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Happiness and Sustainable Consumption

Psychological and physical rebound effects at work in a tool for sustainable design

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Abstract

Goal, Scope and Background. Life cycle assessment has emerged into a useful tool to assess and potentially reduce the environmental impacts per functional unit. This has contributed to increase eco-efficiency but not necessarily to decrease absolute pollution per capita. The number of functional units is increasing and new functions add to the impacts of consumption. Despite the attempts to use different levels of definitions for the functional unit and applying LCA in the field of lifestyle studies there has been little success to grasp the consumption side of sustainable production and consumption. This contribution aims to tackle the consumption side by at least two extensions: the function of products, services, and activities is assessed with a multi-attribute need function and the propensity to cause both psychological and physical rebound effects are considered in the design phase.

Methods. We develop a checklist approach with an evaluation and assessment table. The elements of the checklist are rooted in a number of independent fields of science: needs matrix, happiness enhancing factors, a number of limiting factors that can cause rebound effects, and streamlined LCA.

Results and Conclusion. For illustration purposes we comparatively evaluate gardening, having a dog, a weekend house, and starting yoga classes and show that the new analysis framework is able to make transparent and operable the inclusion of a number of additional factors that remained so far implicit or neglected. The additional factors considered can be grouped into factors that may cause rebound effects through psychological or physical mechanisms. The assessment table combines the degree of satisfying needs and enhancing happiness in a psychological rebound score. The physical rebound score considers six factors that may constrain consumption: Costs, time, space, other scarce resources, information, and skills. This allows predicting the potential for rebound effects that would increase total impacts from consumption. In addition, it gives also a handle on how to use the knowledge on rebound effects to not only reduce the impacts of the product or activity at hand but also reducing other consumption that in turn might have adverse impacts.

Recommendation and Perspective. Many assumptions in selecting and quantifying the additional factors and the final assessment procedure remain conceptual and therefore provisional. This contribution opens new avenues of investigations that need both further refinements of the theories and empirical evidence. Consumerism and materialism has undermined much of the success stories of improved eco-efficiency and LCA. We suggest using some of the very same psychological and physical mechanisms to foster sustainable consumption.

Keywords: Back-fire effects; induced effects; life cycle assessment (LCA); materialism; needs; quality of life; rebound assessment; subjective well-being

Introduction

Product and production related policies that aim to reduce environmental impacts often include strategies and tools, such as cleaner production, energy- and eco-efficiency, and integrated product policies. These policies helped to reduce energy consumption and environmental impacts of single production processes and over whole life cycles of products. However, total energy use, emission of greenhouse gases and other environmental impacts hardly decreased or even increased. Why do national and global trends not fully reflect achievements in technology improvements? Among other reasons like, e.g., population growth and economic development, a major factor is the increasing efficiency in using capital, labor and resources. This has improved productivity and reduced unit costs. The reduction in unit costs allows – assuming at least constant real disposable income – an increase in the number of consumption units. If the increase in consumption units is larger than the increase in energy- and eco-efficiency then we call this the 'efficiency trap'.

In welfare economics the increase in productivity and the following increase in consumption is intended and considered to increase national welfare. However, in energy and environmental economics, reduction of energy use and pollution are the goal and an increase in production units may compensate the eco-efficiency improvements. Therefore, these effects are often called 'back fire', 'take-back', 'offsetting behavior' or as we shall call them 'rebound effects'. In the field of energy economics the following effects are distinguished (Greening et al. 2000):

- *Direct Rebound Effect* (substitution effect, pure price effect): Greater efficiency may lead to a lower price of the service (or product or technology) which in turn may induce an increased use of this cheaper service.
- *Indirect Rebound Effect* (income effect, secondary effect): If prices of other commodities and income are constant, the reduction of costs for one commodity due to a particular efficiency increase implies that consumers have more money to spend on other goods.
- *General Equilibrium Effect* (economy-wide effects): The direct and indirect rebound effect lead to changed prices and consumption throughout the economy, which may increase or decrease production in distant sectors and changes the production functions.
- *Transformational Effect*: This includes changes in consumer preferences, alteration of social institutions, and the rearrangement of the organization of production.

In another context, TDM Encyclopaedia (2002) defines rebound effect as a law of demand: "A program or technology that reduces consumers' costs tends to increase consumption. Where costs include financial costs, time, risk or discomfort." This definition is derived from transport research and indicates that other factors are relevant next to costs alone. Rebound effects are obvious when new road capacity is built. Typically, 50–90% of such additional capacity is absorbed by induced traffic. Strategies likely to generate additional traffic are: compressed work week, flextime, park & ride, ridesharing, and telework (TDM Encyclopaedia 2002). Surprisingly, these are exactly some of the changes that have been suggested to reduce traffic.

Many LCA studies have looked into the question whether disposable one-way diapers or washable cotton diapers are preferable. The results of these studies depend not only on the commissioner but also how many times each of the diapers are changed per day, what type of washing and washing technology is used and which type of disposal (incineration or landfill) is applied. However, the options may also vary in terms of expenses and time use. The family that washes all diapers at home and dries them in the garden will use a considerable amount of time that cannot be used for other purposes, be it for environmentally benign activities like social interactions and playing with the baby, or for additional consumption like visiting the gym, reading newspapers, etc. The same argument can be made for the expenses related to the different diaper systems. Money that can be saved with one system may well be spent on, e.g., other baby equipment. Therefore, accounting for differences in used time and income may change the ranking of the alternatives.

