Product Design Theory and Methods for Changing User Behaviour

by

Jayesh Srivastava

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy

Graduate Department of Mechanical and Industrial Engineering University of Toronto

© Copyright by Jayesh Srivastava 2016
Product Design Theory and Methods for Changing User Behaviour

Jayesh Srivastava
Doctor of Philosophy
Graduate Department of Mechanical and Industrial Engineering
University of Toronto
2016

Abstract

Design for behaviour-change is a growing field with a great deal of potential. Changing the behaviour of users through products and services can help users be happier, companies be more profitable and also help mitigate environmental problems. My research goals were to gain a good understanding of human behaviour models, models of product-user interaction and design methods for generating concepts that solve behaviour-change problems. First, I developed an ontology to formally represent and connect the varied sources of literature. Next I developed a new way of studying and working with the notion of affordances and using that to design products that change behaviour. Finally, I discuss a multi-motive framework that allows designers to change the behaviour of users with different needs, apply many different types of behaviour change strategies and be able to work on problems of many different types. This model and design tool were tested with student and professional designers who both derived benefits from it. Directions for further development of this work include testing the efficacy of the products designed using the methods presented in this dissertation to change user behaviour.
Acknowledgments

नहि ज्ञानेन सदृशं – There is nothing quite like knowledge in this world

Alla sätt är bra utom de dåliga. – All methods are good, except the bad ones

I am grateful for the consummate guidance and support of my supervisor, Professor L. H. Shu throughout the course of my doctoral studies. I am also thankful to the Department of Mechanical and Industrial Engineering at the University of Toronto, the National Science and Engineering Research Council of Canada, and the Social Science and Humanities Research Council of Canada for funding my research.

I would also be remiss without acknowledging my parents for their inspiration and love and my friends for their constant support.
# Table of Contents

Product Design Theory and Methods for Changing User Behaviour.................................i
Acknowledgments..................................................................................................................iii
Table of Contents....................................................................................................................iv
List of Tables............................................................................................................................viii
List of Figures...........................................................................................................................ix
Introduction...............................................................................................................................1

1 Reviewing the Literature of Behaviour Change..............................................................2
   1.1 Theories of Human Behaviour.......................................................................................2
      1.1.1 Antecedents: Psychologists, Behavioural Economists and Behavioural Scientists agree that behaviour is predicated on common elements.......2
      1.1.2 Processes: Behaviour is often explained as a product of two mental systems, one fast acting, the other slow acting.................................6
   1.2 Products influence users...............................................................................................14
      1.2.1 Designers have a say in how products influence users........................................14
      1.2.2 Users can interact with products in unexpected ways........................................15
      1.2.3 Affordances offer a way to discuss the three factors important in user-product interaction.................................................................................15
   1.3 How do we design products and services to influence users? ...............................20
      1.3.1 Design theorists face three kinds of design challenges....................................20
      1.3.2 Design methods address these design challenges in five ways......................21
   1.4 It is important to know when it is permissible to influence users..........................29
      1.4.1 Prescriptive ideals of behaviour..........................................................................29
      1.4.2 Descriptive frameworks of behaviour ................................................................29
      1.4.3 Applying ethical tests to behaviour-change problems is difficult..................30
      1.4.4 Ensuring that designers apply these tests is not possible...............................32
1.4.5 Checklists could be easier to understand and enforce.............................32
1.5 Conclusion: The State of Behaviour Change Research.............................33
2 Organizing the Literature of Design For Behaviour Change.............................34
  2.1 Formal methods of representing knowledge........................................34
  2.2 The Behaviour-Change Ontology (BCO).............................................35
    2.2.1 Ontology syntax.............................................................................35
    2.2.2 Source material for the ontology..................................................35
  2.3 Structure of the BCO............................................................................35
    2.3.1 Problem Type................................................................................35
    2.3.2 Barriers.........................................................................................36
    2.3.3 Principles.......................................................................................36
    2.3.4 Strategies......................................................................................37
    2.3.5 Mechanisms...................................................................................37
    2.3.6 Applications...................................................................................39
    2.3.7 Authors..........................................................................................39
  2.4 Navigating the ontology...........................................................................40
  2.5 Planned benefits of the ontology............................................................40
  2.6 Example..................................................................................................42
  2.7 Limitations of the BCO that became apparent with repeated use.............43
    2.7.1 Using the ontology can be complex..............................................43
    2.7.2 Updating the ontology has limitations.........................................44
3 Changing User Behaviour through Affordances..........................................46
  3.1 Introduction............................................................................................46
  3.2 Affordance based design..........................................................................47
    3.2.1 Challenges in affordance-based design........................................47
    3.2.2 Designing features to afford product uses.....................................47
3.2.3 How sociocultural norms are acquired.................................................48
3.2.4 Sociocultural norms and affordance perception.................................49
3.2.5 Intentionality and affordance perception...........................................50
3.2.6 Sociocultural norms, intentionality and the benefits of absence...........50
3.3 The Affordance of Absence......................................................................53
  3.3.1 Major Dimension: Physical absence...............................................53
  3.3.2 Minor Dimension: User control.......................................................55
  3.3.3 Minor Dimension: Permanence of absence.....................................57
3.4 Summary of the affordance of absence phenomenon.............................59
3.5 Applying Affordance of Absence............................................................59
  3.5.1 Absence of material at the part level...............................................59
  3.5.2 Absence of part at the product level.................................................60
  3.5.3 Absence of product at the system level............................................62
3.6 Discussion and Summary.........................................................................63
  3.6.1 Relation to affordance-based design...............................................64
  3.6.2 Limitations of the affordance of absence method.............................65
4 Persuasion, User Heterogeneity and Motivation.........................................67
  4.1 Recapitulating behaviour literature......................................................67
  4.2 The multi-motive framework: A design framework and method for generating concepts to behaviour-change problems.................................................67
  4.2.1 Motives: Strategies grouped by how the user perceives the benefit of the behaviour.................................................................70
  4.2.2 The Dimension of User Control: Strategies grouped by how much control the user has.................................................................71
  4.2.3 Concept Polarity: The notion of positive and negative concepts.........72
4.3 Experimental validation of the multi-motive framework..........................72
  4.3.1 Methods............................................................................................73
  4.3.2 Results...............................................................................................77
4.3.3 Discussion.................................................................................................79
4.3.4 General findings ........................................................................................81
4.3.5 Results........................................................................................................83
4.3.6 Discussion and summary for Section 4.3.....................................................86

4.4 Evaluating and Refining the Multi-Motive Method........................................89

4.4.1 Study 1: Student designers using the multi-motive design method vs. 6-3-5 method..........................................................................................................................89
4.4.2 Study 2: Professional designers using the multi-motive method ..........93
4.4.3 Summary for section 4.4...............................................................................98

Conclusion ..........................................................................................................100

References ..........................................................................................................104
List of Tables

Table 1.1: Models of Behaviour – p19  
Table 1.2: User-Artefact Interactions – p27  
Table 1.3: Design Methods for Behaviour Change - p33  
Table 3.1: Object usage observed in Bangladeshi Groups – p62  
Table 3.2: Building materials in Bangladesh – p63  
Table 4.1: Confirmatory Factor Analysis (CFA) – p88  
Table 4.2: Correlation between motive and concept ratings – p88  
Table 4.3: Multiple Regression Analyses to Test Relationships between Concept Ratings and Motivation-Type Assessments – p89  
Table 4.4: Confirmatory Factor Analysis (CFA) – Trial 2 – p95  
Table 4.5: Correlation between motive and concept ratings – Trial 2 – p95  
Table 4.6: Multiple Regression Analyses to Test Relationships Between Concepts and Motivation Type Ratings- Trial 2 – p96  
Table 4.7: Qualitative ratings of the multi-motive method (n=10) - p108
List of Figures

Figure 2.1: Schematic of the Ontology structure - p48
Figure 2.2: Map of the ontology – p51
Figure 2.3: Web interface for BCO - p55
Figure 3.1: Multi-function rescue tool – p60
Figure 3.2: AidPod – p64
Figure 3.3: Pan with removable handle – p67
Figure 3.4: AltaVista and Google landing pages from 1999 – p68
Figure 3.5: Sloped top of hallway lockers – p69
Figure 3.6: Resilient House – p73
Figure 4.1: The multi-motive framework – p79
Figure 4.2: Concepts generated for the reusable grocery bag and elevator tasks – p85
Figure 4.3: Modifications to the egoistic bags – p92
Figure 4.4: Modifications to the sociocultural bags – p93
Figure 4.5: Modifications to the altruistic elevator concept – p94
Figure 4.6: Completed matrix of ideas to encourage stair usage – p99
Figure 4.7: Average Concepts generated per group member – p102
Figure 4.8: Number of strategies explored by each group – p103
Figure 4.9: Photograph of whiteboard version of the multi-motive method – p106
Figure 4.10: Number of strategies explored by each group - p107
Introduction

In this dissertation I present my research efforts aimed at better understanding how we can design products and services that change user behaviour. Being able to change user behaviour has many potential benefits. Firstly, it addresses an important market need. Consumers are clearly interested in buying products that help them adopt new behaviours (e.g., living a healthier lifestyle, cessation of bad habits, increasing their productivity etc.). Secondly, companies are also clearly interested in modifying the behaviour of their users to improve their business profitability. A telecom company wants its customers to pay for hardware upgrades more frequently, restaurants want happy customers to share good reviews on social media, automotive companies would like their customers to service their cars more frequently etc. Thirdly, large scale changes in user behaviour can help mitigate many societal and environmental problems. For example, encouraging people to adopt less wasteful behaviours can significantly reduce a society’s resource consumption. In this dissertation I discuss the following:

Chapter 1: A review of literature relevant to the study of behaviour change and the study of design for behaviour change

Chapter 2: Formally relating the disparate sources of knowledge that scholars of design for behaviour change have to be familiarized with. Also added is a method for using these formal relationships to generate ideas for behaviour-change problems.

Chapter 3: A new theory of using affordances (or their absence) to change user perceptions and a method for applying this theory and generate solutions for behaviour-change problems in a simpler way.

Chapter 4: A framework and design tool for addressing user and problem heterogeneity and generating solutions for behaviour-change problems.
1 Reviewing the Literature of Behaviour Change

Over the course of my research, I reviewed a myriad of sources on the topics of:

1. human behaviour
2. behaviour change
3. user-product interaction, and
4. design for behaviour change.

