# Framing the role of technology in transformation of consumption practices: beyond user-product interaction

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**Abstract**

Lifestyle changes can contribute to climate change mitigation. Social and technical changes are however intimately related, and consumption practices entangled with technology. Design researchers have distinguished several strategies for facilitating more sustainable practices through design. However, many actors and structures influence both technology development and how consumption practices evolve. Understanding the preconditions for design-led contribution requires looking beyond the designer-product-user triangle. To frame further investigation into the role of design in transformation of consumption practices, theoretical concepts from the social sciences are introduced. Laundering practices are used to examine the dynamics at play and how to theoretically cope with them.

*Keywords: Design for sustainability, behavioural change, agency, practice, socio-technical systems*

## 1. Introduction

The behaviour of individual consumers is central to the impact societies have on the environment. According to the IPCC Fourth Assessment Report (2007), there is high agreement and medium evidence that across all sectors, changes in lifestyles and behaviour patterns can contribute to climate change mitigation. Consumption practices are however entangled with technologies. How technologies are interacted with determine their actual sustainability impact. At the same time, consumers' physical environment – the buildings, infrastructures and technologies they interact with, influence and constrain their choices and opportunities for changing lifestyle. Nevertheless, the traditionally perceived disconnect between behaviour on one hand and technology on the other still seems to dominate (Jelsma, 1999; 2006b). This split is often reflected in policy-makers' emphasis on information campaigns as means for changing behaviour, and energy efficiency measures when targeting technology. However, there is no one-to-one correspondence between pro-environmental attitudes and pro-environmental behaviour (Jackson, 2005), and reductions in energy demand due to increased energy efficiency rarely pan out in practice (Wilhite, 2008). Rather than seeing consumers as moral actors that need to have their attitudes changed so global goals can be achieved, and efficient technologies as silver bullets against unsustainable practices, it is necessary to acknowledge the role of the complex, dynamic landscapes in which consumers lead their life, where technologies and behaviours are interwoven. Questions should rather centre on the possibilities for redesigning this environment, to make more sustainable practices viable.

### *1.1 Design research into 'design for sustainable behaviour'*

In contrast to perceptions of behaviour and technology as disassociated, a growing branch of design research is concerned with the possibilities for altering unsustainable behaviour and consumption patterns through design (Jelsma, 1999; Jelsma and Knot, 2002; Lilley *et al*., 2005; Lockton *et al*., 2008; Pettersen and Boks, 2008; Wever *et al*., 2008). This line of thought has strong theoretical ties to Akrich's (1992) script concept. A 'script' is the framework for action designers inscribe into a product or system, indicating that technologies to some extent can prescribe the actions of users by inviting some behaviours and counteracting others. So far, several strategies for design-led influence on behaviour have been identified. In addition to script theory (Akrich, 1992; Latour, 1992), they are based on theoretical concepts such as feedback intervention theory (Kluger and DeNisi,

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1996), persuasion (e.g. Cialdini, 1993), affordances (Gibson, 1979; Norman, 1988) and critical design (Dunne, 1995), and draw on theory and techniques from user-centred and user-involved design disciplines like interaction design and participatory design. What in essence is argued is that by understanding users, it is possible to use design strategically to nudge individuals towards more sustainable use patterns. Strategies include providing feedback on the consequences of behaviour, empowering users by making sustainable choices available, encouraging critical reflection upon practices through critical design, persuading, steering or forcing users into sustainable use patterns, and obstructing unsustainable use. A central variable is how much decision-making power should be delegated to the technology. Others advocate emphasising the 'emotional durability' of design solutions, to prevent premature replacement (Muis, 2006). The conceptual ideas abound, mostly targeting individual devices. So far, research has largely addressed designers' solution space and decision-making process, but not how well the identified strategies work for different product and system categories, how to successfully integrate design for sustainable behaviour into industrial practice, or how to ensure that industrial efforts translate into actual effect on consumption practices.

At the same time, the structural context within which commercial design practitioners operate may be said to work against rather than contribute to sustainable consumption. Mazé and Redström (2008) point out that design is often said to be about value creation for both individual businesses and consumers. However, designers do by no means work exclusively on satisfaction of fundamental human and societal needs. As companies continuously strive for market share, design resources are often directed at fuelling overconsumption among the affluent and creating wants and desires by constantly envisioning new products and services (Woodhouse, 2001). Moreover, while formal design processes may be informed by use and users, from script theory it follows that users de-scribe or react to what is prescribed to them by design solutions (Akrich and Latour, 1992). It is not possible to force actions upon individuals through well-designed artefacts, as they never determine user behaviour completely and unintended outcomes do occur. It is extensively documented that users often ignore and even counteract the inscriptions of designers (Silverstone and Haddon, 1996). In processes of 'domestication', consumers appropriate technologies they bring into their private cultural spaces, giving them meaning and making (or not making) them familiar and part of routines and everyday life, in ways that may or may not have been intended by the designer. This may in turn be detected by market research and stimulate the design of new product generations. Designed artefacts shape and are shaped by the contexts in which they are used (Ingram *et al*., 2007). The role and potential of design must be seen in relation to the broader sets of dynamics that are at play both in the design and the use context. To investigate the preconditions for designers and design to successfully facilitate more sustainable consumption patterns, it is necessary to look beyond the triangle of designer, product and user.

### *1.2 Goal of the paper*

The aim of the paper is to frame what is seen as further, necessary research into the role of design-led initiatives in transformation of consumption practices. The fundamental question is under what conditions designers and design interventions can contribute to making consumption practices more sustainable. To get closer to an understanding of such issues, the paper examines theoretical concepts that may shed light on the relationship between behaviour and technology and the possibilities for altering it, in connection with the complex dynamics going on both within production and consumption, and what possibilities might open up by drawing on them. First, a brief overview of the status of design for sustainability and sustainable innovation in industry is provided. Next, the opportunities for theoretically framing the role of technology in transformation of consumption practices are explored by drawing on theoretical concepts and resources such as agency, scripts, practice theory, socio-technical systems and theories on technological change, mainly borrowed from sociological consumption studies and science and technology studies (STS). The adequacy of the theories is discussed. Finally, the practice of laundering is chosen and the theoretical frameworks applied to explore the dynamics at play and how to cope with them theoretically.

