Joining Forces: Investigating the influence of design for behaviour change on sustainable innovation

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Abstract
Design is a significant driver of behaviour change, enabling, encouraging or discouraging particular practices from taking place. Despite design's clear influence on behaviours, limited frameworks exist for the effective implementation of Design for Behaviour Change (DfBC) in professional and public contexts. This paper takes a first step towards developing a comprehensive framework map by comparing current models and approaches of DfBC from key areas of ecological sustainability, safety, health and well-being, and social design. The objective being to develop a better understanding of the opportunities and challenges in stimulating ecological and social innovations for lasting behaviour change.

Keywords: Sustainable innovation, design for behaviour change, University-industry collaboration

1   Introduction: sustainable innovation through behaviour change

Herbert Simon's early understanding of design acknowledged its capacity to create change in "devising courses of action to change existing situations into preferred ones" [1]. While the influence of design on human behaviour has been recognised for some time, Design for Behaviour Change (DfBC) has only been recognised formally in the last decade and is still immature and without a (set of) coherent approach(es) or framework(s) for its effective implementation. In response, this paper reviews existing approaches to DfBC from five key design areas in ecological sustainability, safety, health, well-being and social design in order to develop a better understanding of DfBC approaches in the different disciplines and their

relationships. The aim is to provide a first step towards a better understanding, access and evidence based implementation of DfBC across the different fields of its application to stimulate lasting behaviour change. The review identified underlying behaviour change philosophies as well as approaches and toolkits used in DfBC, which are complemented by DfBC examples to illustrate their application. The identified approaches were thematically analysed to map out the different perspectives utilized, common and dominant approaches, and the absence of approaches in each area. These insights have further been used to highlight opportunities and challenges for the effective implementation of sustainable innovation through DfBC. The review is underpinned by an online survey as well as two focus groups with representatives from non-academic stakeholders, especially SMEs who constitute over 99% of businesses in Europe [2], to add further information about the use of DfBC in the innovation process. This paper will focus on the literature review but we will come back to some of the results from the online survey in our conclusion.

2   Designing, change and responsibility

Today, it is widely recognised that design in its various guises of objects, services, interiors, architecture and environments can play an important role in influencing human behaviour [3-8]. Design can create both desirable as well as undesirable change. For example, the impact of cars has been profound with respect to social mobility, transforming cities and increasing resource demand. Computers have transformed the speed, social code and mediums used to communicate. Design also has a history of attempting intentionally to create positive change. For example IDEO's Coasting bike platform sought to address the fact that a large segment of the US adult population were not riding. Despite the population's fond memories of cycling, they were put off by the lycra clad bike brigade and complex bikes. The resulting design took cycling back to basics focusing on the simplicity of cycling to encourage a large part of the population to take to cycling again [9]. Although change is only implicit in this case study and no explicit reference to behavioural change theory was acknowledged, IDEO's design process identified barriers to cycling in complexity, safety and sales. This can be considered as intentional change aligning to Simon's early understanding of design changing existing situations into preferred ones.

While it can be argued that designers have always attempted to utilise design to lead to "preferable outcomes", Jelsma posits that designers should take moral responsibility for the actions that take place as a result of humans interactions with artefacts, intentional or not: 'Artefacts have a co-responsibility for the way action develops and for what results. If we waste energy or produce waste in routine actions such as in the household practices, that has to do with the way artefacts guide us' [10]. Importantly, DfBC, acknowledges this responsibility and for this reason draws on a range of explicit theories, approaches and tools which have been developed with an attempt to encourage pro-environmental and social actions and lifestyles from the user. What we are most interested in in this paper is to explore this relatively new body of work with the explicit focus on designing for behavioural change, while acknowledging that the scope of how design can be applied to change behaviour is broad and extremely multidisciplinary.