While reviewing these topics, I gleaned particular insights which prompted further investigations and became the bases for my research directions. In this chapter I highlight those insights. For readers interested in a quick overview of the field, I have included a set of tables at the end of the chapter which summarize the main points of the major theories discussed here.

1.1 THEORIES OF HUMAN BEHAVIOUR

Reviewing prevailing models of human behaviour was necessary in order establish a foundation for my research. These models offer explanations for why people behave the way they do. Though the sources reviewed vary greatly in scope, methodology and intent, the information they present can be divided into two categories: antecedents and processes. Antecedents are the factors/parameters used in the model of behaviour being presented. Processes are the causal connections made between those antecedents as well as other explanations of how behaviour occurs.

1.1.1 ANTECEDENTS: PSYCHOLOGISTS, BEHAVIOURAL ECONOMISTS AND BEHAVIOURAL SCIENTISTS AGREE THAT BEHAVIOUR IS PRECICATED ON COMMON ELEMENTS

Four antecedents of behaviour occur across many different behaviour models. They are summarized below:
1. **Personal Norms** and **Social Norms** predict behaviour

   » Norms represent expectations we have internalized about how we are supposed to behave. Two commonly discussed types of norms are Personal Norms and Social Norms. Personal Norms are expectations of behaviour we have of ourselves, based on reasoning or past experience (Thøgersen, 2009; Doran & Larsen, 2016). Personal norms are experienced as moral obligations. Social Norms are expectations for behaviour formed based on what how we expect others to behave in a situation (**descriptive social norms**, Cialdini 1990) or how we think others expect us to behave in a situation (**injunctive social norms**, Cialdini 1990). Social norms are experienced as social pressure. Personal and social norms were identified as significant antecedents of behaviour in three major behavioural models. Schwartz’s (1977) Norm Activation Theory cites personal norms as the main motivators of behaviour. Triandis (1977)'s Theory of Interpersonal Behaviour postulates that behaviour is produced by three antecedents (**intention**, **habit** and **facilitating conditions**). Personal and social norms are two of the determinants of **intention**. Ajzen’s (1991) Theory of Planned Behaviour suggests that behaviour is produced by three factors, of which social norms are one. The significance of social and personal norms is also present in theories that specialize in describing pro-social and pro-environmental behaviour. Weber et al. (2004) state that, when social dilemmas arise (i.e., when people choose between serving their own needs vs. helping others), the degree to which a person identifies with the larger group is one driver of their decision making. Hirose (1994) modelled pro-environmental as being driven by a person’s assumption of personal responsibility to act (i.e., a Personal Norm) as well as an intention to comply with social norms. Stern’s (2000) landmark theory on pro-environmental behaviour has Personal Norms as one of its four major components. Steg & Vlek (2009) in their review of pro-environmental behaviour research list personal and social norms under **moral and normative concerns** as one of the six factors that influence pro-environmental behaviour. Norm (including personal and social norms) is the first of ten factors listed by Kurisu (2015) as encouraging or hindering...
pro-environmental behaviour. Finally, Klöckner & Blöbaum (2010) list normative processes (including personal and social norms) as indirect influencers of behaviour.

2. Individual Differences/Personality Attributes (e.g., motivations, values, emotional states, abilities) predict behaviour
   » Psychologists agree that there are individual personality characteristics that predict a person’s behaviour. Theories discuss a variety of such characteristics. Psychologists also agree that these characteristics vary by the person and by the situation. Bandura’s (1977) Self-Efficacy theory states that people can have very different levels of self-efficacy, which is their confidence in being able to perform an action. High or low self-efficacy in a situation determines peoples’ likelihood of performing an action. People can have different levels of self-efficacy at different times, in different situations and because of innate differences. Ajzen’s Theory of Planned Behaviour (1991) makes reference to a similar notion that it calls perceived behavioural control. Perceived behavioural control is a person’s perceived ease or difficulty of performing a behaviour. A higher perceived behavioural control increases the likelihood of a person performing a behaviour. The previously discussed Triandis’ (1977) Theory of Interpersonal Behaviour has individual emotional states as an antecedent of behaviour. A person’s affect or emotional state predicts his/her intention to perform a behaviour. Another of Bandura’s foundational theories, the Social Cognitive Theory of Behaviour (1986), calls all these personality characteristics personal factors (personal factors include individual expectations, beliefs and self-perceptions) as one of the three main antecedents of behaviour. Deci & Ryan (2000)’s Self Determination Theory states that a person’s motivation for performing behaviour is dependent on three personal factors: his/her feeling of autonomy in a situation (the amount of perceived independence), his/her feeling of relatedness to others in the situation and his/her assessment of his/her own competence (i.e., self-efficacy). In the pro-environmental and pro-social literature, individual factors are also discussed. Rosenstock et al.’s (1988) Health Belief Model lists perceived self-efficacy as one of the six
factors that determine pro-health behaviours. Ölander & Thøgersen's (1995) see behaviour as the product of consumer motivation (based on beliefs, attitudes and intentions). Stern's (2000) theory of behaviour change lists people’s values (What they think about doing things for themselves, for other people and for the environment) as the earliest determinants of behaviour. Kollmuss & Agyeman (2002) have a category called internal factors (awareness of the environmental problems, values, beliefs etc.) as one of the two groups of antecedents of behaviour. In summary, the theories reviewed here differ in the personality characteristics they focus on but all agree that personal characteristics/individual differences are strong predictors of behaviour.

3. **External/Situational Factors** predict behaviour

   » As would be expected, the characteristics of a situation can predict how people will behave in that situation. This is borne out in the theories reviewed. Triandis’ (1977) Theory of Interpersonal Behaviour calls these facilitating conditions that enable or hinder behaviours. Bandura’s (1986) Social Cognitive Theory of Behaviour calls these environmental influences. References to external factors in the pro-social and pro-environmental behaviour literature also occur. Steg & Vlek (2009) include external factors (described by them as contextual factors) in their six predictors of environmental behaviour. Klöckner & Blöbaum (2010) also have external factors (called situational influences) as one of the three types of direct influences in their Comprehensive Action Determination Model of Environmental Behaviour. Ölander & Thøgersen's (1995) model of pro-environmental behaviour change includes situational conditions as one of the three determinants of pro-environmental behaviour. Kollmuss & Agyeman (2002) see pro-environmental behaviour as a product of two antecedents, one of which is external factors. Finally, Kurisu’s (2015) model of pro-environmental behaviour counts external factors (called surrounding conditions) as one of its ten factors.

4. The mapping between **Behaviour Attributes** and **Personal Attributes** predicts behaviour
How well a behaviour maps to a person’s personality is also a recognized predictor of his/her likelihood of performing that behaviour. How close a behaviour is to a person’s existing habits, is one of the main antecedents of behaviour in Triandis’ (1977) Theory of Interpersonal Behaviour. Csikszentmihalyi (1988)’s Flow theory states behaviours that have an element of ease-of-action (i.e. how well they map to the person’s abilities) become attractive to people. Tversky & Kahneman (1974) describe the phenomena of heuristics and cognitive biases which are automatic mental shortcuts people often use to make decisions without expending much cognitive effort. If characteristics of behaviour make it map to well to a particular mental shortcut, it is more likely to be performed. In the prosocial and pro-environmental behaviour literature, Kollmuss & Agyeman (2002) discuss existing behavioural patterns as possible hindrances to picking up new behaviours, Steg & Vlek (2009) have habitual behaviour as one of nine factors that influence behaviours, Klöckner & Blöbaum (2010) list habitual influences as one of three direct antecedents of pro-environmental behaviour and Kurisu (2015) includes habit as one of ten major factors behind pro-environmental behaviour. Thus, the matching between the characteristics of behaviours and people can predict people’s likelihood of acting in a particular way.

1.1.2 PROCESSES: BEHAVIOUR IS OFTEN EXPLAINED AS A PRODUCT OF TWO MENTAL SYSTEMS, ONE FAST ACTING, THE OTHER SLOW ACTING.

In reviewing the various behavioural models discussed here, one particular conceptualization of how the human mind decides to act appears again and again. Evans & Stanovich (2013) explain it as the Dual Process Theory of Higher Cognition. It states that cognitive tasks elicit two types of mental responses. The first type of response (Type 1 Processing) is autonomous, quick and often arises due to past experience, instinct or extensive practice. The second type of response (Type 2 Processing) actively engages cognitive faculties and is slower and more deliberative. The reviewed models in the literature often make use of one or both of these types of processes in their explanations of behaviour. The Heuristics and Cognitive Biases described by Tversky &
Kahneman (1974) are mental shortcuts that people take when assessing situations or making decisions. These belong to Type 1 Processing. Thaler & Sunstein's (2008) concept of nudges is based on creating situations where a person's quick Type 1 reactions lead to the type of behaviour we want to encourage.

Thus, the literature on behaviour models is quite varied but two elements appear frequently:

1. The recognition of personal/social norms, individual factors, external factors and the mapping between the person and the situation as determinants of behaviour

2. The process of behaviour described as being either autonomous and reactive or reasoned and deliberate
Below is a tabulated summary of the behaviour models (both general and those targeted to pro-environmental and pro-social behaviours) listed chronologically.