## 2. The state of design for sustainability and sustainable innovation in industry

### *2.1 Design for sustainability implementation*

Different terms are used to describe the integration of sustainability considerations in the development of products and systems. The transition in terminology use, from the original 'green design' via 'ecodesign' or 'design for environment' in the US (Tukker *et al*., 2001), to 'sustainable design' and 'design for sustainability' (Baumann *et al*., 2002), reflects a broadening in scope from a techno-centric origin to inclusion of social issues and application of 'sustainability' as the overarching concept. Since the early 1990s, researchers have made information on ecodesign principles, modelling tools, assessment techniques, case studies, product data and teaching material available (McAloone *et al*., 2002). The current state of operationalisation is nevertheless described as 'lacking momentum' (Boks, 2008). What still seem to dominate are defensive, reactive strategies to environmental legislation, together with showcases, incremental improvements, niche projects and sustainability reports (Tukker *et al*., 2001; Baumann *et al*., 2002; McAloone *et al*., 2002; Boks, 2008). The problem appears to be diffusion and implementation of ecodesign principles beyond environmental departments and into daily product development where time and cost pressures and increasing product complexity work against pro-environmental efforts (McAloone *et al*., 2002). Sustainability issues are often outside of developers' core competency and firms' core priorities, stretch far beyond the boundaries of the individual company and over time periods much longer than typical product-planning horizons (Baumann *et al*., 2002). Whereas sustainability issues are linked to the long-term, common good, designers, companies and consumers focus on their short-term interests in their activities. This is a core discrepancy in diffusion and implementation of ecodesign principles.

Baumann *et al*. (2002) argue that literature is missing a business focus, ignoring the financial, managerial and competitive implications of green product development, as well as the integration of management issues, environmental issues and product development activities. Methodology development has been designer oriented (Tukker *et al*., 2001). As mentioned introductorily, the key issue towards which design resources are geared is the chase for market share, and in product specifications sustainability requirements are still often absent in sufficiently explicit formats (Luttropp and Lagerstedt, 2006). This is in turn related to the perceived lack of market demand for design solutions that are superior from a sustainability perspective. Presented alone and without addressing other product attributes, environmental issues have shown to play a minor role in consumers' purchase decisions (Jansen and Stevels, 2006). An increasingly acknowledged way of opening up for broader customer segments is however to link environmental benefits to economic and social benefits (Boks, 2008). There is not necessarily any fundamental contradiction between business opportunities and sustainable design. However, it has not been sufficiently charted under what circumstances and time horizons synergetic effects can be reassured, and in industrial practice the general impression may still be that such contradictions exist. Moreover, it remains uncertain to what extent regulative approaches for certain product categories, such as the EuP legislation, will ensure increased adoption of sustainable design routines.

### *2.2. Conditions for sustainable innovation*

To make development sustainable in the time-frame of a generation, a factor 10 reduction in the environmental impact of how societal functions are delivered is thought necessary (Tukker *et al*., 2001). Reductions of the impact of design solutions can happen at different levels. These include incremental improvements of existing products, redesign of existing solutions, functional innovation or finding new ways of delivering functionality, and finally, system innovation (Nuij, 2001). As innovation levels rise, so do companies' investments in terms of R&D, time and money. This may eventually pay off in terms of market share. For companies, the greatest innovation potential lies in taking the function as a point of departure for design. The highest innovation levels involve processes far beyond the influence of one firm or a cluster of companies, as they may require infrastructural change and initiatives from other stakeholders.

Compliance with regulatory requirements does not contribute to competitive advantages or gains in market share (Carlson and Rafinejad, 2008). Voluntary initiatives might. To achieve radical

environmental improvements and innovations, the early stages of innovation processes and product portfolio management – the process of evaluating, selecting and prioritising new projects and comparing them with existing ones, are recognised as critical (Bhamra, 2004; Ölund and Ritzén, 2004). These processes are however reported to lack tools that can facilitate integration of environmental considerations and support decision-making processes (Bhamra *et al*., 1999; Ölund and Ritzén, 2004). Additionally, such early decision-making often happens at a management level, leaving designers with little influential power.

Baumann *et al*. (2002) argue that researchers need to adopt a more systemic perspective and see the internal process of product development in relation to other processes within the company, as well as to processes of competition and cooperation with the economic actors in the product chain and to the formulation and implementation of governmental policy programmes. This further underlines the need for a broad perspective on the actors and structures that influence the potential for technological modification of consumption practices.

## 3. Introducing theoretical concepts from the social sciences

Ingram *et al*. (2007) argue that design practice and education champion what in biological terms would be called a creationist approach, promoting designers' creativity as the major driving force in new product development. In practice however, the emphasis on keeping design processes informed by use and users rather suggests that things and practices become what they are in evolutionary-like processes of selection and variation. The previous section presented a more nuanced picture of designers' role, introducing some of the many factors and considerations that influence innovation processes. Despite being positioned at the interface between supply and demand, designers' influential power is limited. Designers, products and users do not operate in isolation. In this section, theoretical concepts from the social sciences are introduced. They are discussed in terms of their potential for improving the understanding of technological influence on consumption practices, in light of the complex systems and contexts in which designers, design and users function.

### *3.1 Agency*

For questions concerning influential power, the notion of agency is useful. Wilhite (2008) quotes Ortner (1999), who defines agency as 'the capability or power to be the source and originator of acts'. In the social sciences, the concept of agency has been central in many debates, one of them centred on whether nonhumans including technologies at all are agentive. This relates to the split between technology and behaviour touched upon in the introduction. Wilhite (2008) refers to two opposing theoretical positions that have dominated attempts to alter consumption practices. The first, represented by technology progressivism, sees technologies as completely agentive and efficient technologies as neutral silver bullets able to trigger leaps in development. The other camp is inhabited by 'behaviouralists', who basically replace technological determinism with social determinism and perceive users as completely agentive. Users domesticate technologies in ways not intended or foreseen by designers, and technologies' success or failure is determined by the outcome or 'closure' of social processes where users give them meaning (Jelsma, 2006a). Thus, to have individuals consume more sustainably, one must target their values, attitudes and intentions (Wilhite, 2008). While the first view disregards the influence of social relations upon technologies, the second underestimates the influence of technologies upon social relations. As opposed to such one-sidedness, and in line with thinking in the philosophy of science, contemporary STS scholars have come to the conclusion that 'it is mistaken to think of technology and society as separate spheres influencing each other: technology and society are mutually constitutive' (MacKenzie and Wajcman, 1999, p. 23). As proposed by Wilhite (2008), it seems more fruitful to think of agency as distributed.

### *3.2 ANT and scripts*

A rather radical theoretic framework truly acknowledging nonhuman actors is actor-network theory (ANT), established by authors such as Latour, Law and Callon (Fallan, 2008). It rejects both technological determinism, social constructivism and the distinction between human and nonhuman

actors (Law, 2000), and is rather concerned with socio-technology, which is seen as a dynamic co-production that only makes sense in a relational perspective (Fallan, 2008). Actors, human and non-human, have different interests and agendas that are played out in negotiations. Networks are made up by relations, which should be understood as transformations and translations and not physical entities (Latour, 1999). When applying ANT, one should pay attention to the relations built and the actions taking place and not to the specific actors or networks per se. Things are not what they are, but what they have become in networks with other actors (Jelsma, 2006a). ANT may be fruitful for exploring the importance of nonhuman actors and interactions between people and things, but, as Fallan (2008) states, not discriminating between human and nonhumans can be a challenge, especially in empirical work.