Such a more comprehensive view on products and consumption makes obvious that product comparisons based on LCA alone are not sufficient to achieve absolute reduction of environmental impacts. Will it be sufficient to consider the mentioned rebound effects? Is it true that the availability of money, time, security and comfort alone stimulates and directs consumption? We suggest here that the fulfillment of needs and striving for happiness and quality of life are among the relevant drivers for consumption and behavior. Section 1 will elaborate on why we chose fulfillment of needs and enhancing happiness as indicators for psychological rebound effect. Section 2 will suggest which further indicators are useful in quantifying physical rebound effects. In Section 3 we introduce a new design and evaluation tool that takes a radically progressive approach by actually using the indicators for the identified rebound effects to design products, services and activities that maximize happiness and the fulfillment of needs and is designed to reduce consumption of other related and un-related goods. In the final section, we discuss how much closer we got in getting a tool for sustainable consumption, and which further steps are needed.

1 Psychological Rebound Effects

Tread mill effects may occur if needs are not really satisfied or consumption does not make happier. Therefore, the impact on consumption may be rather similar to classical rebound effects as described in the introduction. In order to differentiate the mechanisms of satisfying needs and enhancing happiness from the other rebound factors rooted in limiting factors we use here the grouping of psychological versus physical rebound factors. Although we hope that these terms will facilitate the intuitive understanding we are well aware that the physical rebound effects are as well mediated by psychological mechanisms. In risk analysis such more indirect and induced effects are sometimes described as ripple effects (Hofstetter et al. 2002) without differentiating between a more physical or psychological nature. While the paper and presented tool is structured along this difference between physical and psychological rebound effects, both remain intentionally transparent in terms of actual rebound factors considered.

1.1 Drivers for behaviour

What motivates people to act in one or another way? What is it that we really want? What are the drivers of consumption? Thomas Hobbes (1588–1679) as cited in Hirschmann (1973) answered these questions with: "…men are continually in competition for honour and dignity". Our truly final demands are "striving for power, prestige, and respect, the maintenance of old friendships and associations and the cultivation of new ones, participation in public affairs, and – why not? – the pursuit of achievement, truth, creativity, and salvation." The French Encyclopedic Denis Diderot (1713–1784) condensed the answer to these questions by stating: "The whole economy of human society is based on one general and simple principle: I want to be happy…" (cited in Elchardus 1991). These early citations lost little in actuality. It is important to understand these drivers towards ultimate utility when we attempt to change consumption patterns and make them more sustainable. If an eco-design process results in an alternative that scores lower in some of the dimensions mentioned in the citation above then the acceptability may be low or induce additional consumption that provides the lost utility.

From the more recent literature reviewed a number of more structured and sometimes empirically based approaches to explain behavior and consumption have been developed (see, e.g., Maslow 1954, Fromm 1976, Max Neef 1991, Leitschuh-Fecht 1999, Csikszentmihaly 2000, Gatersleben 2001). Common elements include the satisfaction of basic needs, the social and cultural dimension of consumption, and striving for quality of life.

In LCA but also in the discussion on product service systems it is usually assumed that consumers are only interested in the end-services, i.e., not in the product or process to provide the end-services. Jalas (2002) notes that sociological and psychological research rather supports the view that "consumption may be a means to achieve a social status or to distinguish between social strata..." It may have more psychological meaning in terms of identity creation and thus also be more a play. "Also the findings that it is difficult for consumers to explain the reasons of actions may be a sign that consumption is less rational and not driven by such 'functional' needs as presumed in the eco-efficiency discussion" (Jalas 2002:3). And he adds "buying bread from the supermarket may not be a substitute for home baking and a handy person may be happy when repairing his or her own car" (Jalas 2002:3). This non-functional view on consumption may indeed describe some of the observed gaps between the models of the efficiency revolution and actual development. In sustainable consumption, we are just at the beginning of understanding the potential of this 'non-functional' view towards consumption. Marketing has adapted much earlier to this view and was very successful in selling, e.g., brands, visions, dreams and associations rather than 'just' products (Jensen 1999, Klein 2000). This could prove to be the true potential of sustainable consumption!

From this incomplete overview we suggest in this paper that at least two drivers need to be captured in modelling for more sustainable consumption: (i) the degree to which needs are satisfied considering social and cultural dimensions as well as (ii) the degree to which quality of life and subjective well-being are improved.

1.2 Needs and satisfiers

Both, the sufficiency and the efficiency path within sustainable consumption focus somehow on needs. The sufficiency approach stresses individuals to focus more on their basic needs and prioritize consumption. The efficiency approach attempts to provide a given demand for services and products at a lower level of resource consumption. However, when we define the observed demand in this efficiency paradigm we may do so on the level of established products, e.g., blue toothbrushes, or at the level of service, e.g., cleaning teethes, or probably even at the level of more basic needs such as maintaining healthy teeth. This means that design for sustainable consumption needs in any case to have a clear concept of basic needs that seek satisfaction. This is also at the heart of the acceptability of such sustainable activities and contributes – in the case of economic goods – to the market success.

The most famous compilation of needs was probably published by Maslow (1954). His five-level hierarchy has stimulated much academic discussion and one can at least summarize that the hierarchy is not universally accepted by scholars. While it is widely accepted that physiological needs did not only dominate in the stone-age but are also a necessary condition for human and any other life today, there is little agreement on the hierarchy of the remaining needs 'safety', 'social', 'esteem', and 'self-actualization'. Individual and cultural variability on the remaining needs is much higher. This has also much to do with actual living conditions that are very different for different places, socio-economic groups, and spiritual orientations.

These different starting points of different individuals, regions, countries and cultures have been explicitly a concern when Max-Neef (1991) published on the *human scale development*. He developed a matrix that spans nine basic needs[1] and four existential categories[2] (**Table 1**). The matrix was suggested as a regional planning tool where stakeholder groups would fill in together the cells. In a first step they would look into what factors prevent the fulfilling of the basic needs. In a second step they would then fill-in their views on what would satisfy the basic needs best.