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>AUTHORS</th>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Models of Behaviour</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Heuristics and Biases    | Tversky and Kahneman (1974) | Decisions and assessments are often based on mental shortcuts that can lead to errors. They can be grouped under 3 main categories:  
Representativeness  
People think that an item or person belongs to a particular group if some attributes of the item or person match the stereotypical representative of that group. E.g., people might expect a person described as being “quiet” to more likely be a programmer than a pilot even though no information about that person’s profession has been given.  
Availability  
People assess the frequency or likelihood of an event by the ease with which prior occurrences of that event can be brought to mind. E.g., people whose neighbours’ homes have been burgled are likely to overestimate the frequency of burglaries in their community.  
Adjustment and Anchoring  
People often make estimates by starting from an initial value which is then adjusted to yield the final answer. E.g., expensive items on restaurant menus are often displayed in eye-catching ways in order to anchor the diners’ price expectations. Diners are then willing to pick a more expensive meal than they otherwise would have. |
| Self-Efficacy Theory     | Bandura (1977)             | Self efficacy is individuals' confidence in their ability to perform an action. Self efficacy has 3 dimensions:  
1. Strength (Strong vs. weak sense of self-efficacy)  
2. Generality (Self-efficacy across many situations vs. self-efficacy in only some situations)  
3. Level/Difficulty (Having self-efficacy in only easy tasks vs. having self-efficacy in even difficult tasks) |
| Norm Activation Model    | Schwartz (1977)            | Personal Norms (feelings of moral obligation) guide behaviour. Personal norms are determined by 2 factors:  
1. Awareness of the consequences of a behaviour  
2. A feeling of responsibility for performing the behaviour |
| Theory of Interpersonal Behaviour | Triandis (1977) | Behaviour has 3 main antecedents:  
Intention  
Intention has 5 determinants:  
1. Self Identity  
2. Personal Normative Beliefs (How the user thinks he/she is expected to behave)  
3. Perceived Social Norms (Role Beliefs / Normative Beliefs)  
4. Perceived Consequences  
5. Affect (emotions and emotional state)  
Habit (current frequency of the behaviour)  
Facilitating Conditions (external factors) |
| Social Cognitive Theory of Behaviour | Bandura (1986) | Behaviour is described as one component in Triadic Reciprocal Determinism where Behaviour, Personal Factors and Environmental Influences all function as interlocking determinants of one another.  
1. Behaviour (actions)  
2. Personal Factors (Expectations, beliefs, self-perceptions, goals, intentions, sensory abilities, physical structure of individual, emotional state)  
3. Environmental Influences (Situations) |
| **Flow Theory** | Csikszentmihalyi (1988) | People are intrinsically motivated to perform behaviours when the behaviours offer enjoyment and engagement. A state of “flow” (that leads to enjoyment) is characterized by 5 factors:
1. A holistic feeling of being immersed in an activity
2. A merging of action and awareness
3. Focus of attention on a limited stimulus field
4. Lack of self-consciousness
5. Feeling in control of one’s actions and the environment
Flow is only possible when the person has a high enough level of skill in performing the activity and the task is challenging enough. |
| --- | --- | --- |
| **Theory of Planned Behaviour** | Ajzen (1991) | Behaviour is a result of intentions. The Intention to act depends on 3 determinants:
1. Attitude Toward the Behaviour (The degree to which the user has a favourable or unfavourable appraisal of the behaviour)
2. Subjective Norm (The perceived social pressure to perform or not to perform the behaviour)
3. Perceived Behavioural Control (The perceived ease or difficulty of performing the behaviour) |
| **Self Determination Theory** | Deci & Ryan (2000) | People can express different levels for motivation for performing behaviours. Levels of motivation fall along a continuum:
1. Amotivation (Lack of motivation)
2. Externally regulated (Engaging in behaviour to gain rewards or avoid punishment)
3. Introjected (Engaging in behaviour to feel worthwhile or to avoid feeling guilty)
4. Identified (Choosing a behaviour because you recognize its importance or see it as a valid solution to a problem)
5. Integrated (Choosing a behaviour because it’s consistent with your self-identity)
6. Intrinsic (Choosing a behaviour because it is intrinsically interesting or enjoyable)
The further on this continuum an individual’s motivation is, the more likely they are to sustain a behaviour over the long term. An individual’s degree of motivation depends on 3 situational factors:
1. Autonomy (Perceived control over the situation)
2. Relatedness (Perceived connectedness to others)
3. Competence (Perceived self-efficacy and proficiency) |
| **Glucose Model of Self-Control** | Gailliot, Baumeister, DeWall, Maner, Plant, Tice, Brewer, Schmeichel (2007) | This model connects willpower to physiological processes. It states that:
- Performing acts of willpower reduces blood glucose levels
- Low blood glucose following an act of willpower predicts poor performance on subsequent self-control tasks
- Replenishing glucose reduces or eliminates the self-control impairments from an initial self-control task |
| **Evolutionary-Ecological Model of Motivation** | Aunger and Curtis (2013) | This model states that motives are psychological mechanisms that produce behaviour that solves evolutionarily important tasks for humans
There are 3 categories of motives:
**Physiological Motives (Related to Bodily Functions)**
- Lust (to propagate one’s genes)
- Hunger (to acquire metabolic resources)
- Comfort (to maintain body)
- Fear (to avoid hurt from out-group threats)
- Disgust (to avoid hurt from in-group threats)
**Situational Motives (Related to External Conditions)**
- Attract (to acquire attention from potential mates)
- Love (to maintain reproductive relationships)
- Nurture (to protect and support offspring) |
<table>
<thead>
<tr>
<th>Dual Process</th>
<th>Proficiency Motives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory of</td>
<td>hoard (to acquire</td>
</tr>
<tr>
<td>Higher</td>
<td>surplus consumable</td>
</tr>
<tr>
<td>Cognition</td>
<td>resources and power)</td>
</tr>
<tr>
<td></td>
<td>create (to modify</td>
</tr>
<tr>
<td></td>
<td>the world around</td>
</tr>
<tr>
<td></td>
<td>us to make it</td>
</tr>
<tr>
<td></td>
<td>more amenable)</td>
</tr>
<tr>
<td></td>
<td>affiliate (to</td>
</tr>
<tr>
<td></td>
<td>cooperate and</td>
</tr>
<tr>
<td></td>
<td>seek alliances</td>
</tr>
<tr>
<td></td>
<td>with peers)</td>
</tr>
<tr>
<td></td>
<td>status (to</td>
</tr>
<tr>
<td></td>
<td>accumulate</td>
</tr>
<tr>
<td></td>
<td>resources and</td>
</tr>
<tr>
<td></td>
<td>power, to</td>
</tr>
<tr>
<td></td>
<td>acquire</td>
</tr>
<tr>
<td></td>
<td>recognition)</td>
</tr>
<tr>
<td></td>
<td>justice (to</td>
</tr>
<tr>
<td></td>
<td>preserve social</td>
</tr>
<tr>
<td></td>
<td>structures and</td>
</tr>
<tr>
<td></td>
<td>to preserve the</td>
</tr>
<tr>
<td></td>
<td>environment)</td>
</tr>
<tr>
<td>Evans and</td>
<td>curiosity (to</td>
</tr>
<tr>
<td>Stanovich</td>
<td>seek new</td>
</tr>
<tr>
<td>(2013)</td>
<td>sensations and</td>
</tr>
<tr>
<td></td>
<td>knowledge)</td>
</tr>
<tr>
<td></td>
<td>play (to acquire</td>
</tr>
<tr>
<td></td>
<td>skills and</td>
</tr>
<tr>
<td></td>
<td>mastery)</td>
</tr>
</tbody>
</table>

This theory describes two kinds of thinking that explain how people make decisions. Cognitive tasks evoke two forms of processing that contribute to observed behaviour.

**Type 1 Processing**
- Autonomous and does not require controlled attention
- Tends to be rapid
- Can include processes of emotional regulation, implicit learning and rule-based decision making that has been practiced to the point of automaticity

**Type 2 Processing**
- Used for tasks that use working memory and general intelligence measures
- Includes hypothetical thinking and consequential decision making

| Trans-      | Behaviour change has 5 stages: |
| Theoretical  | 1. Precontemplation |
| Model of     | 2. Contemplation    |
| Behaviour    | 3. Preparation      |
| Change       | 4. Action           |
| Prochaska,   | 5. Maintenance      |
| DiClemente,  |                   |
| Norcross     |                   |
| (1992)       |                   |

**Health Belief Model**
- Behaviour depends on 6 factors:
  1. Perceived susceptibility to problem
  2. Perceived severity of problem
  3. Perceived benefits of solutions
  4. Perceived barriers to action
  5. Cues to action
  6. Perceived self-efficacy