The already mentioned script concept is based on actor-network theory (Geels, 2004), and implies that products and systems can be constructed to 'configure' users in certain ways. In design, the idea of strategically using physical product properties or constraints and affordances to have a user operate the product in desired ways is by no means controversial. On the contrary, design disciplines such as interaction design have long traditions for deliberately configuring interfaces between humans and nonhumans (Ingram *et al*., 2007). Tasks may for example be laid out in a sequential manner to increase the ease of use of applications. However, literature on socio-technical scripting goes deeper. Script theory sees technologies as able to influence consumers' behaviour by permitting certain and preventing other actions, but simultaneously, humans are capable of both resisting and complying with the inscriptions. The script concept does not only pay attention to the psychological and physiological factors involved in users' responses, but also contextual, practical and semiotic factors. Normally, multiple socio-technical scripts are embedded. Then, technologies afford several uses, meanings and practices. For example, a TV may be used for watching television shows, as a digital radio, a digital picture frame, a computer monitor or even a heater. It may be seen as a stylish interior element, strengthen the sense of national identity through satellite-connection to life in a country left long ago, trigger fights over what to watch, or be a means for gathering the whole family on a Friday night. Thus, both human and nonhuman actors participate in defining what technologies are and can be used for (Jelsma, 2006a). Agency is seen as an outcome of the relation and interaction between artefacts and humans; as distributed in and emergent from the technology-behaviour relationship (Shove *et al*., 2007). Jelsma (1999; 2006b) introduces four groups of properties for describing scripts. They may also serve as dimensions for designers' decision-making.

- 'Force' refers to the prescriptive force or the extent to which scripts are open or closed. Closing scripts means preventing unwanted use or strengthening stimuli for desired use. However, even closed scripts are open to resistance (Ingram *et al*., 2007). For example, where automatic systems for lighting are installed, people may cover up movement sensors to be in charge themselves. Scripts may also be invisible, meaning that users do not notice how they are configured. Solutions optimising consumer products' energy efficiency are in practice invisible or black-boxed. TVs may dim the backlight in darker scenes, or use built-in light sensors to adjust brightness settings according to surrounding light conditions.
- 'Scale' refers to the level of complexity or breadth in scope of designs; whether scripts are concerned with individual artefacts like washing machines, chains of devices delivering a function such as clean clothes, or whole regimes, such as the dwelling.
- 'Direction' concerns 'to where' behaviour is steered, and depends on how and where so-called gradients of resistance for behaviour are created in the socio-technical landscape. These guide human behaviour, making some routes easy to follow and others harder. Going along with existing rules, beliefs, values and preferences requires less force from scripts. Socio-technical landscapes do however look different for different actor groups and across cultures. People who have grown up with computers may not see them as obstacles, but for older generations the increasing dependency on computers in daily life may be stressful.
- 'Distribution' refers to the distribution of tasks, responsibilities and power between humans and nonhumans. When artefacts fully control a function, it is called delegation or automation.

While useful for theoretically capturing the dynamics between designer, design solution and user, the script concept cannot be used to establish general predictions about responses to 'design for behavioural change' or to optimise systems' reliability. While seemingly omitting the socio-technical context of designers – the business context they operate within, scripts do not make sense when

detached from the socio-cultural context into which they enter. The concept seems to have untapped potential as a means for discussing configuration of users in relation to their socio-cultural and socio-technical context. It implies that for scripts to function as desired, designers need knowledge about the world into which the scripts will fit. The danger is that if such knowledge is deduced and not empirically explored, solutions may end up not working, as the many failed control systems for heating and lighting.

### *3.3 Practice*

New products are incorporated into existing regimes and lifestyles, and can be said to bear with them potential for certain consumption practices (Ingram *et al*., 2007). Reckwitz (2002, p. 249) defines a practice as 'a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge'. Shove *et al*. (2007) argue that individuals actively configure and integrate complex assemblies of material objects into configurations that consist of both material and symbolic components and competencies. From a practice perspective, design solutions and resources are not important in their own right, but with respect to the practices they make possible and the ways in which they are used to accomplish what are believed to be normal ways of life (Ingram *et al*., 2007). Not just artefacts, but also individuals are seen as bearing with them potential for practices, and the different habitual procedures, competencies, understandings and desires are perceived as attributes of practices that humans participate in and nonhumans partly shape, and not as qualities of either human or nonhuman actors. The practice of cooking cannot be reduced to an oven, a kettle or a cook. Ingram *et al*. (2007) argue that due to this interrelatedness and processes where artefacts and practices co-evolve, the *practice* should be the centre of attention, and not artefacts or individuals. This implies seeing the effect production has on consumption as mediated by practices; paying less attention to individual choices and more to how modes of acceptable everyday life behaviour are developed collectively (Warde, 2005).

Viewing consumption from a practice-oriented perspective means highlighting the mutual dependency and effects within complexes of components, opening up questions about what parts of practices artefacts carry knowledge about and potentials for, and how to discourage unsustainable global outcomes. It is imaginable that by placing a practice or activity – what is actually done, rather than single products, at the centre of attention for product and system development, one could open up for larger sustainability improvements. A deeper and more holistic understanding of consumption practices and the actors and structures influencing them might inform development of new solutions emphasising strategic guidance of practice development. This relates to what has been the focus of the field of product service system (PSS) research. Such approaches do however conflict with existing manufacturing regimes, and are likely to require co-production of design solutions in partnerships with other manufacturers and stakeholders. A problem with practice-, product- and user-oriented approaches may be the danger of losing sight of and connection to challenges present in the technology development context, for example related to resources and lock-in to existing tools and manufacturing lines. An opportunity for systematically including the design and business context in the analysis is to conceptualise the co-evolution of technology and society as socio-technical systems (Geels, 2004).

### *3.4 Socio-technical systems and multi-level perspectives on socio-technological change*

To connect the socio-technical contexts of design and consumption, the concept of socio-technical systems is introduced. It has much in common with ANT and scripts. Geels (2004) defines socio-technical systems as the linkages between elements necessary to fulfil societal functions, and splits them into the sub-functions 'production', 'diffusion' and 'use'. These sub-functions consist of the elements or resources necessary to fulfil them, such as artefacts, knowledge, capital, labour and cultural meaning. In contrast to common practice in STS, Geels (2004) analytically distinguishes between three interrelated dimensions: socio-technical system, actors, and institutions and rules. The socio-technical system works as an outcome of activities of human actors embedded in social groups.

