

I know that buying or using the P/S will not contribute to resource depletion – I'll make a friend for life.

I like to foster regional cycles, employment, and know the story behind the P/S.

Financial freedom gives me more time and flexibility.

Transparency of the P/S gives me a feeling of confidence and connectedness.

	Solution A	Solution B	Solution C
Low material or energy input			
Low waste intensity			
Low scrap rate			
Low material diversity			
Low transport intensity			
Low packaging intensity			
Minimised appropriation of land area			
Minimised use of harmful substances			
TOTAL PHASE SCORE			
Not applicable			

SOCIO-ECONOMIC ASPECTS

RECYCLING/DISPOSAL PHASE

I feel good about the P/S being easy to recycle without too much harm to the environment.

It makes me happy when I can reuse the P/S for other purposes instead of discarding it.

It is comforting to know that the P/S tells me how to recycle or discard it.

It is exciting to have a P/S that exists of parts that have their own interesting life histories.

	Solution A	Solution B	Solution C
Minimised use or emissions of harmful substances			
Continued use, reuse incl. transport intensity			
Easy dissasembly or separability			
Low cleaning effort			
Re-use of components			
Recycling of materials			
Low material or energy input			
Secondary utilisation of materials			
TOTAL PHASE SCORE			
Not applicable			

ALL PHASES

I feel good if I know that everyone involved in the supply chain of the P/S is treated properly.

The P/S supports employees being treated humanely who are able to work under conditions that allow them to live a satisfying life.

	Solution A	Solution B	Solution C
Working conditions such as: Health/Safety, Training / Learning, Belonging			
Human rights such as: Dignity/Self-Esteem, Self-Actualisation			
Social security such as: Safety, Inclusion			
TOTAL PHASE SCORE			
Not applicable			

The P/S guarantees my acceptance to a social group. It represents a positive status symbol for me and helps me to develop my own lifestyle..

The P/S causes a positive social rebound effect. It helps me to become a better person in terms of my consumer behaviour. It helps me to behave more sustainably and thus gives me a good feeling. .

The P/S makes me feel more secure as it is trustworthy and simple to use. Knowing that the P/S and its components are not harmful makes me feel secure

My stuff is no longer separated into pieces but instead fits smoothly together, and it's easily kept up to date. It's easily adaptable to my own lifestyle, and individualisation is easy to do. The timeless nature and high quality of the P/S is comforting.

The P/S makes me feel good and is valuable to me.

As the P/S is easy to maintain, I have more time for things that are really important to me.

USE OR CONSUMPTION PHASE including RETAILER

	Solution A	Solution B	Solution C
User Acceptance			
Training and education for positive sustainable effects			
Minimised use or emissions of harmful substances			
Product safety (prevention of wrong use, accidents etc, using security)			
Modularity			
Durability (material)			
Upgradability			
Non-fashion oriented design			
High value estimation			
Low maintenance effort			
Easy repairability			
TOTAL PHASE SCORE			
Not applicable			

FINAL TOTAL SCORE for different solutions

	Solution A	Solution B	Solution C
All Phases			
Production Phase			
Use or Consumption Phase including Retailer			
Recycling/Disposal Phase			
TOTAL SCORE			

7 Decision making

	SOLUTION A	SOLUTION B	SOLUTION C
Short description			
Main benefit(s)			
Additional benefit(s)			
Total score			
Not applicable Best possible solution (tick and briefly explain your choice)			

Notes