<table>
<thead>
<tr>
<th>Models of Pro-social Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interdependence Theory</td>
</tr>
<tr>
<td>Thibaut and Kelley (1959),</td>
</tr>
<tr>
<td>Kelley et al. (2003)</td>
</tr>
<tr>
<td>Many decisions require</td>
</tr>
<tr>
<td>compromise between one’s own</td>
</tr>
</tbody>
</table>
| needs and the needs of others.
| Any decisions between two     |
| partners in a dilemma can be  |
| modelled as a product of the  |
| following 9 factors:          |
| 1. The structure of the situation |
| 2. Level of dependence of each partner on the other |
| 3. Mutuality of dependence (whether one partner has more power in the situation than the other) |
| 4. Basis of dependence (the ways one partner influences the other’s outcomes) |
| 5. Covariation of interests (whether the partners’ outcomes correspond or conflict) |
| 6. Temporal structure (the length of the situation, impact of the current situation on future situations) |
| 7. Informational availability (how much each partner knows about the five factors listed above) |
| 8. The psychological processes of each partner (needs, thoughts and motives) |
| 9. The interaction pattern between partners |
1. Recognition of a situation (whether a situation is recognized as being cooperative or not)  
2. Identity (the degree to which the person identifies with the larger group)  
3. Decision Rules and Heuristics (Personal rules about how to behave in various situations) |
|---------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------|
| Nudge Model | Thaler and Sunstein (2008) | Humans have 2 decision making systems:  
1. System 1 is Impulsive and Spontaneous  
2. System 2 is Deliberative and Mindful  
Nudges are prompts that take advantage of the difference between these two systems to influence behaviour |
| MODELS OF PRO-ENVIRONMENTAL BEHAVIOUR | | |
| Two-Phase Model | Hirose (1994) | Pro-environmental behaviour is modelled as a two phase process. In Phase 1, the user develops a Goal Intention.  
Goal Intentions are based on:  
1. The perceived seriousness of the environmental problem  
2. The ascribing of responsibility for acting on the user  
3. A belief in the effectiveness of the behaviour  
This leads to the Behaviour Intention.  
Behaviour Intentions are based on Goal Intentions as well as:  
1. The feasibility of the behaviour  
2. The costs/benefits associated with the behaviour  
3. Concordance with social norms around the user |
| Motivation Ability Opportunity Model of Pro-Environmental Behaviour | Ölander and Thogersen (1995) | There are 3 determinants of pro-environmental consumer behaviour:  
1. Motivation (Based on user beliefs, evaluation of outcomes, attitudes toward the behaviour, user intentions and social norms)  
2. Ability (Knowledge of the task/behaviour, and the ease of performing the behaviour)  
3. Opportunity (situational conditions that make the behaviour possible) |
| Value-Belief-Norm theory of Environmentalism | Stem (2000) | Behaviour is modelled as a series of phases:  
**Values**  
Biospheric  
Altruistic  
Egoistic  
**Beliefs**  
Ecological worldview (Results of values)  
Adverse consequences for valued objects (Result of Ecological worldview)  
Perceived ability to reduce threat (Result of Adverse Consequences for valued objects)  
**Personal Norms**  
Sense of obligation to take pro-environmental actions (Result of Perceived Ability to Reduce Threat)  
**Behaviours (The final phase)**  
Activism  
Non-activist public-sphere behaviours  
Private sphere behaviours  
Behaviours in organizations |
| Model of Pro-Environmental Behaviour | Kollmuss and Agyeman (2002) | Pro-environmental behaviour is a product of Internal and External Factors.  
1. Internal Factors have to do with Environmental consciousness (knowledge of the problem, feelings/ emotions, values, attitudes).  
2. External factors have to do with infrastructure and the social, cultural and political situation around the user.  
Pro-Environmental behaviour can be hampered by:  
1. Old problematic behaviour patterns  
2. Lack of external incentives or possibilities  
3. Lack of internal incentives  
4. Negative or insufficient feedback about behaviour  
5. Lack of environmental consciousness |
| Goal Framing Theory | Lindenberg and Steg (2007) | Environmental behaviour is governed by 3 types of goals  
1. Hedonic goals (pleasure, excitement, avoiding effort)  
2. Gain goals (money, status, resources)  
3. Normative goals (what “ought” to be done)  
One goal is prioritized in every situation. Personality traits and situational factors affect the strength of the goals. |
| Integrative Review of Pro-Environmental Behaviour Change | Steg and Vlek (2009) | The factors that influence environmental behaviour can be described as follows:  
1. Motivational Factors  
2. The comparison between costs and benefits of environmental behaviours  
3. Moral and normative concerns (user values, level of environmental concern, personal norms and moral obligations to act pro-environmentally, social norms to act pro-environmentally)  
4. Affect (the emotional response of the user)  
5. Contextual Factors  
6. Habitual Behaviour |
| Comprehensive Action Determination Model of Environmental Behaviour | Klöckner and Blöbaum (2010), Klöckner (2013) | Behaviour is determined by 3 types of direct influences:  
1. Intentional (Intentions, Attitudes, Beliefs)  
2. Situational (Objective Constraints, Subjective Constraints)  
3. Habitual (Schemata, Heuristics, Associations)  
The three are combined with indirect influence from: Normative Processes (Values, Social Norms, Personal Norms, Awareness of Need, Awareness of Consequences) |
| Stage Model of Self-Regulated Behavioural Change | Bamberg (2013) | Behavioural change has 4 stages, each with a set of predictors:  
1. Preadoption (Dependent on Personal Norms, Emotions Associated with Goal Progress and Perceived Goal Feasibility)  
2. Preadoption (Dependent on Attitude towards the suggested behaviour intervention over alternatives and Personal Norms)  
3. Action (Dependent on Ability to plan, Ability to adapt to new situations, and Confidence in maintaining a plan)  
4. Postaction (Ability to recover from a lapse in behaviour) |
| Pro-Environmental Behaviour | Kurisu (2015) | Pro-environmental behaviours can be encouraged or hindered by the following factors:  
1. Norm (Whether the behaviour matches personal rules, external expectations, moral expectations or something the user sees other people doing)  
2. Attitude (whether the behaviour is considered good, necessary or considered environmentally friendly)  
3. Affect (whether the behaviour is cool or enjoyable)  
4. Cost and Benefit (whether the behaviour saves money or time)  
5. Knowledge (user understanding about the behaviour)  
6. Ability (whether the behaviour is easy to do) |
7. **Habit** (whether the behaviour is habitual or easily forgotten)
8. **Opportunity** (whether there are many chances to perform the behaviour)
9. **Surrounding conditions** (whether there are products/facilities available to perform the behaviour)
10. **Sub-effects** (whether the behaviour is good for health or comfortable)
1.2 PRODUCTS INFLUENCE USERS

Modern philosophers of science recognize that technologies and products are more than just tools humans use to achieve their ends. The technologies also affect the humans interacting with them. The philosopher Don Ihde (1990) posited the notion of mediated relations that describes the different ways that artefacts mediate how humans interact with the world. Verbeek (2008), building on work by Latour (1987), adds that when humans and artefacts are interacting, it is difficult to ascribe agency to only one party. Humans interact with the artefact and the artefact interacts back, and both together interact with the world. This provides philosophical foundation for the notion that artefacts affect humans.

1.2.1 DESIGNERS HAVE A SAY IN HOW PRODUCTS INFLUENCE USERS

The way an artefact affects the human it is interacting with (hereafter called user) is determined by the designer of the artefact (hereafter called product). Akrich (1992) uses the concept of scripts to describe how designers think about the products they design. Designers assume particular characteristics about their intended users: their preferences, demographics, expectations etc. Designers also assume particular characteristics about the environment where their designed product will be used: the availability of resources, the moral expectations of society, economic conditions, state of science etc. This vision of the world is said to be inscribed into the product, with designers expecting users to “follow a script” or “assume a role” when interacting with the product.
1.2.2 USERS CAN INTERACT WITH PRODUCTS IN UNEXPECTED WAYS

The designer’s inscription is only a prediction and users may end up assuming a different role or following a different script than the one envisaged by the designer.

User-product interactions thus depend on three factors:

1. The designer’s intended use for the product
2. The user’s perceived use of the product
3. The uses of the product that are actually possible given the characteristics of the product and the environment where it is used

1.2.3 AFFORDANCES OFFER A WAY TO DISCUSS THE THREE FACTORS IMPORTANT IN USER-PRODUCT INTERACTION

In the design literature, the concept of affordances has been used to talk about designer’s intended uses, the user’s perceived uses an the actually possible uses of a product. The use of the term is not always consistent however and therefore it is helpful to review its history.

Affordances were first defined by Gibson (1979) as that which is offered, provided or furnished to an animal by the environment around it. To be an affordance, the animal must also be able to make use of what is being offered, provided or furnished. For example, a large animal cannot use a small rock as shelter. As such, affordances were defined as complementary and dependent on both the characteristics of the environment as well as the animal.

Affordances were brought into the design literature by Norman (1988) working in HCI tradition. Norman was the first to refer to the term as the uses that products can afford their users. Initially, Norman’s definition was centered on the user’s perspective: that is, affordances were the uses of a product that a user imagined. In his later work (Norman, 1999) made a clearer distinction between uses of a product perceived by a user versus uses that were actually possible with the product, respectively terming them perceived affordances and real affordances. For example, all chairs have the real affordance of
sitting (by definition) but whether a chair can be carried varies depending on the design of the chair and the strength of the user. Users may even perceive a chair to be carryable even when it cannot be carried by them. Here, Norman first laid out the possible disconnect between the designer’s intent and the user’s perception.

The disconnect between user perceptions and designer intents is important to consider. Misattribution of affordances can occur in two ways: users’ can perceive affordances that are not real and users may not perceive some real affordances of the product at all. For example, a chair may not afford sitting to a particular user if (s)he does not have appropriately long legs to be able to sit in it. My past work (Srivastava & Shu, 2013) discusses these very same distinctions among user-perceived uses, designer-intended uses and actually possible uses. To conclude this introduction, it is important for the reader to appreciate that the definition of affordances is still not fully agreed upon. Brown & Blessing (2005), Still & Dark (2012), Burlamaqui & Dong (2015a) and Brown & Maier (2015) all note the lack of consistent usage and meanings for the term and offer clarifications. For my work, it has been most productive to discuss affordances as potential product uses and that is the definition I will be carrying forward. Table 1.2 provides more detail about the history of human-artefact interactions and the history of the terminology around affordances. Also included are notes about how affordances are related to functions, which are more commonly used in mechanical design work.
<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>AUTHORS</th>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actor Network Theory</strong></td>
<td>Latour (1987) (as described by Walsham, 1997)</td>
<td>Actor-Network Theory is a way of describing social-technological relations. Humans and technological artefacts are described as actors in a network that work towards aligned interests together</td>
</tr>
<tr>
<td><strong>Mediated Relations</strong></td>
<td>Ihde (1990) (as summarized in Van den Eede, 2010)</td>
<td>Ihde is a philosopher was one of the first to describe how artefacts/products (called technologies in his parlance) mediate people’s experience with the real world. The user has an effect on the product and the product has an effect on the user. He explains four ways that technologies can mediate people’s relations with the world: 1. Embodiment relations — The technology enhances or adds to existing human abilities to interact with the world (e.g., eye-glasses) 2. Hermeneutic relations — The human gains new abilities to perceive the world through the technology (e.g., electron microscopes) 3. Alterity relations — The human has a relationship with the technology as an entity in and of itself (e.g., the relationship a car enthusiast might have with his/her car) 4. Background relations — The human does not think about the technology very much but the technology still has an effect on the human (e.g., a domestic HVAC system)</td>
</tr>
<tr>
<td><strong>Scripts</strong></td>
<td>Akrich (1992)</td>
<td>Products have inherent scripts in them: - The vision of the world incorporated in an object - The program of action the product is supposed to accomplish</td>
</tr>
<tr>
<td><strong>Cyborg Mediation</strong></td>
<td>Verbeek (2009)</td>
<td>Verbeek adds to Ihde’s four types of human-technology relations, with a new, fifth type of relation: 5. Cyborg relations — Humans and technology intentions become unified in perceiving and interacting with the world. Humans direct technologies and technologies direct humans to form a composite way of interacting with the world</td>
</tr>
</tbody>
</table>