The groups have relative autonomy and are internally coordinated, sharing characteristics like roles, responsibilities, norms and perceptions. They interact with each other, forming mutually dependent networks. Their perceptions and activities are guided and coordinated by institutions and rules. The three groups of rules are regulative rules – the explicit, formal ones such as regulations, standards and laws; normative rules, which include values, norms and role expectations; and cognitive rules, such as shared belief systems, expectations and guiding principles. Rules are linked in private or collectively shared rule systems, and are carried and reproduced in actors' activities. As in the script concept, rules are also embedded in artefacts. For economic and material reasons, technologies can be harder to change than other rules, and they can make social relations more durable. As argued in actor-network theory, the socio-technical system with its material properties forms an enabling and constraining context for action. Changes in the socio-technical system arise as effects of actors' moves. For example, improvements in existing or introduction of new technologies may lead to changes in behaviour and the introduction of new governmental regulations.

Further, Rip and Kemp's (1998) model of socio-technical change can explain what happens when new technologies are introduced and how technology and society co-evolve. The multi-level model consists of three levels – micro, meso and macro. The micro level is the niche level. The meso level layer is the level of technological regimes. A regime is the 'rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures' (Rip and Kemp, 1998, p. 338). Regimes are outcomes of earlier changes, structuring changes that follow and working as intermediaries between innovations as they are invented, developed and introduced, and the macro-level socio-technical landscape. The socio-technical landscape on the other hand, comprises the material environments including physical infrastructures and artefacts, shared cultural beliefs, symbols and values.

What usually is called technology diffusion is explained as a transformation process where new technological regimes grow out of the old. When new technologies are adopted, behaviours, organisations and society rearrange themselves in adopting and adapting to them. In these co-evolution processes both technology and the social context change (Rip and Kemp, 1998). Rip and Kemp (1998) argue that novelty evolves within existing regimes and socio-technical landscapes, starting at the micro-level of local practices. There, rules are not yet stable or clear, while they in regimes have become stable and have more structuring effects on the activities performed (Geels, 2004). What happens in the niches often targets problems in the regimes, and the goal is to come up with novelties that can be used in or even replace the regime. This is difficult as regimes are stable – institutionally, organisationally, economically and culturally. Socio-technical landscapes structure activities even more strongly than regimes. Eventually, novelties may however transform the socio-technical landscape (Rip and Kemp, 1998). What counts is adoption, not the introduction of technologies. Adoption and diffusion of a technology reduces uncertainties regarding its capabilities, performances and technical and social interdependencies, and leads to some degree of standardisation. From adoption and standardisation, irreversibility emerges, making the technology difficult to change and a structural factor in itself. Technology implementation, adoption, use and domestication create and maintain social and technical linkages that not easily can be undone.

The multi-level model suggests that it might be possible to steer long-term technological transitions. Strategic niche management (SNM) is one such approach, related to the notion of path dependency. 'Path dependencies refer to the interrelatedness of artifacts with other artifacts, infrastructures and routines' (Rip and Kemp, 1998, p. 354). New technologies have to change or undo existing linkages, and that meets resistance. When authorities or society desire a new technology, not only must it be constructed, but so must the transition path towards it. The idea in SNM is to develop innovations within protected niches while learning processes take place and an 'institutional embedding' or network is built to support it in the transition from niche to regime (Hommels *et al*., 2007). Governmental subsidies or strategic company investments can be used to protect radical innovations against market forces while improving their performance and thus possibilities for succeeding (Geels, 2004). Addressing the governance of socio-technical transitions, Smith *et al*. (2005) call for more attention to the contexts and conditions for regime transformation. They see regime change as a function of the shifting selection pressures regimes continuously are exposed to, and adaptation to these through coordination of resources available inside and outside of the regime.

Over time, the most adaptive regimes are expected to succeed, and the less adaptive to be included in them or substituted. As differences in transition contexts lead to variation in the form and direction of regime change, they propose to map context types according to two dimensions, the first measuring whether or not change is foreseen and actively coordinated by regime members or through overarching governance processes; the second the degree to which responses are based on resources available within the regime or dependent on capabilities only available on the outside. When transitions are based on internally available resources, changes are likely to be more incremental and structural relationships within the regime less likely to be overturned. Internal lack of resources or rigid actor and technology configurations make major structural change more likely. Bringing in the notion of agency, here denoting the ability to change the balance of selection pressures or adaptive capacity, it is emphasised that making changes requires the exercise of political, economic and institutional power through networks of actors and institutions. Agency relates to the relative notion of regime membership, which may be defined related to the degree to which actors participate in carrying out functions reproducing the regime. Thus, Smith *et al*. (2005) propose to see sustainable technology transitions as changes mediated by the resources, interests and expectations of institutionally embedded networks of actors.

## 4. The case of laundering

Next, laundering is used to illustrate the role of technology in sustaining and transforming consumption practices, applying the introduced theoretical frameworks and further exploring their adequacy. Laundering is chosen as an example due to the significance of the interaction between humans, products and systems in determining its overall sustainability impact. 'Doing the laundry' is a necessity, and it is a source of energy, water and detergent consumption. Several products and systems are involved, and while the energy throughput of key technologies may be optimised, the activity is subject to socio-technical and socio-cultural lifestyle- and behaviour-related influences. It is and has been carried out in different ways and for different reasons. Through the use of this example, the intention is to explore and clarify what potential the introduced theoretical frameworks represent for understanding such mechanisms, and for bringing in new perspectives on how to design for sustainable consumption.

### *4.1 The practice of laundering*

For the activity of laundering, collective conventions and expectations related to overarching concepts such as cleanliness and convenience are relevant, and a range of material and symbolic components are involved. This provides the rationale for taking a practice-oriented look at how laundering-related habits and conventions develop, attending to the collective construction and transformation of conventions. At the same time, the notions of scripts, configuration and appropriation are relevant.

Practices have a history – a trajectory or path of development (Warde, 2005). Laundering habits have changed considerably over the last century (Shove, 2003b). While there is no obvious yardstick for measuring the development of laundering-related standards, Shove proposes to think of it as a service shaped and given meaning by a complex consisting of ingredients related to questions like why it is done, what is washed, what washing involves, and when it is done. In 16$^{th}$ century France, changing clothes was seen as a way of refreshing and washing the body (Shove, 2003b). Today, laundering is perceived as almost the opposite; as taking care of clothes that have been in touch with the body. Washing clothes is not just about getting rid of bacteria, dirt and sweat; it is increasingly about recovering smell, texture and freshness. 'What is washed' is related to the number of garments in the wardrobe, the types of fabrics they are made of and how they are treated, reflecting developments in textiles and fashion. For example, the introduction of mass-produced cotton made washing easier, even without a machine, while the introduction of synthetic fabrics like nylon in similar ways further expanded the stocks of machine-washable garments. In 2007, 90 % of Norwegian households owned a washing machine and 45 % a tumble dryer or drying cupboard (Statistics Norway). Laundry-appliances have had a central role in reshaping collective conventions. What it means 'to do the laundry' is intimately related to what is inscribed into appliances in terms of options