Max-Neef (1991) makes a clear distinction between basic needs, its satisfiers, and economic goods. This is also help-

[1] His original version does not include 'Transcendence' because he considered this need not to be universal in the 1980s. However, he envisages that it may well do so in future. Considering that our work focuses on the highly developed world and that 20 years have passed since the creation of the matrix, we suggest adding this tenth basic need.

[2] We show here only the two categories 'Being' and 'Doing'. The categories 'Having' and 'Interacting' have not been used for our purpose.

Table 1: Categorisation of need satisfiers according to Max-Neef (1991/1992). The cells indicate a variety of need satisfiers

Basic Needs	Being-Satisfiers	Doing-Satisfiers
Subsistence	Physical health, mental health, equilibrium, sense of humour, adaptability	Feed, procreate, rest, work
Protection	Care, adaptability, autonomy, equilibrium, solidarity	Co-operate, prevent, plan, take care of, cure, help
Affection	Self-esteem, solidarity, respect, tolerance, generosity, receptiveness, passion, determination, sensuality, sense of humour	Make love, caress, express emotions, share, take care of, cultivate, appreciate
Understanding	Critical conscience, receptiveness, curiosity, astonishment, discipline, intuition, rationality	Investigate, study, experiment, educate, analyse, meditate
Participation	Adaptability, receptiveness, solidarity, willingness, determination, dedication, respect, passion, sense of humour	Become affiliated, co-operate, propose, share, dissent, obey, interact, agree on, express opinions
Leisure/ Idleness	Curiosity, receptiveness, imagination, recklessness, sense of humour, tranquillity, sensuality	Day-dream, brood, dream, recall old times, give way to fantasies, remember, relax, have fun, play
Creation	Passion, determination, intuition, imagination, boldness, rationality, autonomy, inventiveness, curiosity	Work, invent, build, design, compose, interpret
Identity	Sense of belonging, consistency, differentiation, self-esteem, assertiveness	Commit oneself, integrate oneself, confront, decide on, get to know oneself, recognise oneself, actualise oneself, grow
Freedom	Autonomy, self-esteem, determination, passion, assertiveness, open-mindedness, boldness, rebelliousness, tolerance	Dissent, choose, be different from, run risks, develop awareness, commit oneself, disobey
Transcendence		

ful for our purpose. We see the satisfiers as an abstraction level between basic needs and economic goods. The level of satisfiers is probably most suited to serve as a level where different services[3] can be measured and compared.

We conclude from this introduction that activities and economic goods for sustainable consumption should be designed in a way that they serve as a set of satisfiers for different basic needs. In addition, the activities and goods need to be designed for low environmental impacts and positive social and economic contributions. This will help to maximize need satisfaction with a minimal number of goods and environmental impacts. Whether and how this would also make people happier is discussed in the next section.

1.3 Striving for happiness

Based on a literature review we suggest that self-reported happiness might be a good measure to capture a number of aspects relevant to quality of life and subjective well-being (Hofstetter & Madjar 2003). The following arguments are relevant for our choice:

1. Happiness is considered by some economists as an attractive surrogate for ultimate utility (e.g., Frey & Stutzer 2002).
2. The happiness measure does not just measure hedonic well-being but needs to be understood as measure including eudaimonic well-being (see, e.g., Ryan & Deci 2001).
3. Although more than half of the difference in happiness between people can be explained by genes alone, Lyubomirsky et al. (2005) suggest that about 40% of the variance can be explained by factors under personal voluntary control and 10% by circumstances.
4. There is a large body of literature and case-studies on what makes people happy or not (Veenhoven 1994).
5. Happiness research is very active and also spreading into other related fields such as capability approaches (Hofstetter & Madjar 2005a).
6. Self reported happiness is easy to measure and leads to one index only. Weighting between sub-indicators is not needed.

Happiness has a different meaning and relevance in different cultures and due to different languages one may associate not exactly the same concept across language borders. However, exactly the same limitation applies to consumption and marketing and also the previously discussed area of needs and satisfiers is affected by such differences. Therefore, we do suggest that the presented framework is universal but acknowledge that nationally or culturally adjusted implementation is a must.

In order to maximize individual happiness, **Table 2** offers a list of happiness enhancing activities that have been collected from psychologists, psychiatrists, anthropologists and other scientists (see, e.g., Fordyce 1993, Wiesemann 2003, Myers 2004, Varughese 2004, Montier 2004). This unique list of happiness enhancers has been analyzed using elements of Vester's (2000) paper computer to identify those factors that are likely to play a very active role in stimulating or buffering other factors (Hofstetter & Madjar 2005b). These insights on the relative influence on each other have led to a subjective preliminary weighting of the happiness enhancers.

Table 2: List of happiness enhancers and a preliminary relative weighting of importance

Happiness Enhancers	Weight
keep busy and active	1
become an outgoing social personality creating networks	1.5
meaningful work that engages your skills	1.5
lower expectations & aspirations	1
positive, optimistic thinking for present and future	1
become present oriented	1
healthy personality (food, sleep, movements)	1.5
skill engaging leisure activities	1.5
be yourself	1
prioritize close relationships	1
nurture spiritual (religious) self	1.5
focus beyond self	1
don't equate happiness with money	1
take control of your life, get organized	1
enhance self-esteem	1.5
act extraverted	1.5
have sex with a person you love	2
prioritize happiness, act happily	2.5
be grateful	1
give love a high value in life	1
set achievable important non-materialistic goals	2.5
be open for new experiences / changes in believes	1

1.4 Does maximizing happiness lead to more consumption?

Our framework builds on the hypotheses that:

a) The better an activity, product, or service satisfies basic needs and maximizes ultimate utility, the lower the propensity for more (material) consumption. In other words: There is a saturation for the willingness to increase utility and therefore also a saturation in consumption.
b) Maximizing ultimate utility is possible without increased material consumption or even with less than average consumption.