**AFFORDANCES**

<table>
<thead>
<tr>
<th>Affordances in Psychology</th>
<th>Gibson (1979)</th>
<th>&quot;Affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill&quot; - Affordances depend on the ability of the environment to provide a function as well as the ability of the organism to make use of that function (having only one of these is not enough) - Affordances either exist or do not exist, there is no ambiguity - A surface at knee-height of a person, affords sitting for that person - Products can facilitate certain user behaviours through affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordances in Product Design</td>
<td>Norman (1988)</td>
<td>Affordances are the fundamental properties of an artefact that determine how it can be used - These properties can be perceived or real - A chair affords sitting; chairs also usually afford carrying</td>
</tr>
<tr>
<td>Affordances</td>
<td>Norman (1999)</td>
<td>- Designers should focus on perceived affordances, rather than real affordances - Perceived affordances are the actions a user thinks are possible with a product - Sometimes perceived affordances relate to real affordances, sometimes they do not</td>
</tr>
<tr>
<td>Signifiers</td>
<td>Norman (2008)</td>
<td>Signifiers are clues present in the design of the product that tell the user how to use it - Signifiers can be deliberately placed by the designer or accidental and a result of product features</td>
</tr>
<tr>
<td>Affordances</td>
<td>Norman (2013)</td>
<td>Affordances refer to the relationship between the properties of an object and the capabilities of an agent (person/animal/robot) - A chair can afford sitting provided that the person has the right leg length to sit in it</td>
</tr>
</tbody>
</table>
| Affordances | Gaver (1991) | **Affordances are absolute and exist regardless of user perception**  
- Inspiration from Signal Detection Theory (affordances can be present in a user-artefact pairing but they still have to be noticed by the user)  
- Hit (affordance is there and perceptible)  
- Miss (affordance is there but not perceived)  
- False Alarm  
(affordance is not there but perceived to be there)  
- Correct Rejection (affordance is not there and not perceived) |
|---|---|---|
- Function has to do with user expectations of artefact uses  
- Behaviour is what the artefact does (e.g. a pendulum swings)  
- Structure is the elements of the artefact and their connections  
- Functions are described as user desires |
| Affordances | McGrenere and Ho (2000) | **Affordances are action possibilities or offerings**  
- Affordances exist regardless of the user's ability to perceive them  
- Affordances can be nested under other affordances (e.g., a button can afford pressing and also afford starting/stopping a machine)  
- Affordances can be sequential (a button can afford pressing, which can lead to a door opening)  
- There are 2 dimensions that relate to affordances and design:  
1. The ease with which the affordance can be undertaken  
2. The ease with which the affordance can be perceived and understood |
| Affordance Based Design | Maier and Fadel (2008) | **Affordances describe the potential-use relationships that exist between a user and an artefact**  
- Affordances also describe relationships between two artefacts  
- Affordances are much broader than functions and functions can be described as a subscript of affordances  
- Functions are necessarily transformation of matter or energy  
- Affordances offer a more natural way to collect user needs, because users think in terms of affordances  
**Method:** Convert user needs (i.e., the things the user wants) into affordances, either user-artefact or artefact-artefact |
| Object Identification | Bub, Masson and Bukach (2003) | **Brain activity tests showed that there were two ways that people perceive object affordances**  
1. Relating to the functional/properties of the object (i.e., the actions the object was designed to perform; when shown images of a doorbell, the gesture of poking was primed in the brain)  
2. Referring to the shape of the object (i.e., the actions that are possible because of the way the object is shaped; when shown a doorbell, the gesture of grasping was also primed in the brain) |
| Affordance Perception | Borghi and Riggio (2008) | **Two new ways of describing artefact affordances:**  
**Stable affordances:** those uses of the artefact that are perceptible even when the artefact is in an unusual orientation or has parts missing (e.g., using a pencil for writing is apparent as a use even when it is sideways or broken) |
<table>
<thead>
<tr>
<th>Affordances</th>
<th>Pols (2011)</th>
<th><strong>Temporary affordances</strong>: those uses of the artefact that are only apparent when it is in the correct orientation or context (e.g., the use of shaving brush to spread shaving foam becomes less obvious if the brush is shown upside down)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordances</td>
<td>Burlamaqui and Dong (2015a, 2015b)</td>
<td><strong>Affordances are “cues of the potential uses of an artefact by an agent in a given environment”</strong>&lt;br&gt;- Affordances are cues that invite an agent to act upon the artefact&lt;br&gt;- Affordances perception has 2 dimensions:&lt;br&gt;1. <strong>Classification</strong> — how obvious the intended uses of the object are, regardless of external context (strongly classified objects have in intended use that is easily discernable in many different situations, weakly classified objects have intended uses that become less apparent if the context changes)&lt;br&gt;2. <strong>Framing</strong> — how many different uses the object is capable of fulfilling (Strongly framed objects can do little more than their expected use, weakly framed objects can be used for many different purposes depending on the users’ intent and creativity)&lt;br&gt;- Functions are what an artefact is capable of being used for, as relating to the artefact’s purpose</td>
</tr>
<tr>
<td>Affordances, Functions and Use Plans</td>
<td>Pols (2015)</td>
<td><strong>Function</strong>: The purpose of the product that can be realized with its <em>rational proper use</em>&lt;br&gt;<strong>Proper use</strong> — The purpose(s) for which a product has been designed&lt;br&gt;<strong>Rational use</strong> — The purpose(s) for which the user can justifiably expect the product to be used for&lt;br&gt;<strong>Affordances</strong> — Opportunities for action&lt;br&gt;<strong>Use Plan</strong> — The series of actions the user needs to take to accomplish the intended purpose of the product</td>
</tr>
<tr>
<td>Affordances</td>
<td>Glâveanu (2016)</td>
<td>Glâveanu has developed a new definition for affordances to reconcile the fact that affordances depend on properties of the artefact, properties of the user and expectations the user has of the artefact based on past experience.&lt;br&gt;<strong>Affordances are represented through a Venn diagram of three overlapping circles.</strong>&lt;br&gt;<strong>Circle 1: Materiality</strong> (the “could”)— The actions that are possible to be performed with the artefact based on its physical properties&lt;br&gt;<strong>Circle 2: Intentionality</strong> (the “would”)— The actions that the user wants to perform with the artefact based on his/her appraisal of it&lt;br&gt;<strong>Circle 3: Normativity</strong> (the “should”)— The actions it is considered correct to perform with the artefact based on how the user has been socially conditioned to interact with the artefact&lt;br&gt;The intersection of the three circles represents the “conventional” or “canonical” uses of the products (i.e., those uses that are possible because of the artefact properties, intended by the user, and considered normal by social expectations)</td>
</tr>
</tbody>
</table>
1.3 HOW DO WE DESIGN PRODUCTS AND SERVICES TO INFLUENCE USERS?

Products influence users and many different methods have been proposed in the literature to help designers change user behaviour. I reviewed nineteen recently developed methods and frameworks that aim to help designers solve behaviour-change problems. Most methods work by connecting the behaviour-change problem to a strategy that can be used as a starting point for generating concepts. Strategies are guidelines that instruct the designer to think of concepts in a specific way (e.g., a strategy could be: make the goal behaviour easier to perform by reducing the number of steps in the task).

1.3.1 DESIGN THEORISTS FACE THREE KINDS OF DESIGN CHALLENGES

There are three challenges that design theorists grapple with when devising behaviour-change design methods:

1. Behaviour-change problems can differ greatly from one another, and a good method must accommodate these differences
2. The end users targeted by designers can also vary greatly in their preferences. Designers must find a way to satisfy a large enough number of them to make the product or service viable
3. Product and service designers are typically not used to working on behaviour-change problems and need guidance to ensure that they focus on the behavioural aspects of the problem

All of the methods reviewed recognize and address at least one of these design concerns.
1.3.2 DESIGN METHODS ADDRESS THESE DESIGN CHALLENGES IN FIVE WAYS

The design methods reviewed adopt one or more of the five following tactics to address the design challenges discussed above.

1. **Provide designers with a large menu of strategies**
   Many methods provide the designer with a menu of behaviour-change strategies that have been developed from a theoretical basis or have been found from past studies. The designer is then expected to choose strategies from the menu based on what is appropriate for his/her behaviour-change problem. Menu methods offer flexibility but make the designer responsible for selecting suitable strategies. More experienced designers will therefore be better at selecting appropriate strategies.

2. **Sorting the problem into categories and then recommending a smaller set of strategies**
   Other methods guide the designer through a problem-definition phase which helps sort the behaviour-change problem into one of several pre-determined categories. The designer is then given one or more behaviour-change strategies best suited for that category of problem. I hereafter refer to these methods as **problem pre-categorization** methods. Pre-categorizing methods offer more guidance to the designer but the small number of strategies they recommend can limit creativity.

3. **Sorting the intended user into categories and then recommending a smaller set of strategies**
   Another way of guiding the designer is by sorting the behaviour-change problem according to the type of user that is the designer’s target. There are several **user pre-categorization** methods that recommend different strategies depending on characteristics of the user.

4. **Make designers think of concepts along solution dimensions**
   There are also some methods that help the designer think of applying strategies in different levels of intensity. These methods focus on a smaller set of strategies, but treat them like **dimensions** of the solution space. For example, it is known that interrupting a
user can be a good way of stopping them carrying out an undesirable behaviour. This notion is captured in the **obtrusiveness** dimension used in the design method developed by Daae & Boks (2014). Designers are made to think about how obtrusive they want their solution to be. I will refer to these methods hereafter as dimension methods. As with menu methods, the designer selects the appropriate level of each dimension and his/her judgment plays a role in the quality of the solution.

5. **Focus designer attention on the steps of the process to ensure they emphasize the correct aspects of their problem**

Finally, there are many methods that focus on making sure that the designers prioritize the right things during the design process, or that the design process is carried out in the right order. I will refer to these methods as **process** methods hereafter.
The nineteen methods reviewed are described in Table 1.3, and coded to show which of the five tactics discussed here they employ.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Authors</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Liking</strong> (People like those who like them)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uncover similarities with the user/consumer and offer genuine praise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Reciprocity</strong> (People repay in kind)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Give the user/consumer what you want to receive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Social Proof</strong> (People follow the lead of similar others)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the power of peers whenever it’s available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Consistency</strong> (People align with their clear commitments)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make the users’/consumers’ commitments active, public and voluntary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Authority</strong> (People defer to experts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expose your expertise and experience to users/consumers, do not assume it is self evident.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Scarcity</strong> (People want more of what they can have less of)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highlight unique benefits and exclusive information.</td>
</tr>
<tr>
<td>Value Sensitive Design</td>
<td>Friedman, Kahn and Borning (2002)</td>
<td>An iterative method with 3 main areas of investigation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Conceptual investigations</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Determining direct and indirect stakeholders affected by the design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Determining the values relevant to the stakeholders and any value tradeoffs that might need to be made</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Empirical Investigations</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Learning more about the stakeholders through empirical methods including observations, interviews, surveys, experimental manipulations, literature review, measurements of behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Testing prototypes using empirical methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Technical Investigations</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Studying how technologies support or hinder the stakeholders’ values</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Designing systems to support the values identified in the conceptual investigation</td>
</tr>
<tr>
<td>Fogg Behaviour Model</td>
<td>Fogg (2009)</td>
<td>Behaviour is a product of 3 factors:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Motivation</strong> (Pleasure/Pain, Hope/Fear, Social Acceptance/Rejection)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Ability</strong> (Time, Money, Physical Effort, Brain Cycles, Social Deviance, Non-Routine)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Triggers</strong> (Sparks, Facilitators, Signals)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To perform a behaviour, a person must be sufficiently motivated, have the ability to perform the behaviour and be triggered to perform the behaviour.</td>
</tr>
<tr>
<td>Axis of Influence</td>
<td>Lilley (2009)</td>
<td>Behaviour-changing interventions can be categorized along an <strong>axis of influence</strong> that ranges from the user being in control to the product being control. There are 3 categories of interventions on the axis:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Eco-Feedback</strong> (Provide aural/visual/tactile signs to inform users of resource use)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Behaviour Steering</strong> (Use embedded affordances and constraints to encourage user to behave in prescribed ways)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Persuasive Technology</strong> (Change what people think or do, sometimes without their knowledge or consent)</td>
</tr>
<tr>
<td>Framework</td>
<td></td>
<td>This framework has 28 principles, categorized under 4 attributes of any persuasive product or system:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Primary Task Support</strong> (Helping the user carry out the behaviour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Reduce complexity of behaviour</td>
</tr>
</tbody>
</table>
**Process**