and classification of programmes (Shove, 2003b). There is however no one-to-one relationship between appliance design and developments in skills and decision-making in terms of when and why laundering is done. Water temperatures have dropped, for example due to more efficient detergents, but the frequency of laundering has increased. Energy efficiency improvements are offset by increased use and the tendency to wash smaller amounts of garments more often. When it is 'necessary' to wash now generally relates to the goal of having socially suitable items to wear, not to the fear of 'running out'. In 18th century Germany, the amount of clothing owned was an index of social standing (Shove, 2003b). Infrequent laundering cycles would in that sense imply having a comprehensive wardrobe, and reflect a high position in the social hierarchy. In structuring routine and practice, Shove sees the personal sense of obligation as a powerful force. Laundering may even be considered a form of work (Shove, 2003a). While the tools and their use may have some significance for status and identity-construction, washing machines, tumble dryers and irons are utility and not lifestyle products. Style and matching is not as relevant when choosing a washing machine as when picking a sofa, and washing machines are not as likely to be replaced for psychological reasons as cell phones. For facilitation of more sustainable use patterns, this means that strategies for optimising the sustainability performance over products' lifetime are more important than extending their psychological lifetime. Replacement may even be justified when more energy efficient alternatives are available.

Shove (2003a) argues that the constant redefinitions of service and what it means to do the laundry emerge as a consequence of practices, technologies and conventions, and, that for the overall sustainability impact, key technologies' resource efficiency matters less than the service concepts they sustain (Shove, 2003c). Since no fixed measures for cleanliness and convenience exist, it is possible that future concepts will be less environmentally demanding. Given this, the challenge becomes to shift focus from developing efficient technologies, to designing for practices that in sum are more sustainable. A perspective missing from Shove's account is however that laundering practices are embedded in and linked to clusters of other practices, such as time management and the organisation of working life. Wilhite (2008) argues that changes in other practices in the social-cultural context may activate potential that is latent in technologies involved in a consumption activity. To illustrate, he explains that when refrigerators were introduced to South India in the 1960s, interest was low. Food refrigeration conflicted with local ideology and health traditions, and the refrigerators adopted were bought to save space. With time, and with the breakdown of joint family households and women increasingly entering into working life, young families' use patterns changed and refrigerators and freezers were eventually used to store food prepared in bulk. Socio-cultural changes may have activated the potential refrigerators have for saving time spent on cooking. Wilhite (2008) explains this as the socio-cultural context acting together with the potentials embedded in the technology and constituting a distributed agency for changes in consumption practices. When it comes to the opportunities for positively influencing laundering practices through design, this illustrates the need for a deep understanding of users' socio-cultural context, and the mechanisms that influence what notions such as comfort and convenience actually means to people. It is imaginable that similar dynamics can determine whether or not potentials intentionally embedded in laundering-related equipment are activated and thus affect the resulting sustainability impact. The total sustainability gains from large-scale laundering services providing users with the benefit of having clean clothes delivered at their door will be offset if this service, for time-saving and convenience reasons, only comes in addition to individually owned appliances used to wash the most urgently needed garments. Going back to the script concept from section 3.2, this is about 'direction'; gradients of resistance in the socio-technical landscape and how going along with rules, beliefs, values and preferences requires less force. It also opens up questions about where to draw system boundaries, as rebound effects may occur and savings from one area may shift to another.

Bringing in these considerations and departing from what Shove (2003a) distinguishes as the interdependent dimensions of the laundering practice, Table 1 aims to provide an overview of the factors influencing it. Related to each dimension, it lists what influences and configures user behaviour, and how consumers' in turn may domesticate or appropriate the different aspects. The areas most relevant for design intervention are shaded. The table is not intended to be exhaustive, but to provide an overview of the many components influencing the development of practices and their sustainability consequences, thus giving an impression of what the context for technological

interventions is. It does however not say anything about the relative distribution of power or influence on transformations.

*Table 1: The practice of laundering, based on Shove's (2003a) five questions concerning its dimensions*

| **Dimensions of the laundering practice** (Shove, 2003a) | **Material and symbolic aspects configuring users and influencing practices** | **Users' domestication and appropriation** |
|---|---|---|
| *Why launder?* | - Social, moral and medical norms (e.g. remove bacteria, dust mites, dirt, sweat) | - Habits are developed within socially accepted limits (e.g. remove smell, dirt, stains, restore texture and freshness)<br>- Preferences (e.g. style, feel, image, social decency) |
| *What is there to launder?* | - Social, cultural and medical norms<br>- Fashion<br>- Types of textiles, fabrics (wool, silk, linen, cotton, synthetic materials etc.)<br>- Fabric labelling<br>- Climate (both outside and indoors) | - Habits (e.g. sorting garments by colour)<br>- Stocks of fabrics (e.g. number of garments, what is used when)<br>- Way and period of use (e.g. how dirty/sweaty) |
| *When to launder?* | - Social, moral and medical norms (e.g. not on Sundays)<br>- Regulations (e.g. community association)<br>- Availability of technology or services | - Habits (e.g. organisation of daily life)<br>- Personal sense of obligation (e.g. bedclothes 'should' be changed every two weeks, perceptions about what needs washing) |
| *What are the tools of laundering?* | - Social and cultural norms (e.g. cold or hot wash)<br>- Characteristics of and access to infrastructure, availability, quality and cost of resources (water and energy)<br>- Energy and environmental labelling systems (influence on purchase decision, cost of ownership)<br>- Tests, reviews (performance)<br>- Access to washing and drying technology (individual ownership vs. public/ commercial systems) | - Attitudes, values (e.g. whether or not environmental labelling influences purchase decision)<br>- Habits (e.g. detergent brand)<br>- Beliefs, perceptions (e.g. wool should be hand-washed, tumble drying wears out textiles)<br>- Resources (e.g. money, availability of time)<br>- Preferences |
| *How is laundering done?* | - Social, moral and cultural norms<br>- Information campaigns<br>- Design and marketing of washing machines, tumble dryers, drying cupboards, irons: ads, instruction manuals, awards, labels, design and functionality (e.g. feedback on behaviour, energy-saving options, persuasive dialogues, physical steering, clever design, aesthetics), lock-in<br>- Access to and cost of resources (water and energy)<br>- Design and marketing of detergents, rinse aids, conditioners, dyes, bleach<br>- Fabric labelling<br>- Physical environment: space for drying on racks/clothes lines)<br>- Local climate | - Attitudes, values (e.g. whether or not to fully load the washing machine and use eco-programmes)<br>- Habits (using tools for different purposes and in different ways)<br>- Frequency of use<br>- Who does the laundering<br>- Preferences (comfort, convenience, e.g. refreshing clothes in the tumble dryer daily to improve scent and remove wrinkles, preferring the 'fresh feel' clothes lines-drying gives over tumble drying)<br>- Beliefs and perceptions (about efficiency, performance, cultural and symbolic significance, e.g. high temperatures kill germs)<br>- Competencies (e.g. interpretation of functionalities) |

### *4.2 Laundering as a socio-technical system*

The previous section addressed the co-evolution of everyday laundering practices, technologies and conventions. Influences on the laundering system are however not limited to the consumption context and what happens in households. They relate to both design and use – supply and

demand, and the feedback loops between them. For example, the interactions, competitions and cooperation taking place in the sector of companies developing new tools and technologies, are strongly connected to the resulting conceptions citizens have about laundering. To reconnect contexts and elements and enable further studies of actors and their relations, the laundering system is conceptualised as a socio-technical system, drawing on (Geels, 2004).