There is only limited evidence in the literature to support those two hypotheses. Sure, there is enough evidence that non-materialistic people can have very high levels of happiness or that some countries with low GDP per capita score high on happiness (Kasser 2002, Jackson 2005). However, we know little about what happens when these people attempt to change their happiness and/or consumption level. Extended reviews in Hofstetter & Madjar (2003) and Madjar & Hofstetter (2004) provide enough support to justify work that builds on these hypotheses because there is as well no evidence against these hypotheses. Some evidence in favour of these hypotheses is presented here.

Frey & Stutzer (2002) show that although income per capita in Japan rose between 1958 and 1991 from less than 3,000 US$ to about 15,000 US$ the life satisfaction was more or less

[3] We will use the terms services and products interchangeably, observing that most products can also be described as service and that providing services can as well be seen as products.

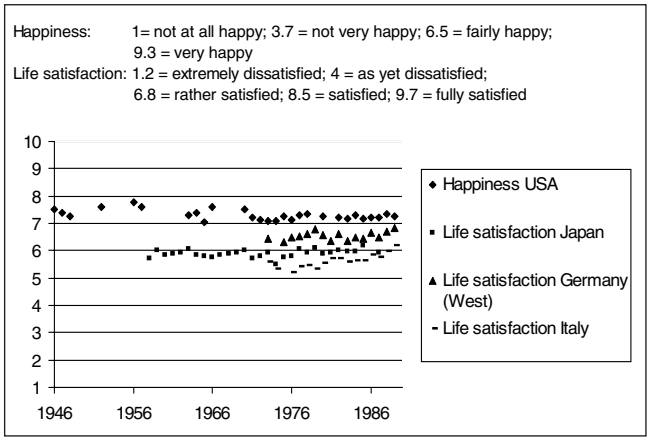

Fig. 1: Happiness and life satisfaction over time in four different nations (Veenhoven 1993). The scales have been transformed and the difference in values between nations has no meaning here

Fig. 3: Relation between life satisfaction and love respectively money (Diener & Oishi 2000)

stable over this time (**Fig. 1**). The same applies to happiness levels in the USA and life satisfaction levels in Germany and Italy. This suggests that if GDP per capita increases in industrialized countries there is no correlation with happiness and life satisfaction. This is a necessary condition for hypothesis (b).

Kasser (2002) analyzed the influence of making progress towards materialistic and non-materialistic goals and showed that making progress in materialistic goals did not enhance the well being level (high materialistic line) while achieving non-materialistic goals enhances the well-being level (**Fig. 2**). However, not achieving non-materialistic goals lowers the well-being level while not achieving materialistic goals doesn't affect well-being. These are important findings and support at least hypothesis (b).

Diener & Oishi (2000) show that those valuing love higher than money have a much higher life satisfaction than those who give priority to money (the higher the importance of love is, the higher is also the life satisfaction level (**Fig. 3**). They used data from 7,167 students in 41 countries. Therefore, this outcome is not biased by cultural factors. There is a positive correlation between love and life satisfaction but a negative correlation between money and life satisfaction. Therefore, this excludes 'money' as measure for ultimate utility and would support hypothesis (a).

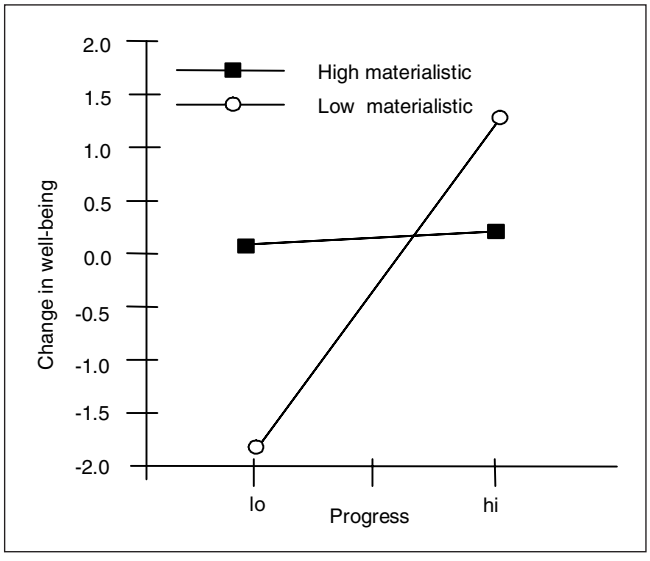

Fig. 2: Changes in well-being as a function of the progress in materialistic and non-materialistic goals (Kasser 2002)

Diener & Seligman (2004) discuss the causal way of happiness and materialism and suggest that although most studies concluded that materialism tend to decrease happiness it could also be that unhappiness could drive people to focus on extrinsic goals such as material wealth. Further they state that "longitudinal data indicate that part of the typical correlation between income and well-being is due to well-being causing higher incomes rather than the other way round". If this is true then it would be interesting to analyze what influence enhancing happiness will have on materialism and consumption. Income is rather highly correlated with consumption. If higher income goes into savings, how will this trigger investments and consumption by others? Will this possibly higher consumption be sustainable? Would this lead again to a negative effect (rebound effect) on happiness? This is why we suggest in Section 4 to falsify our hypotheses with additional analysis.