- Use tunnelling to guide user
- Provide information tailored to the user or setting
- Offer personalized content
- Help users track their own performance
- Allow user to see between the cause and effects of their actions
- Provide a means for the user to rehearse behaviour

**Dialogue Support** (Interact with the user)

- Offer praise to the user
- Provide rewards for correct behaviour
- Provide reminders
- Provide suggestions
- Systems should imitate the users to make users more comfortable
- Have a look and feel that users find appealing
- Using the system should provide the user with some social benefit

**System Credibility Support** (Make users believe in the system or product)

- System should provide unbiased and truthful information to engender user trust
- System should demonstrate expertise and knowledge to user
- The look and feel of the system should suggest competence of the system
- System should highlight the individuals/people behind its content
- System should reference people or groups in authority whenever possible
- System should be endorsed by third parties
- System should provide ways to verify its accuracy

**Social Support** (Provide social benefits to users)

- System should allow users to observe how other users are learning
- System should allow users to compare performance with other users
- System should provide a way for users to get together to establish performance norms
- System should provide a way for users to meet others
- System should allow cooperation between users
- System should allow for competition between users
- System should allow for users to get recognition from other users

| Trantheoretical Behaviour-Change Model method | Behaviour change is a process with five phase. Designers must determine which phase the user is in and then apply the following strategies:
| He, Greenberg and Huang (2010) | 1. **Precontemplation**
- Plant the seed to help users recognize the problem of climate change and learn about the need to behave in sustainable ways

2. **Contemplation**
- Tip the balance in favour of change (i.e., make it easier to adopt the goal behaviour than to maintain the status quo)

3. **Preparation**
- Develop a plan for the user that is acceptable, accessible and effective

4. **Action**
- Positively reinforce actions that can be sustained over the long term

5. **Maintenance**
- Maintain the behaviour change in a way that is durable to contextual changes

| The Design with Intent Method | A catalogue of 100 examples of persuasive products. The examples have been grouped under 7 'lenses:'
| Lockton, Harrison and Stanton (2010) | 1. **Architectural** (Using the structures of systems to influence behaviour)
2. **Errorproofing** (Making deviations from the intended behaviour impossible, difficult or unpleasant)

3. **Persuasive** (Providing the user contextual information, advice and guidance to the user to change behaviour)
<table>
<thead>
<tr>
<th>Design with Intent (Revised)</th>
<th>Lockton, Harrison and Stanton (2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A revised catalogue of 101 examples of persuasive interventions. The interventions have been grouped under 8 lenses:</td>
<td></td>
</tr>
<tr>
<td>1. Architectural (Use the structure of systems to influence behaviour)</td>
<td></td>
</tr>
<tr>
<td>2. Errorproofing (Make it easier for users to work without making errors or make errors impossible in the first place)</td>
<td></td>
</tr>
<tr>
<td>3. Interaction (Users’ interaction with the system affect how their behaviour is influenced)</td>
<td></td>
</tr>
<tr>
<td>4. Ludic (Use games to influence people’s behaviour)</td>
<td></td>
</tr>
<tr>
<td>5. Perceptual (Influence user behaviour by taking advantage of how they perceive patterns and meanings in products and systems)</td>
<td></td>
</tr>
<tr>
<td>6. Cognitive (Take advantages of cognitive biases and heuristics to influence users)</td>
<td></td>
</tr>
<tr>
<td>7. Machiavellian (Any method of influence where the ends justify the means)</td>
<td></td>
</tr>
<tr>
<td>8. Security (Deter or prevent undesired behaviours through countermeasures)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behaviour Wizard</th>
<th>Fogg and Hreha (2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on the Fogg Behaviour Model</td>
<td></td>
</tr>
<tr>
<td>The method involves:</td>
<td></td>
</tr>
<tr>
<td>1. Clarifying the flavour and duration of behaviour</td>
<td></td>
</tr>
<tr>
<td>2. Identifying triggers to the behaviour</td>
<td></td>
</tr>
<tr>
<td>3. Generating concepts</td>
<td></td>
</tr>
<tr>
<td>There are 5 flavours of behaviours:</td>
<td></td>
</tr>
<tr>
<td>» Green (a new behaviour)</td>
<td></td>
</tr>
<tr>
<td>» Blue (a familiar behaviour)</td>
<td></td>
</tr>
<tr>
<td>» Purple (a behaviour to be increased)</td>
<td></td>
</tr>
<tr>
<td>» Grey (a behaviour to be decreased)</td>
<td></td>
</tr>
<tr>
<td>» Black (a behaviour to be stopped)</td>
<td></td>
</tr>
<tr>
<td>There are 3 durations of behaviours:</td>
<td></td>
</tr>
<tr>
<td>» Dot (1-time behaviour)</td>
<td></td>
</tr>
<tr>
<td>» Span (behaviour with specific duration)</td>
<td></td>
</tr>
<tr>
<td>» Path (behaviour to be performed indefinitely)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design for Socially Responsible Behaviour</th>
<th>Tromp, Hekkert and Verbeek (2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product influence on a user can be described along 2 dimensions:</td>
<td></td>
</tr>
<tr>
<td>1. Force (the product can exert a weak or strong influence on the user)</td>
<td></td>
</tr>
<tr>
<td>2. Salience (the product can exert influence in an implicit or explicit manner)</td>
<td></td>
</tr>
<tr>
<td>This results in 4 types of influence:</td>
<td></td>
</tr>
<tr>
<td>1. Coercive (High Force &amp; High Salience)</td>
<td></td>
</tr>
<tr>
<td>» The user is aware of the influence of the product and has no choice but to behave in a prescribed way</td>
<td></td>
</tr>
<tr>
<td>» This type of influence should only be applied when the intended behaviour is universally agreed upon, otherwise users will see it as a curb on their freedom</td>
<td></td>
</tr>
<tr>
<td>2. Persuasive (Low Force &amp; High Salience)</td>
<td></td>
</tr>
<tr>
<td>» The user is aware of the influence of the product but feels as though they have more control over their behaviour</td>
<td></td>
</tr>
<tr>
<td>» This is also best applied when collective concerns are in line with individual concerns</td>
<td></td>
</tr>
<tr>
<td>3. Decisive (High Force &amp; Low Salience)</td>
<td></td>
</tr>
<tr>
<td>» The user does not realize that they are being influenced but has no choice but to act in a prescribed way</td>
<td></td>
</tr>
</tbody>
</table>
**4. Seductive (Low Force & Low Salience)**

- The user does not realize that they are being influenced but also sees their own behaviour as internally motivated and not encouraged from an outside source.

**11 Strategies are outlined for facilitating behaviour change**

1. Create a perceivable barrier for undesired behaviour (i.e. warn users that pain or injury will result with undesired use of the product)
2. Make unacceptable user behaviour overt (i.e. publicly shame users who perform the unacceptable behaviour)
3. Make the behaviour a necessary activity to perform to make use of the product function (i.e., include design elements that require the user to perform a specific behaviour to make the product operate properly)
4. Provide the user with arguments for specific behaviour (i.e., provide the user with objective information about the consequences of undesirable behaviour)
5. Suggest actions (i.e., propose specific behaviour to the user)
6. Trigger different motivations for the same behaviour (i.e., add extra functions to the product to get the user to use it in the prescribed way)
7. Elicit emotions to trigger action tendencies (i.e., try to provoke an emotional response to change user attitudes and encourage a behaviour)
8. Activate physiological processes to induce behaviour (i.e., Make users get into physical states that are amenable to the intended behaviour)
9. Trigger human tendencies for automatic behavioural responses (i.e., Take advantage of instinctive human responses to particular stimuli)
10. Create optimal conditions for specific behaviour (i.e., Make the desired behaviour easier by eliminating any situational obstacles to its performance)
11. Make the desired behaviour the only behaviour to perform (i.e., Restrict the ability of the user to perform anything other than the intended behaviour)

<table>
<thead>
<tr>
<th>Design Strategies for Sustainable Behaviour</th>
<th>There are 5 main ways of making users engage in pro-environmental behaviour:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidman and Renström (2011)</td>
<td>2 ways where the user has high control and chooses to change his/her behaviour:</td>
</tr>
<tr>
<td></td>
<td>1. Enlighten (Influence users’ knowledge, values, attitudes and norms)</td>
</tr>
<tr>
<td></td>
<td>2. Spur (Encourage or tempt users through incentives or by making the behaviour more fun)</td>
</tr>
<tr>
<td></td>
<td>2 ways where the user has low control but chooses to change his/her behaviour:</td>
</tr>
<tr>
<td></td>
<td>3. Steer (Use physical or cognitive constraints or affordances to make the prescribed behaviour the obvious choice)</td>
</tr>
<tr>
<td></td>
<td>4. Force (Compel users to perform the prescribed behaviour)</td>
</tr>
<tr>
<td></td>
<td>1 way where the product changes to fit the user, accomplishing resource reduction while not requiring the user to change behaviour</td>
</tr>
<tr>
<td></td>
<td>12. Match (adapt the product to the behaviour the user already performs)</td>
</tr>
</tbody>
</table>

**Choice Architecture**

- Thaler, Sunstein and Balz (2012)

**MENU**

**There are 6 main ways of designing nudges:**

1. **Defaults** (Make the desired behaviour the default choice)
2. **Expect Error** (Make the system forgiving to the users)
3. **Give Feedback** (Tell users when they are not performing a behaviour optimally)
4. **Mappings** (Put the potential outcomes of a decision into terms the user understands)
5. **Structure Complex Choices** (Simplify complex decisions into a series of simpler decisions)
6. **Incentives** (Determine the motives of the user and offer incentives that match)