Socio-technical systems form contexts for action and are maintained and changed by the activities taking place in them (Geels, 2004). While the laundering system is not a system built deliberately like the electricity or sewage system, Shove (2003a) argues that its components are critical to the operation of the totality and what is taken to be normal practice. As she sees it, the actors involved – be they policy-makers, manufacturers or users, deploy their resources in fixing what they identify as problems, opening up for further development, but not necessarily pulling in the same direction. For example, policy-makers may introduce mandatory requirements and labelling systems for energy consumption levels. While complying with these, appliance manufacturers may offset gains by encouraging even more energy-intensive habits in their attempts to satisfy users' perceived desire for convenience, for example by devising tumble dryer programmes for daily refreshing of shirts and removing of wrinkles, eliminating the hassle of ironing. Actions taken and moves made on different fronts have implications for the other actors. Geels (2004) describes this as strategic games of making moves within rules and regimes. Games are played inside and between groups; among consumers, between manufacturers, between industrial actors and authorities. Different actor groups have their own perceptions, preferences, aims, strategies and resources, and act and interact to achieve their goals and strengthen their positions. Manufacturers may aim to tackle sustainability demands by investing in incremental product improvements and using the environmental benefits of replacing old appliances with more energy-efficient ones as a key argument when addressing consumers and policy-makers. In companies, what Shove calls 'problem-fixing' happens for example through R&D. Companies search for new solutions in response to existing or expected regulations, or in the chase for market share and niches. Detergent manufacturers may work on how to make liquid detergents give tumble-dried textiles the smell of clothes dried outside in the fresh breeze, washing machine manufacturers on further reducing their products' resource consumption, and textile manufacturers on developing materials that are solid enough to tolerate frequent washing cycles. Having supply-side actors operate consistently by focusing energy policy unilaterally on energy efficiency seems impossible. Figure 1 visualises the actor groups participating in the socio-technical laundering system; the social infrastructure involved in manufacturing, distribution and use.

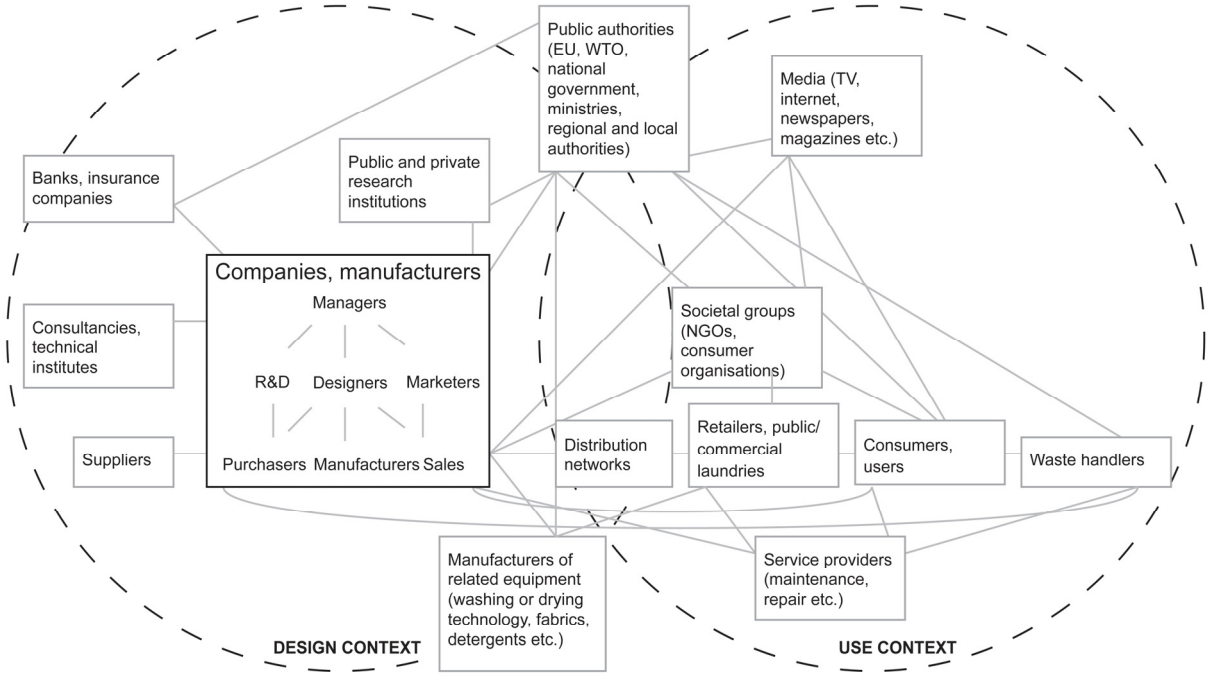


*Figure 1: Actor groups reproducing the socio-technical laundering system, extension of (Geels, 2004)*

Groups have different characteristics, but are interdependent as they interact with each other, align their activities to other groups' activities and form mutually dependent networks (Geels, 2004). Relationships between groups shift over time, and new groups emerge. The agentive power is not equally distributed. What resources actor groups have access to varies, as do their opportunities for realising their interests and changing rules. Negotiations, conflicts and power struggles do take place. Manufacturers of tools like textiles, detergents and appliances have key roles in defining what cleaning implies; what is cleaned and how it is done, with the washing machine being particularly significant. Figure 2 visualises elements involved in the socio-technical laundering system, connected to the sub-functions design, distribution and use.