2 Physical Rebound Effects

Disposable income is certainly the most commonly discussed factor that limits consumption and no further elaboration on the different ways how changes in prices and income can trigger rebound effects (see introduction) will be discussed here. Which additional limiting factors need to be considered when a switch to more sustainable consumptions shall be achieved?

Time rebound has probably its origin in transportation research where the fixed travel time budget hypothesis has been proposed (Goodwin 1978, see, e.g., Schipper 1997 or Binswanger 2002 for short overviews). Many studies con-

firm the hypothesis that travel time remains about the same even if environmental and technological factors change. Faster trains and highways may reduce on the short run total travel time. On the long run, people tend to travel larger distances. Since faster traffic means more energy use per km this leads to a time-rebound effect that increases net energy use. Of course, there are differences in travel time across different nations (Schipper 1997) and the travel budget is not fixed for all times. Disproportionate changes in the share of transport costs in relation to household income or additional activities during travel (use of mobile phones, entertainment centers thanks to traffic control systems, etc.) may change the travel time budget.

Schipper et al. (1989) were probably among the first to quantify the energy use per time unit. They combine 15 energy use sectors and 40 time use sectors and calculate energy intensities per time. From this analysis they conclude that transport is by far the most energy intensive activity per time unit and that moving activities from 'at home' to 'personal services' may increase total energy demand. However, rebound effects are not really addressed. Energy forecasting has been the primary focus of the analysis.

Binswanger (2001) suggests that time-rebound may be more relevant than price-related energy rebound effects and extended in Binswanger (2002) the classical household production functions (see e.g., Becker 1965, Winston 1982) by not only including time but also energy. From this basic model he confirms that when the wage rates are high and energy prices low, time-saving innovations are likely to increase energy consumption. This means that there is a time-rebound effect that may increase total energy use, even if the new time-saving activity uses less energy than the substituted one.

Zeckhauser (1973) argues that time should not just be treated as constraint as Becker (1965) and Linder (1979) do but as 'the primary commodity', since "our primary objective is to enjoy ourselves, to reap periods of high utility." Reisch (2001) takes a similar stand when she makes a clear distinction between 'wealth in time' and 'wealth in goods' where time gets an intrinsic value per se as a genuine aspect of personal wellbeing. The example of feeding a baby is used to show that reducing the time to do so may decrease satisfaction with and motivation for the activity. With the example of the 4-day week at Volkswagen (VW) she also demonstrates that more time does not need to result in sustainability gains. Rinderspacher (1996) claims that environmentally friendly behaviors are time investments in the environment because many environmental friendly behaviors need more time (gardening, public transport).

Due to the suggested relevance of time as second limiting factor we refer to the review in Hofstetter & Madjar (2003) for a summary of quantitative studies on time use and energy intensities per time unit. What other limiting factors to consumption that have a potential to cause rebound effects may be relevant for our purpose?

Perrels (2002) introduces the notion that skills are a relevant limiting factor that is able to substitute for time and/or money. Schipper et al. (1989) mentions the following constraints: demographics, economics, physical and social, and legal infrastructure. Spreng (1988) suggested that time, information and energy are exchangeable substitutes, where industrial men have no time, primitive men have no information and the starving philosopher has no energy. Goedkoop et al. (2002) mention three limiting factors 'cost', 'time' and 'volume' as constraints towards consumption. They mention that in order to be able to buy a second car one needs a parking slot that may not be available. The minimization of electronic products probably started exactly for this reason: Average Japanese apartments and houses offer much less (storage) space than American houses which was probably identified as limiting factor to selling more electronic products. Rebound effects due to (the extension of) social, organizational and safety limits may be relevant as well. An example is the theory of risk homeostasis or risk thermometer (Adams 1995). This theory or hypothesis says that if one lowers, e.g., risks in the traffic by separated lanes, seat belts, or air bags, the drivers tend to drive faster and more reckless. Sometimes, they also adopt new risky hobbies such as paragliding, bungee jumping, or diving.

From this review of factors that may constrain consumption and therefore trigger rebound effects we select those that are of immediate relevance to personal consumption. These are 'costs', 'time', 'space or volume', 'skills', 'information', and 'other scarce resources' such as energy, and other physical resources. Social and legal infrastructure and demographics can hardly be altered by an individual consumer. However, on a governmental level they may provide a fruitful starting place to think about policy measures for sustainable consumption.

3 Making Use of Rebound Effects in Design for Sustainable Consumption

Rather than complaining that rebound effects eat up the efforts and successes of improvements in eco-efficiency we suggest here to use the presented insights on psychological and physical rebound effects to design activities and products with negative total rebound. This means that total impact (here environmental) is not only reduced by the activity or product itself but in addition through the indirect effect on the total consumption pattern. Therefore, we present here a checklist approach for designing for negative total rebound effects. In order to quantify design alternatives a preliminary assessment table is suggested (see Table 3). The illustrating example in Section 3.2 should help to get a flavour on the potential of such a new design and assessment approach.

3.1 Checklist and assessment table

The semi-quantitative checklist approach combines four so far separated fields of importance to sustainable consumption:

i) The satisfiers for basic needs by Max-Neef (1991) (see Table 1) are re-interpreted and operationalized.
ii) Happiness-enhancers from Table 2 are actively used for design and assessment.

iii) The six physical limiting factors that have been proposed to cause rebound effects are combined to a physical rebound factor.
iv) A streamlined life cycle assessment is used to quantify potential environmental life cycle impacts.