**Design Behaviour Intervention Model**

- Tang and Bhamra (2012), Bhamra, Lilley

**A method that combines 5 different facets of behavioural change:**

1. **Factors affecting the user**
   - Intention (Attitude, Social Factors, Affect)
   - Habits
| USER PRE-CATEGORIZATION DIMENSION | and Tang (2012) | 2. **Stage of change the user is in**
- Contextual factors
- Declarative stage (awareness / consideration)
- Knowledge compilation stage (practice)
- Procedural stage (Repeat action until habitual)

3. **Level of intervention**
- Inform
- Persuade
- Force

4. **Strategy chosen**
- *Eco-information* (make resource consumption visible)
- *Eco-choice* (provide sustainable use options to users)
- *Eco-feedback* (tell users about their individual resource consumption)
- *Eco-spur* (prompt and/or punish users into behaving more sustainably)
- *Eco-steer* (affordances and constraints that enable sustainable use)
- *Eco-technical intervention* (automatic control of user behaviour)
- *Clever design* (product reduces user consumption without altering user behaviour)

5. **Design category (Product, System or Service)**
| MENU | Behaviours can be encouraged through the application of 4 principles:

1. **Make it Easy**
- Make the goal behaviour the default choice
- Reduce the effort required to perform the behaviour
- Simplify the message being sent to people

2. **Make it Attractive**
- Attract the attention of people through images, colour, personalization etc.
- Provide rewards and punishments for maximum effect (e.g., lotteries)

3. **Make it Social**
- Show people that other people already perform the goal behaviour
- Take advantage of social connections, encourage collaboration and collective efforts
- Encourage people to make a commitment to others

4. **Make it Timely**
- Prompt people when they are receptive (e.g., around large life events)
- Short term costs and benefits are felt more acutely by people than later ones

5. **Consequences**
- Help people plan out how they will maintain the behaviour in adverse conditions

**Integrated Framework for Encouraging Pro-Environmental Behaviour**

| Steg, Bolderdijk, Keizer and Perlaviciute (2014) |
| MENU | Based on Goal-Framing Theory. Pro-environmental behaviours are usually a conflict between **normative goals** (how we believe we are supposed to act) against **hedonic goals** (feeling good) and **gain goals** (getting something).

2 strategies are recommended:

1. Promote the hedonic or gain benefits of pro-environmental behaviours

2. Target users’ biospheric values to increase the strength of normative goals

**The Hooked Model**

| Eyal (2014) |
| MENU | Behaviours can be made habitual through a 4-phase model:

1. **Triggers (things that attract the user)**
- External (Prompts that encourage the user to engage in the behaviour)
- Internal (Emotions and memories that encourage engagement in a behaviour)

2. **Action (The steps the user needs to undertake)**

3. **Rewards**
- Rewards of the tribe (social acceptance)
- Rewards of the hunt (finding something that the user is looking for)
| Dimensions of Behaviour Change | Daee and Boks (2014) | A card-based method where the designers generate concepts after considering 9 areas:  
1. **Control** (User in control vs. Product in control)  
2. **Obtrusiveness** (Demand user attention vs. unnoticed by user)  
3. **Encouragement** (Promotion vs. Discouragement)  
4. **Meaning** (It is fun vs. It is sensible)  
5. **Direction** (Agrees with user’s wishes vs. Undesirable to the user)  
6. **Empathy** (Focus on the user vs. Focus on others)  
7. **Importance** (Users find it important vs. Users don’t care much)  
8. **Timing** (User should be prompted before / during / after behaviour)  
9. **Exposure** (User should encounter the intervention rarely vs. frequently) |
| Social Implication Design (SID) | Tromp and Hekkert (2014) | A method that helps designers focus on the social implications of the problem they are designing for. There are 3 layers (Social, Behaviour, Interaction) and 5 design steps:  
**Social Layer**  
1. Phenomenon (Framing the project)  
2. Social Statement (Defining the desired social effect)  
**Behaviour Layer**  
3. Behaviour (Focussing on a particular behaviour to reach the social effect)  
**Interaction Layer**  
4. Strategy (Understanding what it will take to make users behave in the desired way)  
5. Design Proposal (Generate a product concept) |
| Pathways of Sustainable Behaviour | Strömberg, Selvefors and Renström (2015) | A framework that posits 5 general ways that products (or artefacts) can be designed to promote pro-environmental behaviour:  
1. **Choice of artefact** (Choosing a less environmentally harmful product)  
2. **Changed use** (Using a product less or using it differently to reduce consumption)  
3. **Maintenance and repair** (Keep a product in good condition to reduce its resource consumption)  
4. **Mediated use** (Use a second product along with the existing one to reduce the main product’s resource usage)  
5. **Regulated artefact** (Add a second product that controls and regulates the main product’s resource usage) |
| Personality Traits and Energy Conservation | Shen, Cui and Fu (2015) | Energy conservation can be encouraged in households by showing homeowners consumption of their neighbours (i.e., taking advantage of social norms). But different homeowners require different types of encouragement. Homeowners can be categorized according to how they score on the Openness and Agreeableness dimensions of the Big 5 personality test. There are 6 categories of homeowners:  
1. Effective Altruists (Very high openness, ) – Provide them with consumption rates of their most efficient neighbour  
2. Socially Outgoing  
3. Easy Going  
4. Adaptive  
5. Traditionalists  
6. Resolute Believers |
1.4 IT IS IMPORTANT TO KNOW WHEN IT IS PERMISSIBLE TO INFLUENCE USERS

While designing products to change user behaviour, it is important to think about the potential harm users may face as a result of the persuasion to change behaviour. I reviewed sources discussing the ethics of behaviour change and summarize my main findings here. Most sources appear to talk about the ethics of behaviour change using one of two types of notions: 1) Prescriptive ideals about how people should behave, and 2) Descriptive frameworks of behaviour.

1.4.1 PRESCRIPTIVE IDEALS OF BEHAVIOUR

Prescriptive-style supporting arguments permit reduction in user autonomy as long as some greater behavioural purpose is being met. Recent work has used the traditional philosophical school of thought of virtue ethics as theoretical scaffolding for its behaviour-change arguments. Boon et al. (2014), state that reducing the impact of human activity on the environment and on other, poorer societies can be characterized as a virtue. It is therefore justifiable to attempt to change the character of users to make them care more about the environment and those around them. It is conceivable that another traditional school of philosophical thought, deontological ethics, could be used in a similar vein. If protecting the environment or reducing harmful impacts of product use on other people can be framed as a Kantian maxim, something that individuals have a duty to follow, it could be used to justify behaviour modification for those purposes. While well rooted in modern philosophical discourse, prescriptive justifications for behaviour change can be difficult to use as product-design guidelines. Further, these ideals tend to encourage us to aim for characterological change and a change in user values, rather than a simple change in the performance of a specific behaviour. They therefore could be overreaching for behaviour-change applications.

1.4.2 DESCRIPTIVE FRAMEWORKS OF BEHAVIOUR

Descriptive frameworks justify behaviour change interventions as being a way to help individuals achieve their own aims. As such, they may relate to consequentialist ethics
which are concerned with the end result of actions. Under descriptive frameworks, I found two approaches, the deterministic approach and the intentional approach. In both cases, the influencing of users is justified through the concepts of bounded rationality (Plough et al, 2014) or reasoning failure (Aggarwal et al., 2014). According to these terms, individuals cannot be expected to always make rational decisions for a myriad of reasons. People often lack the skills or knowledge necessary to make the most logical decision. Altered mental states or illness can also make it difficult for people to decide rationally. External persuasion can thus be used to help people be more rational about their choices. Where the deterministic and intentional approaches differ slightly is in their assessment of what interventions are acceptable. In the deterministic view, behaviour is generally a combination of environmental conditions and innate cognitive processes. Being cognizant of these limitations, individuals can choose to give up their autonomy to a governing body that is acting in their interest. As such, governments, medical professionals etc. can make decisions on behalf of individuals for their benefit, the benefit of society and/or the benefit to future generations. Thus, interventions can be considered ethical if they are justifiable through one of those means. Of late, a line of thinking known as libertarian paternalism, based on this very framework, has become popular (Thaler & Sunstein, 2009). In this approach, experts (governments, medical professionals, counsellors etc.) are given the moral license to persuade individuals to perform behaviours as long as the individual retains final say in deciding whether to comply (hence the libertarian descriptor). The intentional approach, on the other hand, privileges the desires of the user. Rather than simply react to environmental stimuli and cognitive patterns, humans are seen as having intentions and goals that require fulfillment. Individuals therefore must actively give consent to being influenced. Researchers using this framework advise that interventions should never persuade a person to do something that they would not be otherwise willing to do (Pettersen & Boks, 2008).

1.4.3 APPLYING ETHICAL TESTS TO BEHAVIOUR-CHANGE PROBLEMS IS DIFFICULT

In sum, ascertaining whether a persuasive intervention is ethical appears to entail the establishment of tests. In prescriptive frameworks, it is the final goal of the user behaviour that is put to test (against deontological maxims or virtues). In descriptive frameworks, it is the user's autonomy that is put to test (against the amount of agency
the user has ceded to experts or governance structures, or against the user’s own goals and desires). The application of this these test mechanisms to product design is highly problematic. Prescriptive frameworks can be difficult to reason through, especially for designers who are unlikely to have a good understanding of constructing virtue-ethics or deontological arguments. Descriptive frameworks can appear easier to work with but have their own challenges. Deterministic approaches promise the benefit of a clear reasoning structure (as user actions can be modelled as a result of psychological characteristics and environmental stimuli). Hence, traditional deterministic fault-prediction methods such as FMEA (Failure Modes and Effects Analysis), long used in engineering design, are now being applied to behaviour interventions in settings such as hospitals (Shebl et al., 2012). Unfortunately, practitioners are also finding out that complex behaviour is very difficult to predict using deterministic models, at least much more difficult than predicting the outcome of faults in engineering systems. Thus, these models of human behaviour, which are used to justify the taking away of user autonomy by physicians etc., have poor validity (Franklin et al., 2015). Intent frameworks have been proposed for use in persuasive product design applications (Lilley and Wilson, 2012) and are simpler to use. The designer only has to think through as many use cases as possible to ascertain whether the intervention will make the user do something they otherwise would not do. What the user is willing to do or interested in doing can also be captured through customer research. Problems arise here as well because this approach limits behaviour-change design to applications where the user has already committed to changing behaviour. In many cases, such as public health, or environmental impact reduction, users may not actually want to curtail their unhealthy or environmentally harmful behaviours. This makes it difficult for designers to justify the need for public behaviour change using an intent framework. Additionally, the distinction of choice vs. non-choice made by paternalistic libertarians seems dubious. As seen in the research on physical product affordances, the very existence or absence of a product feature as an influencing effect on the user. Users can be subconsciously triggered by the affordances in a product. It is thus difficult to describe these physical affordances as allowing the user to retain final say in the performance of an action, when that action might be triggered by subconscious processes.
1.4.4 ENSURING THAT DESIGNERS APPLY THESE TESTS IS NOT POSSIBLE

The greatest problem faced by these frameworks is the lack of enforceability. Ethical tests are easier to perform when they are mandated by regulatory frameworks. For example, at all universities, ethical review is compulsory for the performing of research on human participants. Similarly, there are regulatory guidelines that necessitate the checking of whether the working conditions of a person are suitable for safe and productive work. Product design, on the other hand, is an ad hoc process carried out by many different parties simultaneously. There exists no industry standard that would encourage manufacturers to measure whether their product reduces our impact on the environment or whether their product violates of the user’s right to autonomy. Formal methods that test the ethical quality of an intervention (such as the method described by Lilley & Wilson, 2012) can also seem tedious to perform when the alternative is to not do ethical tests at all.