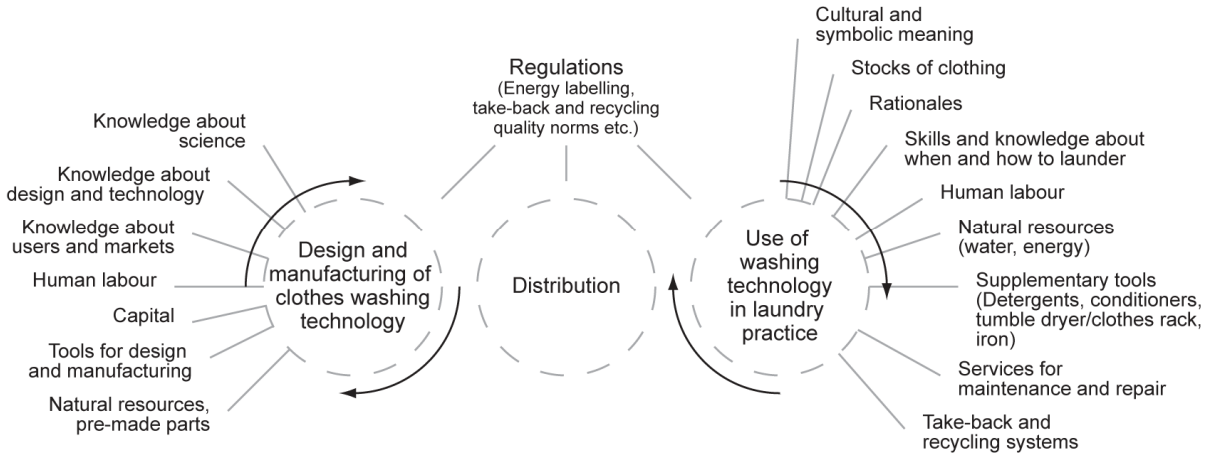


*Figure 2: The sub-functions and elements of the socio-technical laundering system*

The relations between sub-functions and resources (figure 2) and actor groups (figure 1) are dynamic, and outcomes of historical processes of differentiation and specialisation (Geels, 2004). What continuously emerges as definitions of service is a consequence of efforts, practices, innovations and solutions made by multiple actors, driven by their own motivations and strategies, based on the resources they possess. What happens in the conglomerate of sub-systems thus structures the resulting practice and determines the sustainability impact of it.

### *4.3 Opportunities for technological change*

To understand how technological innovation can trigger changes in the way laundering services are understood and delivered, the multi-level perspective on socio-technological change may be useful. A multi-level perspective can make it easier to identify challenges and opportunities for design-led interventions, as well as the broader sets of conditions that need to be in place for initiatives to succeed.

Socio-technical systems are difficult to change as the rules and regimes constituting the previously mentioned strategic game maintain their stability (Geels, 2004). As described in section 3.4, actors operate with cognitive, normative and regulative rules guiding their perceptions and actions. For example, current guiding principles may prevent managers from considering use-related sustainability issues. Moreover, if companies expect that they can meet future sustainability-related regulations with business as usual, focusing exclusively on energy efficiency optimisation as the current regime favours, they will not invest in radical sustainable innovation. Further, the interdependent networks actors and organisations are embedded in also contribute to stabilising the socio-technical system, forming some kind of trust-based capital (Geels, 2004). The characteristics of organisations themselves – their relationships with customers, suppliers and financial institutions, their culture, norms and ideology, further complicate major changes. Additionally, some actors may try to hinder innovations through market control or lobbyism. Central questions are how radical changes are needed, and whether barriers to change have to be removed or solutions developed to fit them. In both

design and use context, the 'hardness' of socio-technical systems created by material components are constraints against change. For example, companies' existing manufacturing facilities and the moulds and tools they have invested in count against going for radically different designs in the next generation of products and product lines. Similarly, in the use context, the compatibility between and the social integration of artefacts in people's lifestyles, as well as the infrastructures and supply chains built up around them hinder replacement. Textiles and detergents are developed for machine washing, and bathrooms and washrooms constructed so a regular-sized washing machine can fit in.

How then, can change happen? While Rip and Kemp (1998) argue that change starts at the micro level, the stability of socio-technical regimes leaves radical innovations few opportunities for leaving the niche condition (Geels, 2004). However, as this stability is a consequence of the actions and interactions between social groups and these not necessarily pull in the same direction, tensions and mismatches may arise. This may be reflected in the rules of socio-technical regimes, creating more space for flexibility and opening up for radical novelties. Tensions may arise for many reasons. Tension on the landscape level, for example caused by threats like climate change, may pressure the regime and cause internal restructuring, for example leading to policy changes. Further, if actor groups acknowledge the existence of internal technical problems, they may turn to R&D and investments in new technical directions. Pressure on the regime may also arise from negative externalities and effects on other systems, often only as they are picked up and pointed to by external actors such as NGOs, external scientists and other companies. For example, controversies concerning the use of nanomaterials in creation of smell-free textiles can arise as researchers and consumer groups express their concern about potential health implications. Also, when user preferences change and established technologies cannot meet them, tensions arise. Finally, strategic games between firms may open up the regime, for example as R&D-related competitions accelerate. The existence of tensions may enable radical innovations to break through in mass markets, entering competition with the existing system and eventually replacing it, with consequences for infrastructure, use practices and policies.

In the context of laundering, a radical shift could for example imply transition from individual appliance ownership to commercial service systems and, in the long run, dematerialisation of laundering practices. Jelsma and Knot (2002) describe the Clothing Care service, a concept based on integration of clothing and textile maintenance. The idea is to offer washing, drying, ironing and folding services, possibly together with dry cleaning, hand wash, fast service, dying, repair, remodelling, take-in and sales of second-hand clothes, and advice on wardrobe management and clothes shopping. The semi-industrial scale of it would give environmental benefits, while customer benefits like flexibility and convenience would be safeguarded by placing depots logically in terms of people's movements, and allowing for drop-off and pick-up of clothes at any time. Lockton *et al*. (2008) imagine augmented versions of existing practices, where washing machines would weigh the garments loaded into them, read information about their treatment from RFID tags and automatically detect the amount of soiling, composing optimal programmes without user intervention. While the conceptual ideas are many, most industrial R&D efforts are invested in incremental improvements (Geels, 2004). Both ideas would require company investments and strategic partnerships between industrial actors and other stakeholders, including thorough processes of consumer research and user- or practice-centred development, to transform or compete with existing regimes. Nevertheless, if efforts are made to refine such innovative ideas, tensions and misalignments as those described above may eventually create openings for technologies carrying potentials for more sustainable practices.

## 5. Conclusion

There are no silver bullets against unsustainable consumption. However, a first step towards more effective interventions would be to abandon the perceived split between behaviour and technology. Seeing behaviours in relation with the technologies enmeshed in everyday consumption practices implies a shift in focus from the attitudes, values and intentions of consumers and the energy throughput of technologies, to the actions and interactions taking place in the socio-technical landscape.

Design researchers investigating the opportunities for pushing consumers towards more sustainable practices through design have largely focused on designers' solution space in relation to individual products and single users. However, the dynamics at play in both design and use context,

reflected in the limited level of design for sustainability implementation in industry and the well-documented, unpredictable ways in which consumers respond to action frameworks inscribed into products and systems by designers, point to the need for taking broader sets of dynamics into account. Here, it is argued that to understand under what conditions design interventions can contribute to making consumption more sustainable, it is necessary to look beyond the relations between designer, design solution and user, and take the broader dynamics in both design and use context into account.