The basic assertion is that activities, products, or services (APS) contribute to sustainable consumption[4] if: (a) they have a favourable LCA impact profile, (b) truly satisfy many needs, (c) enhance consumer happiness, and (d) cause physical rebound effects that reduce rather than increase total consumption. The following 10-step checklist to design for sustainable consumption builds on these pillars:

1. Brainstorm on activities, products and services (APS) based on needs, satisfiers, and happiness enhancers (see Table 1 and 2).
2. Identify for each APS the covered needs and satisfiers. Add the number of covered satisfiers and multiply this number by the number of basic needs that are (partly) covered by these satisfiers.
3. Apply the list of happiness enhancers (see Table 2) to the potentially new APS and make a list of factors that are completely satisfied (3 points), good contribution (2 points), and weak contribution (1 point).
4. Multiply the number of evaluation points from step 2 and 3 with each other. Rank the APS according to the total points and select the top scorers for next steps.
5. Identify for each new APS one to three most similar established APS that might be substituted by APS for sustainable consumption. This should not just be based on intuition but by looking at the basic needs that are most directly satisfied.
6. Adjust the number and repetitions of activities, products, or services to approximately match the size, amount or extent of the new APS described in step 1.
7. Repeat steps 2 and 3 to the identified established APS.
8. Guesstimate for each selected potentially new and existing APS the life cycle costs, hours completely absorbed by APS, space, and other resources. Further, the share of people without sufficient skills and information should be estimated.
9. Perform a streamlined LCA to get a first estimate on environmental life cycle impacts of all APS under consideration.
10. Use Table 3 (p. 113) to evaluate the new APS according to its potential for sustainable consumption and its competitiveness with established APS.

A similar checklist was also developed for improving existing APS and more details are available in Hofstetter & Madjar (2005b).

3.2 Example for illustration

The example used here can not be considered to be a real world application of the checklist. It will rather give a flavor of the potential in the suggested checklist and may stimulate the demand to actually refine and validate the checklist and assessment table. What example should we look at? A Chinese saying shall help:

If you want to be happy for an hour, drink a beer.
If you want to be happy for a week, kill your pig and eat it.
If you want to be happy for a year, then marry.
But if you want to be happy all your life, become a gardener.

Therefore, we illustrate the checklist based on the activity 'gardening'. There are many ways of gardening, the bonsai garden, the wildflower garden, the park, or the 'productive' garden that grows vegetables, salads, berries, and fruits. The latter is what we will focus on in this example. Accepting that most people in industrialized countries live in urban areas makes clear that it is a privilege to have (small) garden to grow all this. It makes a lot of sense to keep inhabited areas densely populated in order to make journeys short and public mass transport efficient. Therefore, our example does not assume that we give up the densely populated cities and villages. We would rather ban cars from cities and villages using gates and park & ride concepts. This frees up lots of parking slots and overly wide streets that can be reallocated to apartments for private gardening. This brings the harmless example of 'gardening' to a much different level where we may easily loose the overview. Therefore, and for the sake of simplicity, we stick to the example of gardening alone, assuming that there are at least 20 m^2 (but better 200 m^2) of land that can be used for gardening.

Although there have been historic movements to promote private gardening (Dr. Schreber gardens starting in 1860 in Germany) we will treat this activity 'gardening' like a new activity that gets a revival and follow the checklist in Section 3.1:

Step 1: We already decided to select 'gardening' due to its superior position according to the Chinese saying.

Step 2: The 129 satisfiers in the columns 'being' and 'doing' from Table 1 are used for this purpose. Gardening covers 79 satisfiers and partly satisfies eight out of the ten needs. Although 'subsistence' is considered to be the most basic need neither Max-Neef nor we did apply a hierarchy to these needs. We also assumed that all satisfiers are equally important. Hofstetter & Madjar (2005b) provide the details which satisfiers have been considered and all further details for this example. The results for each step are listed in Table 3.

Step 3: Already the task in step 2 but especially this task should ideally be the result of a group evaluation rather than just single expert judgment. Our assessment for gardening results in 19 contribution points without weighting the single happiness enhancers and 22.5 points considering the weighting as suggested in Table 2.

Step 4: No prioritization is needed at this stage because our brainstorming did yield only one new suggested activity.

Step 5: This is obviously a very difficult step in our analysis because most basic needs and many satisfiers are covered by gardening. If somebody does gardening for the production of locally grown food an obvious substitute would be to use a home-delivery service by a local farmer (or to use the farmer's farm shop or retailers). Those using the gardening more for the sake of having something to take care of may instead have a dog. Those that enjoy the outdoor quality would

[4] Or at least for the environmental dimension of sustainable consumption.

probably establish a walking or hiking habit during weekdays and/or weekend. Those that look at quiet time for reflection might join Yoga-classes, do meditation, or start knitting. Those that just like to be busy and can afford it would buy a weekend house. From this selection of potential substitutes we will limit our analysis to having a dog, a weekend house in the country side and doing a mix of yoga classes and yoga at home.

Step 6: When we compare gardening with its highly seasonal variations with other activities we should consider a full year as reference. We assume that during the main growing season one would spend at least every second day and almost every weekend in the garden. The dog needs attention several times each day and it is assumed that at least every second day one would go for a longer walk of at least one hour. The weekend house would be visited in the warm season almost every weekend (by car 200 km return trip) and the activities would include maintenance work, daydreaming, and walking/enjoying nature. In the cold season there is only one visit a month, if at all. For the yoga we assume that one class per week is taken plus one to two practice hours per week spent at home.

Step 7: The results of these assessments are summarized in Table 3. They are not a result of a group exercise.