At the most elementary level DfBC attempts to understand people, why they behave the way they do, and to use design to encourage them to 'do', or 'not do' something. In this context, the authors of this paper have identified a common divide in designing for behavioural change that can be seen to date back to [11] early understanding of behaviour, that a person's behaviour (B) is a function of his or her own personality, or other 'internal' factors (P) and the physical and social environment (E): $B = f(P, E)$. Clark [12] divides this into BC approaches

that primarily address *cognition*, and those which address the *context* itself, a division which Simon [13] illustrated through the metaphor of a pair of scissors. Both 'blades' shape behaviour, but often a model or technique will concentrate on either cognition (mind) or context (environment). This divide provides an initial framework to position the behavioural change strategies and emerging from the behavioural sciences that we argue have subsequently been adopted and adapted in a design context.

3   Behaviour change: key models and approaches

This section discusses a small number of key behaviour change models, and their use and adaptation into relevant design approaches.

3.1   Behaviour change models from the behavioural sciences

Behavioural science is broadly the study of human behaviour, drawing on insights from economics, psychology and neuroscience. Darnton's review of behaviour change models and their uses outlines 60 social-psychological models of behaviour, distinguishing between models of behaviour and theories of change [14]. The divide between cognition (person, individualistic rational choice models) and context (environment, social structuralist theories) has been used to map out change strategies in Figure 1. The left hand side of the figure illustrates strategies aimed predominately at influencing the individual, where the right side list strategies that may shift the environment.
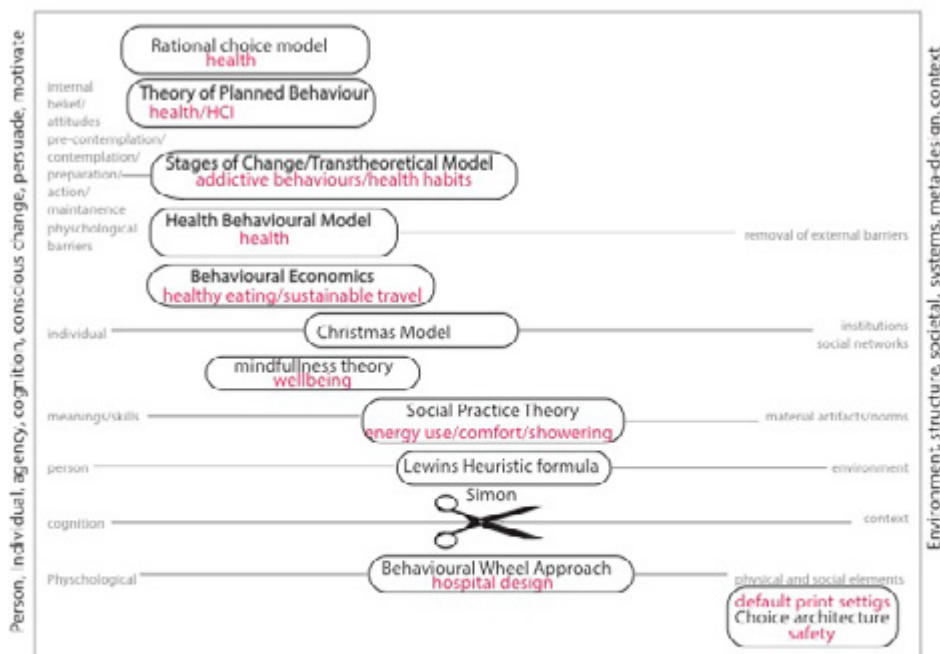

Figure 1. Mapping of BC strategies against the cognition context divide

3.1.1 The individualistic rational choice model

The **individualistic rational choice model** of behavioural change has been dominant in the behavioural sciences, and places agency with an individual to act. The model is founded on three broad principles: choice is rational; the individual is the appropriate choice of analysis; behaviours are self-interested [15]. Theories that follow this model are outlined below.