Exploring ways of theoretically framing further investigation into these issues, theoretical concepts from the social sciences emphasising conceptualisation of socio-technical co-evolution have been introduced. A common denominator for the identified concepts is their ability to deal with complexity and their emphasis on sensitivity to the influences from human as well as nonhuman actors and the social-cultural characteristics of everyday life. The strengths and weaknesses of the various approaches in terms of their relevance and ability to improve design researchers' understanding of and support further research on the preconditions for design for sustainable consumption are drawn out in table 2.

As mentioned introductorily, ecodesign and design for sustainability literature has previously been criticised for its lack of business focus (Baumann *et al*., 2002). To fully understand how to make companies engage in facilitation of more sustainable consumption practices through design-led interventions, many issues remain to be addressed. At the same time however, the introduced social science concepts may provide design researchers with new and more nuanced perspectives on the role of companies, designers and design solutions in the evolution of consumption practices, and improve understanding of the conditions for successfully attending to the sustainability implications of use practices in an industrial setting.

For example, the concept of distributed agency is fundamental for discussing the distribution of influential power between humans and nonhumans, and may, as suggested in section 4.1, also be useful for clarifying the role of socio-cultural contexts and changes as agentive and at times even preconditions for activating potentials embedded into technologies. While the notion of scripts was central to the origin of research into 'design for sustainable behaviour', it seems that with Jelsma (1999; 2006a, b) as an exception, design researchers have not fully exploited scripts and their properties as a means for discussing interventions more broadly, also related to socio-cultural contexts and the 'gradients of force' in the socio-technical landscape. Further, there is practice theory, which conceptualises the sustainability impact of a consumption activity as a result of the interplay between the material, behavioural and symbolic ingredients constituting a practice. It may also be used to study and describe practices taking place in the design context, for example related to how work is currently done and why, how that restricts or opens up for taking use-related sustainability impacts into consideration, and whether the empirical understanding of users needed to inform technological scripts is in place or needs to be acquired so design solutions in turn can translate users' actions into sustainable outcomes. For connecting the contexts of design and use and seeing product development activities in relation to other activities, actors and dynamics inside and outside of companies, the concepts of socio-technical systems and multi-level perspectives on technological change seem better suited. By focusing on specific consumption practices, such approaches can possibly contribute to identifying particularly influential actor groups, exploring strategic games taking place between them, understanding why these groups act as they do and how that affects whole systems, and finally, distinguishing what might be the most promising conditions and actor constellations for developing and implementing technological interventions able to make it to the socio-technical landscape level and deliver services in more sustainable ways. Alternation between these concepts may be helpful for theoretically coping with the complex, interrelated socio-technical challenges outlined. As practical development tools however, they may not be as adequate.

*Table 2: Assessment of the introduced theoretical concepts*

| Theoretical concept | Strengths | Weaknesses |
|---|---|---|
| *Agency* | - Agency and power are intimately related, and core issues when addressing the ability to take action in both design and use context<br>- Adequate for discussing the distribution of power and control between humans and nonhumans, as well as for discussing more abstract influences such as contextual changes | - Assigning agency to nonhumans is still controversial, and may render responsibility issues unclear |
| *Actor-Network Theory (ANT)* | - Acknowledges the role of nonhuman actors and socio-technology<br>- Adequate for tracing relations, transformations and translations | - Controversial<br>- Responsibility issues may become unclear<br>- Difficult to avoid discriminating against nonhuman actors |
| *Scripts* | - Useful for theoretically capturing the dynamics between designer, design solution and user<br>- Permits discussing interventions more broadly than 'human-computer interaction' does, related to the socio-technical landscapes and socio-cultural contexts into which design solutions enter | - Cannot be used to establish general predictions about responses to 'design for behavioural change' or optimise systems' reliability<br>- Seemingly neglects the context of designers |
| *Practice theory* | - Focuses on the sustainability impact of a system as a whole, rather than individual products<br>- Adequate for studying the interplay between the components (material, human, symbolic) practices consist of<br>- Practice- or activity-centred development may potentially bring about larger sustainability gains, although require much more from companies | - Complexity and system boundaries, practices must be seen in the context of (clusters of) other, related practices<br>- Attention is drawn away from how individual products are important to people, e.g. in terms of mechanisms like status, novelty, matching, social comparison<br>- Consumption practice- or activity-focused development implies radical shifts from today's business practices |
| *Socio-technical systems and multi-level perspectives on technological change* | - Connects design and use contexts, links product development to other activities, actors and systems inside and outside of the company, is attentive to broader sets of relevant and influential actors and structures, including political economic 'landscapes', socio-cultural contexts and trends<br>- Useful for systematically addressing complexity and long-term dynamics, conceptualising and studying strategic games, and analysing how enabling or constraining a context for action is<br>- Theoretically conceptualise and analyse ongoing dynamics between conflicting regimes<br>- Possible tool for identifying strategies and promising actor constellations, also beyond and not necessarily with the business-consumer relationship as the starting point and core of everything | - Hard to operationalise for short- and medium-term planning |

Although not being the focus of this article, many of the issues addressed might be relevant also to the field of product service systems (PSS). There, the basic idea is to take the functionality desired by users as starting point for business development, instead of the product fulfilling it, to make

consumption more sustainable, and to then develop the business system and partnerships that can provide this functionality. A transfer from individual product ownership to delivery of services does however not guarantee a reduction in overall sustainability impact (Jelsma and Knot, 2002; Mont and Tukker, 2006), and the environmental potential of product service systems has largely been explored in academia (Cook *et al*., 2006). Cross-pollinating design and social science theory might be useful for addressing some of the challenges faced within the PSS field. PSS research might potentially also benefit from attending more thoroughly to the interaction between user and design solution and the behaviour-related dynamics causing sustainability impact, as well as issues related to contextual changes, user acceptance and the value artefacts actually have to people. On the other hand, in addition to drawing on the more user- and task-focused techniques from human-computer interaction, research into 'design for sustainable behaviour' could benefit from borrowing tools, techniques and thinking from the PSS field, where scenario development, use cases and system architecture is emphasised. In its fundamental form however, PSS seemingly represents a more radical shift from current business practices than integration of attention to use-related sustainability implications necessarily does. The PSS field has more in common with practice-oriented development discussed in section 3.3. When it comes to theoretical support and tools for planning the systemic and infrastructural setup for supply of such practice-oriented solutions, as well as facilitation of joint co-production of services, 'design for sustainable behaviour' and PSS have common interest in drawing on perspectives from business management and systems innovation literature, in this article represented by the socio-technical systems and multi-level perspectives on technological change.

To understand under what conditions practical implementation of design-led efforts on facilitation of more sustainable consumption practices can take place, several questions remain for future research to address. A key issue is what it actually takes to successfully design for sustainable consumption in an industrial setting. This relates to how to justify attention to use-related sustainability implications and obtain managerial support, how to effectively operationalise knowledge about users and consumption, what resources are needed in terms of time, financial investments, knowledge, information and strategic partnerships, and how to make sure that development efforts actually translate into effects on consumption practices. These and other issues will be addressed in future publications.

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