Step 8: Let us give a few hints for the used assumptions in this guesstimate (see Table 3) that is made for illustration only:

Life Cycle Costs: It is assumed that garden is already available at no extra costs. For the dog we basically included food, taxes, doctor appointments and increased transportation fares. For yoga we just included the costs of classes assuming that they take place close from work or home. The weekend house causes extra costs for travel (20 return trips), the rent or mortgage for the property, the equipment with furniture and household ware, fees for phone, TV, etc. and the expenses for maintenance and remodeling work.

Time: This derives basically from the assumed intensities under step 6.

Space: Although the garden does not take up additional dwelling space it does occupy outdoor space. Also, one needs a corner for the gardening tools and for storing the harvest. For dogs and yoga the extra space is obviously small. The weekend house is a special case because it actually generates more and uses more space. Generating more space triggers more consumption. Therefore, we should use a minus sign. Instead, in order to avoid calculation problems, we use 1 m^2.

Resources: There are no extra scarce resources to be considered. (→ all 1). Instead of considering the garden space above we could have included above the storage place for tool and harvest only and include here land as a scarce resource.

Skills: People that are not able to bend would fail with gardening (and people with absolutely no green thumb). For a dog you need to have a minimum skill level to deal with somebody more than just yourself. A weekend house requires the ability to deal with money affairs, pay bills, and sign contracts, etc. For yoga we assumed the highest skill level due to the high concentration that is required.

Information: Although we live in an information society we did guess that the required information level is rather high for all activities. If one does not know what yoga is and where yoga classes take place you can not go and learn it. Acquiring the weekend house of your dreams requires lots of information. Considering failed attempts of short-time dog-holders we believe that the required information to be a long-term dog-holder is high. For gardening, the gap between growing cultures and just eating them has become large in the last decades and many people would not know how to even start gardening.

Step 9: Instead of making a streamlined analysis we estimate primary energy consumption in kWh making the following assumptions: Spending an Euro causes on average the use of one kWh primary energy. The yoga classes are basically a service and cause 0.5 kWh/Euro. We also assume that the gardening will lower the demand for fruit, berries, salad and vegetables in the amount of 200 Euro. Food production is high on energy consumption and we assumed 2 kWh/Euro.

Step 10: Table 3 provides the preliminary results of this example and illustrates the assessment part of our checklist. The highly quantitative nature of this evaluation should not hide that many data are guessed and that the evaluation may look different if others would perform it. The three sub-scores are used to rank the four alternatives where we only accept differences of more than 20% to give different rank points due to the high uncertainties involved. For a full ranking we give equal importance to the environmental impacts of the alternatives themselves and the physical and psychological rebound scores together. Therefore, we double the rank points for the environmental evaluation.

Following this ranking and weighting procedure suggests that gardening scores very well on sustainable consumption and may be added to the recommendation list. The environmental impact may be very low or even negative if organic gardening is applied and the growing conditions comparable to agricultural land (soil quality, sun exposure, water availability). This suggests that gardening is indeed a highly recommendable activity for sustainable consumption. However, this only applies if this does not impact the density of populated areas as mentioned before. If gardening would indeed substitute for weekend houses, the net sustainability benefit may become very large. Yoga is rather low in energy consumption and also very good on happiness and satisfaction. Only the evaluation regarding rebound effects makes yoga looking like a looser. However, the low ranking on rebound effects is due to the relatively low costs and very low space requirements. Therefore, if somebody is, e.g., not space limited, yoga may also do well on rebound effects due to its high time use. As mentioned earlier, there are two sides to the rebound effect score. Low costs and space requirements may actually be a selling argument and help the dissemination. In addition, we would retain 'having a dog' for further evaluation for sustainable consumption. This example illustrates the potential usefulness of this kind of analysis.

Applying our checklist to an illustrative example did pressure us to be explicit about all the quantifications and assessments needed and unveils a large number of (sometimes questionable) assumptions. Further developments and validation could certainly improve the predictability of the used

Table 3: Assessment table for sustainable consumption checklist

Activities, products, services		Gardening	Dog	Weekend House	Yoga	Remarks
Number of covered satisfiers	S	79	64	44	54	from table 1
Number of covered needs	N	8	9	8	10	from table 1
Score	S*N	632	576	352	540	
Score from happiness enhancers	H	22.5	23.5	10	24	from table 2
Score 'psychological rebound effect'	H*S*N	14,220	13,536	3,520	12,960	higher means better potential for sustainable consumption
Life Cycle Costs	Euro/a	200	2000	15000	600	
Ratio (competing alternatives versus gardening)	C	1	10	75	3	Ratio >1 is better for avoiding rebound effects
Hours 100% absorbed	h	150	600	160	125	
Ratio	T	1	4	1.07	0.83	Ratio >1 is better for avoiding rebound effects
Occupied space	m^2	200	5	1	2	
Ratio	D	1	0.025	0.005	0.01	Ratio >1 is better for avoiding rebound effects
Other scarce resources		0	0	0	0	
Ratio	R	1	1	1	1	Ratio >1 is better for avoiding rebound effects (but potentially worse for LCA)
Share of people without required skills	%	10	20	10	30	
Ratio	L	1	2	1	3	Ratio >1 is better for avoiding rebound effects
Share of people without required information	%	50	75	50	30	
Ratio	I	1	1.5	1	0.6	Ratio >1 is better for avoiding rebound effects
Score 'physical rebound effect'	C*T*D*R*L*I	1	3	0.4	0.04	Ratio >1 means better for avoiding rebound effects
Environmental impacts analyzed by streamlined LCA	kWh	–200	2,000	15,000	300	
Rank order psychological rebound effect	H*S*N	1	1	4	1	Highest score gives rank no.1 (only difference >20% justifies different rank)
Rank order physical rebound effect		2	1	3	4	Highest ratio gives rank no. 1 (only difference >20% justifies different rank)
Rank order environmental impacts		2	6	8	4	Lowest Eco-Points gives rank no.1 (double weight rank order points, only difference >20% justifies different rank)
Total rank order points		5	8	15	9	Just sum the three previous rows, lowest sum is best.