The ***Theory of Planned Behaviour*** (TPB) describes a group of cognitive theories which understand behaviour as an external expression of internal beliefs and attitudes [16]. It proposes that the intention to act is the best predictor of behaviour. Intention is determined by appraisal (pros/cons, risks/benefits, alignment/ divergence with social norms) of the intended behaviour [17]. It sees the degree of perceived control over the outcome as a factor in determining intention, together with the level of confidence in our capability to achieve the desired goal, the perceived ease or difficulty with which the individual will be able to perform or carry out the behaviour, and the value placed on the outcome. Widely used in health, TPB is useful for predicting behaviour (20-30% of variance) and for retrospective analysis of behaviour change [18]. While TPB is not considered useful for planning and designing interventions to prompt behaviour change per se [19], it is still considered useful in the design process for identifying particular influences on behaviour that could be targeted for change.

The ***Stages of Change model*** (SoC) is also known as the Transtheoretical model (TTM) [20]. First applied to smoking cessation (Sutton et al 2000), it is now commonly applied to other addictive behaviours as well as the design of energy feedback [21]. The model posits that individuals contemplating a behaviour change go through a five step cycle of preparation, or 'levels of motivational readiness'. These stages are (i) *pre-contemplation*, (ii) *contemplation*, (iii) *preparation*, (iv) *action*, and (v) *maintenance*. Individuals may move back and forth between stages. The transition between stages is determined by two factors (i) *self-efficacy* and (ii) *decisional balance*, i.e. the outcome of individual appraisal of the pros and cons of a behaviour [22]. The rationale behind using a staged model is that individuals at the same stage should face similar problems and barriers, and thus can be helped by the same type of intervention [23]. A number of further individualistic agency-oriented models include: the Resistance & Persuasion Model [24], the Heuristic-Systematic Model (HSM) [25], the Elaboraton Likelihood Model (ELM) [26], Behavioural Economics [27], and the Health Belief Model (HBM) [28].

3.1.2 Social structuralist theories

In contrast to the above approaches that focus on individual agency, **social structuralist theories** suggest that the person is not the appropriate level for analysis. Instead, behaviours in many instances can be viewed as consequences of societal norms and expectations that are held in place by the systems of provision and social structures that the individual lives within.

The ***Choice Architecture Model*** [29] is perhaps the strongest systemic model, which considers how people make choices, and influences behaviour through the 'default' setting. It assumes that the design of a product or service can shape the choice of a person's decision, while always allowing them to depart from it. This is known as 'libertarian paternalism'. Public opinion on behaviour change campaigns found major support for all types of intervention, decreasing with "force". Therefore choice architecture models, in creating default behaviours, may have an important role to play within design.

The ***Christmas model*** [30] is a systemic model, which is structured around Nine Big Questions, conceived to support and structure the process of gathering evidence, listening to viewpoints, and making judgments about behaviour change policies and interventions. In a sense this is similar to the SoC model in creating generative tools to interpret in order to develop behaviour change interventions at a systems level. According to the model, behaviour change is typically best served by a mixture of 'tailored interventions', delivered over a long period of time and modified in response to measurement of impact.

3.1.3 Treading the middleground

Several models also propose to mediate the middle ground between individual action and structural approach. **Social practice theory** (SPT) is one that focuses on everyday "practices". SPT is an approach to the study of human practices rather than a model. SPT recognises that human habits and behaviours are themselves arrangements of various inter-connected and dynamic 'elements' that help shape practices as part of our everyday lives [31]. According to Shove [32] three elements are implicated in the final practice: *Materials*, the physical objects that facilitate activities to be performed in specific ways; *Meanings*, symbols, images, interpretations or concepts associated with activities that determine how and when they might be performed; and, *Skills*, knowledge or competencies that permit, or lead to activities being under-taken in certain ways. The approach particularly emphasises the socio-technical infrastructures within which practices occur.

Mindfulness Theories [33] while person-centred, consider the context to create mindfulness. Mindfulness theories, both Eastern and Western approaches, focus on change through intervention that raises awareness of an individuals' situation, context and other variables, and therefore are a useful model for design. The **behavioural wheel model** utilised in health [34] attempts also to cover both spectrums suggesting behaviours can be influenced by changes to the psychological, physical and social settings.

This brief summary illustrates the large breadth of theories from fields in and outside of 'behavioural sciences', articulating both their potential for application in design as well as the sphere where designers may potentially intervene.

4   Design for Behavioral Change: models and toolkits

The common framing from the behavioural sciences is also useful in identifying the mechanisms for DfBC (see Fig. 2), through motivating behaviour or persuading the individual user [7, 35] decisive design that prescribes the desirable or prevents undesirable behaviour from occurring by redesigning the environment [36]. This section examines how designers have adopted behavioural science, and social science theories to develop DfBC models and 'toolkits'.

3.2.1 Design for Behavioural Change models

Design work leading to DfBC's development was initially conducted under the mantel of design psychology or behavioural design, a term first coined by Don Norman in the 1980s with respect to product design [8]. Models have progressed to be more explicit in influencing behaviour, from emotion design [37], persuasive technology [38] to Design with Intent [35].

The Transtheoretical Model has been used to derive a new framework to design for healthy behaviour [39]. The framework reflects that designers need to consider the different stages which people go through to durably change their behaviour. It provides examples of how design interventions aimed at adopting a healthier lifestyle correspond to the different stages of change. For example, the range of activity measuring apps and devices that is available on the market today may work for people who are in *action* or *maintenance* stage (and, therefore, willing to make a change) but will most likely not reach people in earlier stages (those who are not yet willing to change).

In an environmental context, Stern [40] has developed a framework that discusses both cognitive and structural aspects from an actor oriented perspective which emphasises target behaviours, while Renström and Rahe [41] use goal-framing and affective design theories to design for pro-environmental behaviour. In contrast, Wever et al [42] are promoting a user

centred design for sustainable behaviour approach to encourage industry to design products in such a way that people will be persuaded to use them in an environmentally friendly way. A third approach [43, 44] introduces Sustainable Consumption Behaviour into design. This approach combines a user centred design methodology, consumption behaviour and behavioural intervention strategies to explore how knowledge within these domains can be used in an industry context to stimulate innovative solutions supporting actions for a decreased consumption of resources. In a review of this area, Boks [45] has identified that a lack of common terminology, formalized research protocols and target behaviour selection are still key issues for this approach.
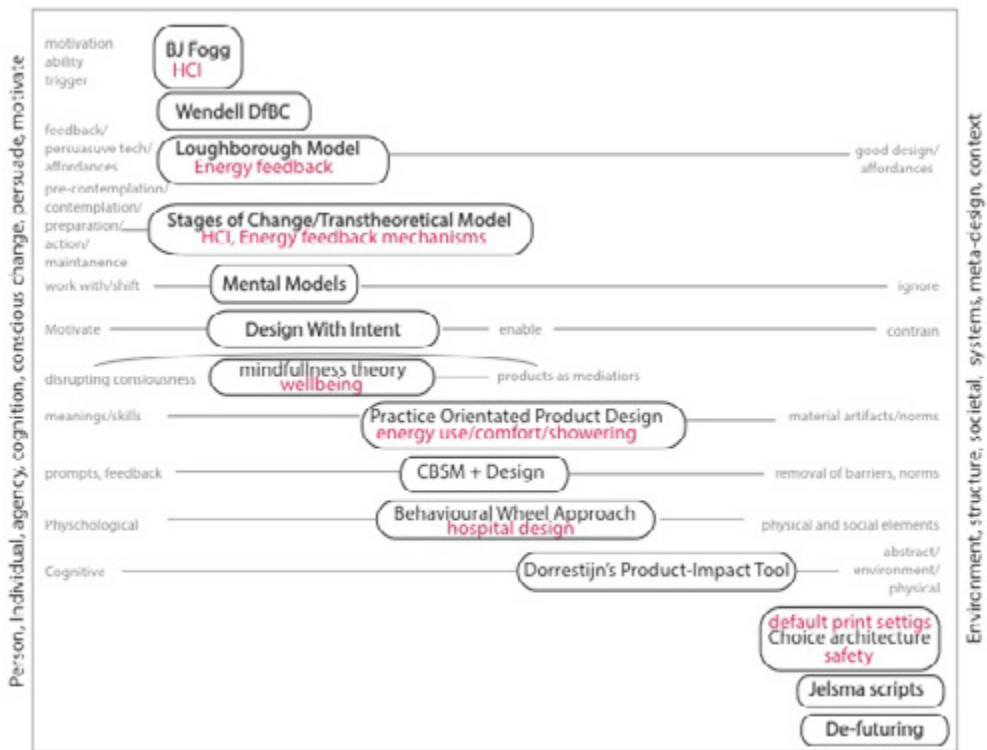