approach and assessment table. Some of the most striking assumptions and simplifications are:

1. The way we use the table of needs and satisfiers. We assume that needs are additive and have each the same importance. The same assumption was used for satisfiers although different numbers of satisfiers per need area were provided. Then we multiplied the numbers of (partly) covered needs and satisfiers. In a given culture and consumer group it should be possible to refine the needs assessment substantially.
2. The way we estimate the potential to enhance happiness. Again we assume additivity although we use this time a subjective weighting between the different factors. Much empirical research would be needed to improve such an assessment. Having a more specific target group in mind would make such an assessment more realistic.
3. The selection of the physical rebound factors and their combination to a rebound score assumes that we truly understand not only what limiting factors are the relevant ones but also the way they compensate or multiply each other. The literature is far from offering decomposition or factor analyses that would allow coming up with a more sophisticated model. Ideally, the actually existing limitations to consumption of specific consumer groups should be the starting point for this analysis.
4. Finally, the way we construct sub-scores and come up with the final rank order points makes it obvious that we lack the understanding how the different physical and psychological rebound factors and scores affects other consumption and how this compares to the environmental impacts of the studied APS.

In Hofstetter & Ozawa (2005) we described an empirical attempt to differentiate changes in happiness, change in consumption patterns and its environmental impacts versus the impacts of the APS at hand. More such attempts need to be made if the predictability of such design tools shall be improved. Also, the careful consideration of the single results in each row of Table 3 may be equally important: this may not only explain major differences in ranks but also stimulate designers for improving the APS.

4 Discussion and Conclusions

The checklist with its assessment table allows considering three major contributors for environmentally sustainable consumption:

1. A classical life cycle assessment or streamlined LCA allows identifying design options and alternatives with the lowest environmental impacts throughout their life cycle.
2. The analysis of limiting factors helps preventing to adopt a product, service or activity that looks from the analysis in point 1 favorable but indirectly allows for or even triggers additional unsustainable consumption. Cheaper, less time consuming or smaller products and services tend to trigger an increase in total consumption. This may 'eat up' the environmental savings of a newly designed service.
3. Consumers do not primarily strive to spend all money, time and space they have (underlying assumption of point 2) but actually try to do both: to satisfy their basic needs as completely as possible and to be happy. Therefore, activities, products and services that are able to satisfy basic needs and enhance happiness are likely to maximize utility. This might stop a treadmill effect and stop triggering again additional consumption to compensate for unfulfilled aspirations.

The checklist for designing new or improving existing activities, products, or services allows to estimate these factors at reasonable costs and offers a proposal on how to condensate the information to indicators on different aggregation levels. This offers maximum transparency and may stimulate further improvements towards more sustainable consumption.

The whole checklist approach has the quality and purpose of a streamlined evaluation before all design, production and marketing parameters are fixed or even known. The full-fledged analysis would follow the procedure implemented in Hofstetter & Ozawa (2005) that derives quantitative results for both, the actual change in happiness and the system wide (including rebound effects) environmental impacts.

There are a number of caveat that apply to both, the basic idea and the operationalization by the checklists. Although there is literature on happiness enhancement, materialism, and sustainable development we did not find conclusive empirical evidence that high levels of happiness or increases in happiness will indeed lower the pressure on (material) consumption. This remains a hypothesis that awaits falsification. Further, we do not know what limiting factors have the largest quantitative impact on the environmental impacts of consumption patterns.

The checklist approach for designing and improving sustainable consumption activities is promising in the way it integrates elements that have been tested and proven useful in their domains. As a next step, applications and experiences will be needed to refine the tool and also get a better understanding on the importance of the mentioned untested assumptions. For the time being we suggest to:

– Use the checklist approach to predict the likelihood that an activity increases happiness, satisfaction, and reduces rebound effects and environmental impacts. This approach can be used for designing new and improving existing activities, products, and services.
– List probable consequences of suggested sustainable consumption activities and assess their impact. E.g., if the purchase of a personal computer indeed requires to buy a printer, equip the house with broadband access, buy an office chair, and buy a carpet that withstands the rolls of an office chair then we should analyze these induced purchases. In order to brainstorm on possible consequences and their probability one might use focus groups or survey techniques.

Epilogue: Why is this paper to honour the legacy of Helias Udo de Haes?

The main author of this paper had the pleasure to work, cooperate, discuss and sometimes argue with Helias for many years. Helias did not only contribute to advance the science behind LCA but he also tried hard to keep LCA within practical boundaries. This certainly helped in the dissemination and acceptance of the tool. I remember when the first versions of eco-efficiency approaches were presented in the mid-nineties, the proponents put much emphasis on the products value that was in their view not enough reflected within LCA. However, the LCA community with strong support from Helias decided to stick with traditional physical descriptions of functional units. I am curious to see whether our attempt in this paper to express product value in terms of need satisfaction and happiness enhancement will survive the critical judgement of Helias now ten years later. At least we believe that we are shedding light on the limitations of existing design tools and believe that it would make an appropriate addition to Helias' tool-box (Wrisberg et al. 2002) and may get a place in the strategies to overcome limitations of LCA (Udo de Haes 1997, Udo de Haes et al. 2004). The extensions presented here are only possible because there is the established LCA that serves as a platform. Helias deserves much of the credit that we have such a robust platform!

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