Figure 2. Mapping of DfBC strategies against the cognition context divide

Langer's theory of mindfulness [46] has been adopted by Niedderer [7, 47] to develop the concept of mindful design to encourage responsible user action and choice. Mindful design seeks to achieve responsible action through raising critical awareness of the different options rather than relying on a safe default situation. To design for more social behaviour, Tromp et al [36] have created a framework that distinguishes four types of influence (*decisive, coercive, persuasive and seductive*) that people experience and that differ on two underlying dimensions: force (weak or strong influence) and salience (implicit or explicit influence). An example discussed by both from their different perspectives is the traffic junction in Drachten, NL, where Monderman took away all signs causing drivers actively to think about how to navigate their environment and to take responsibility for managing the traffic system to improve the situation [48]. The related area of practice-orientated product design is an emerging area that is attempting to apply understanding of SPT to design, that would ultimately shift everyday practices [49, 50]

The above approaches use BC models to provide an understanding of the user's mental models for designers. Mental models can be broadly described as "knowledge of how the system works, what its components are, how they are related, what the internal processes are, and how they affect the components". They thus allow designers "not only to construct actions for novel tasks but also to explain why a particular action produces the results it does" [51]. Within the design process, understanding user behaviour in context, through investigating users' own understanding and mental models of the systems, is critical if a user's current model leads to undesirable, dangerous, or inefficient actions. This then gives the designer the options of designing e.g. to shift the user's mental model (if incorrect) to a more accurate one, perhaps by making the 'system model' evident or by increasing the repertoire of models available to the user. Alternatively, one might redesign a system so that it appears to work in the way that the user assumes, working with the existing model even if incorrect. For example, redesigning thermostat controls to following users logic [52].

The alternative to working with mental models is for designers to outright ignore users' mental models—while still trying to influence behaviour. The most obvious ones are related to safety, where the designer is interested in a particular 'safe' behavioural outcome regardless of whether users' understanding is 'correct' or not. For example, preventing undesirable or erroneous behaviour to increase safety, as in the example of anti-ligature furnishings and fixtures in mental health units [53].

3.2.2 Design for Behavioural Change 'toolkits'
The above models have been appropriated into more prescriptive 'toolkits' to provide step-by-step guidance for DfBC to designers. Fogg's behavioural model for persuasive technology combines both [54]. Drawing on theories from psychology and behavioural economics, it focuses on *motivation, ability,* and *triggers* (prompts) to encourage or discourage users to act in desired ways. The model has a matrix to guide designers on which tools to use depending on whether they wish to encourage or discourage one-off or on-going behaviours. Wendell's 'DfBC' 'Behaviour Grid' [55] based on behavioural economics draws heavily on Fogg. In an ecological context, the "Loughborough model" of DfBC [56, 57, 58] draws on *feedback, behavioural steering (constraints* and *affordances)* and *persuasive technology*. The majority of examples cited in the Loughborough model relate to providing feedback to energy and water users. These different models are predominately associated in influencing the individual, for example developing a pill organiser to minimise or prevent medication errors [59].

Design with Intent [35] outlines multiple tools and techniques that enable, motivate or constrain the user to encourage desired actions. Drawing on a diverse set of theories, it proposes eight lenses by which to understand various aspects of personal behaviour and contexts from a diversity of fields. Also in an ecological context, Clune's model of DfBC [60] appropriates Mackenzie-Mohr's Community Based Social Marketing [61] into design. Utilising tools such as prompts, norms, incentives, commitments, communication and the removal of barriers, the model focuses most strongly on contexts, and suggests that the behaviour expected to change should be specific, and is best addressed at the level of the local community.

The above DfBC models and toolkits are positioned heavily at influencing targeted behaviours. By contrast, Dorrestijn's Product-Impact Tool [62] assesses the impact that technical products have on user behaviour. It was used to assess the Dutch RFID public transport e-payment mechanisms. The tool is one of the few that also seeks to understand how technology (products and visions) have driven change through history. This broader impact of

design driving change is not at the fore of the dominant DfBC approaches, yet appears at times in the Design for Sustainability literature, [e.g. 63, 64].

In summary, the overview over both models and toolkits suggests that the more complex the action or problem, the further away it moves from individual agency, and the more challenging it becomes to identify specific product level solutions.

5　Implication of DfBC for Sustainable Innovation

The previous section has provided a summary review of cross-disciplinary behaviour change approaches in design. The review has provided the first step towards developing a cross-disciplinary design framework for behaviour change in that it has put into context DfBC approaches from across different areas of application, including health, environment, social design etc. The benefit of such a framework will be to assist designers in selecting and / or positioning the approach they are using when designing for behavioural change. As for now, the review has charted and put into relation the various models' influences with regard to the individual or the structural context, or both, acknowledging Simon's view that change occurs at the intersection between cognition and context.

The mapping of approaches has identified that there is a dominance of approaches within DfBC models that focus on creating change through targeting the individual, as opposed to the context. The lack of focus on contextual impact is challenging for design practice in that all design creates change, yet design is traditionally bad at reviewing the impact of the products on all aspects of everyday life because of its complexity. In practice, change via design therefore remains to a large extent implicit and, even though acknowledged, as a consequence is dealt with poorly. This absense compounds when attempting to find explicit examples of intentional change to demonstrate the relevance of DfBC.

The review found that examples of DfBC generated via the application of any explicit method or toolkits were limited. Most examples retrofit theories and philosophy to an existing real world example. This suggests an urgent need for more field controlled trials, and systematic longitudinal studies that measure DfBC impacts. This need was underlined by the results of the online survey and focus groups with SME representatives, which were conducted as part of the research. The results indicated that the accessibility of DfBC models, in terms of both understandability and availability, serves as another obstacle for the application of these models in the innovation processand that clear and relevant examples and evidence of the impact of DfBC will be key for non-academic stake holders, in particular SMEs, to successfully implementing DfBC solutions.

This need is further compounded by reports on SMEs and behaviour change [65] which do not include design, or where examples are not explicit about their behaviour change goals, about their success or how they were evaluated. Therefore in the field trials will be essential to further the understanding and impact of DfBC. Such trials could also be used to determine which design strategies can best be used to design for which kind of change.

6　Conclusion: Developing an evidence base for DfBC

This paper has reviewed and compared current models and approaches of DfBC. The review has illustrated how the behavioural sciences have informed the dominant DfBC models with focus at creating change by influencing the individual, as opposed to context or environment. It has further shown that the cross-pollination of research areas can provide positive development for design approaches through the transfer of established models from one area

into another. The review has also identified a lack of a coherent evidence base to support the implementation of DfBC. While clearly there is a rich and developing literature base, the lack of evidence may limit the application of DfBC in the market place unless it is addressed. Therefore, we propose that in depth research and trials are needed to generate relevant examples and evidence, and that a collection point for such examples would also be desirable to assit in advancing DfBC for sustainable innovation.

Acknowledgements

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