1.4.5 CHECKLISTS COULD BE EASIER TO UNDERSTAND AND ENFORCE

A simpler approach for product designers might be to adopt a checklist approach focused on harm reduction (similar to the guidelines stipulated for experimental research on humans) for the users. Product designers could check to see whether the intervention they have created increases any of the following six risks:

- Risk of physical injury
- Mental duress or risk of psychological injury
- Loss of privacy
- Loss of access to resources/money/power
- Loss of social status
- Loss of personal relationships

This is still not a complete solution as the language of the risks has to be defined (e.g., Would the imposition of a plastic bag charge be considered a loss of access to money for the customer? If not, then what would be the threshold for loss significance?) and arguments can be made for allowing (e.g., public shaming—a type of loss of privacy, might be a justifiable method for curtailing certain wasteful behaviours). I would like to test these risks with more product-use cases to develop the framework further.
1.5 CONCLUSION: THE STATE OF BEHAVIOUR CHANGE RESEARCH

This chapter summarizes the research I reviewed over the course of my PhD work. The main points of the review follow.

The literature on the theories of behaviour, theories of behaviour change and methods for changing behaviour draws from many different types of sources.

Theories of behaviour vary greatly but generally have two foci: identifying antecedents of behaviour and providing a model for the process of behaviour production. Personal and social norms, individual personality differences, external factors and the mapping between the attributes of the person and the behaviour are all behavioural antecedents that are mentioned repeatedly in the literature. The process of behaviour production is explained well by a two-style processing system. One style of processing is reactive and the other style is deliberative.

Humans are influenced by the technological artefacts they use to interact with the world. The field of postphenomenology provides explanations for how users and products work together and are influenced by each other. In the field of product design, the concept of affordances (the potential uses of products) provides a productive way of analyzing user-product interactions.

Many different methods have been proposed to help designers change user behaviour. The methods work in five ways: give designers a menu of strategies to apply to their problem, suggest strategies relevant to the type of behaviour-change problem, suggest strategies relevant to the type of intended user, make designers think about concepts along solution dimensions and focus designer attention on following process steps in the right order.

Finally, we should also try to minimize any harm to the user through the design process. While this is ultimately unenforceable, if ethical concerns are presented as simple checklists, designers will find them easier to follow and implement.
2 Organizing the Literature of Design For Behaviour Change

As discuss in the previous chapter, to work in the area of design for behaviour change, it is important to appraise oneself of literature from many different types of sources. After organizing the reviewed research in simple tables, I looked for a formal way of organizing the concepts I was learning. This chapter discusses my work to create a formal representation of design-for-behaviour-change knowledge. This chapter is adapted from Srivastava J, Shu LH (2014). An ontology for unifying behaviour-change literature. CIRP Annals, 63/1:173-176.

2.1 FORMAL METHODS OF REPRESENTING KNOWLEDGE

Many formal methods have been developed to represent knowledge. Ontologies are a means of formally modelling knowledge structures (Guarino et al., 2009). An ontology can be defined as a unifying framework that defines terms as well as the relationships between entities using formal logic (Uschold & Gruninger, 1996). Entities are analyzed and organized into concepts and relations. Concepts are then organized into a hierarchy and relations describe connections between them. This can be explained using a simple example (adapted from Guarino et al., 2009): If we were interested in creating an ontology for workers at a company, we might deal with concepts such as Employee, Manager and Researcher. Manager and Researcher would be sub-concepts of Employee and therefore situated below it in the concept hierarchy (since any member of the Researcher and Manager sets is also necessarily a member of the Employee set). A relation between Researcher and Manager might be works-with (i.e., Researcher works-with Manager). A person working at the company would be an instance of a concept (i.e., Sarah Brown would be an instance of Manager at the company). The concept-relation structure also allows us to infer relations. For example, if we knew that John Chu was a member of the Researcher set, we could also infer that he was a member of the Employee set and that he had the works-with relation to members of the Manager set.
2.2 THE BEHAVIOUR-CHANGE ONTOLOGY (BCO)

2.2.1 ONTOLOGY SYNTAX

I built the ontology using OWL, the Web Ontology Language (Antoniou & van Harmelen, 2004). In OWL, concepts are described as classes and relations are described as properties.

2.2.2 SOURCE MATERIAL FOR THE ONTOLOGY

I consulted a variety of sources to create the ontology. As the ontology was developed during my literature review process, I selected a subset of sources to draw from. After an initial review, I organized the insights under seven main categories and created classes for each of these.

2.3 STRUCTURE OF THE BCO

The ontology is constructed with seven main classes that capture the different facets of behaviour change present in existing knowledge. In the case of problem type and mechanism, I was able to further distill the existing knowledge into a short list. Therefore, I present these lists in whole. The other classes contain many more members and therefore are only described overall. A reference schematic of the BCO is presented in Figure 2.1. The schematic includes the main classes and some of the properties that connect them. Due to space constraints, only some of the connecting properties between nodes are illustrated. In the ontology, all classes can be connected to all other classes through different properties.

2.3.1 PROBLEM TYPE

Problem type is a class that explains the kind of behaviour change that is to be performed. It contains seven levels. The first level has to do with promoting a behaviour that is completely new to the user; the user does not have any pre-existing desire to perform the behaviour and needs convincing. The second level describes situations where the user knows and wants to adopt a new behaviour but needs educating on how to go about it. The third level describes situations where users want to adopt a new behaviour, know how to do it, but need impetus to follow through. At the fourth level, the user is already performing a new behaviour and needs support to continue
maintaining it. At the fifth level, the user has adopted a new behaviour but needs to increase or intensify its performance. At the sixth level, the user has a behaviour of which he/she wants to reduce the performance. At the seventh and final level, the user has a behaviour that he/she wants to cease performing.

2.3.2 BARRIERS

Barriers describe the obstacles that users face in making behaviour changes, including lack of information about problems, social restrictions around behaviours, and limitations of time or money. Psychology studies that examine user motivations and design studies that aim to capture user needs are good sources for barriers to behaviour change. Many behaviour-change interventions also impose new barriers to effect new behaviours.

2.3.3 PRINCIPLES

Principles are the generalized approaches for changing behaviour that researchers have discovered after reviewing case studies of behaviour-change interventions. Almost all of the background studies used for constructing the ontology present their own principles. Principles have also been presented under different names, such as strategy categories (Zachrisson & Boks, 2010). Principles are excellent explanatory devices in literature as they take information from many different examples and converge them to one abstracted point. Unfortunately, this also makes them difficult to use as a starting point for design. Because they are abstract and general, they may lack the details designers need to guide them towards solutions.
2.3.4 STRATEGIES

Strategies are more specific than principles and describe the particular way(s) that an intervention is intended to affect behaviour. Strategies are stated more clearly (e.g., provide warnings when users deviate from the planned course of action) and are easier for designers to use for generating ideas. The Design-with-Intent (DWI) framework (Lockton et al., 2010) provided 101 of the strategies listed in the BCO. As DWI provides a large number of strategies (called patterns in their parlance), it is a logical place to start. Additional strategies can be added in the future if they are sufficiently different from one of the strategies already present in the ontology.

![Ontology Schematic](Figure 2.1: Schematic of the Ontology structure)

2.3.5 MECHANISMS

Mechanisms are postulated explanations for why a particular strategy succeeded or failed to change a behaviour. After identifying strategies from case studies, researchers often try to determine the underlying mechanisms behind the strategy (Fogg & Hreha, 2010; Daae & Boks, 2011). Based on the sources reviewed I made the following list of six
principal mechanisms (based on Fogg & Hreha, 2010 and Daae & Boks, 2011) that describe how strategies enable behaviour change.

2.3.5.1 OBTRUSIVENESS

Many behaviour-change strategies succeed by increasing or decreasing the obtrusiveness of a product feature for the user. For example, the Are You Sure strategy (Lockton et al., 2010), which suggests having the users reconfirm a decision before a command is carried out in software, works by increasing the obtrusiveness of the decision feature (Daae & Boks, 2011). Machines that require users to use both hands to power them on (in order to prevent injury) are also examples of highly obtrusive behaviour-changing features.

2.3.5.2 USER ABILITY

Behaviour-change strategies also increase or decrease the user’s ability to perform certain actions in order to get him/her to change. For example, the Conveyor Belt strategy (Lockton et al., 2010) gets the object of the behaviour right to the user, thereby increasing the user’s ability to perform that behaviour by reducing physical effort. The modification of factors such as time available, money, physical effort, brain cycles and social pressure all affect the user’s ability (Fogg & Hreha, 2010). For example, workers in an office could be encouraged to exercise more if gym equipment were made available in the building.

2.3.5.3 COMPARISON

Behaviour-change strategies often work by comparing an intended behaviour against other behaviours. The Framing strategy for example suggests presenting an intended behaviour in attractive terms, usually by presenting it alongside unattractive alternatives. Prospective car buyers could be encouraged to purchase the model with the lowest fuel consumption if the average cost of fuel to the customer is provided with the purchase price.

2.3.5.4 TRIGGER

Many behaviour-change strategies make use of cues to prompt users to begin a behaviour. This is commonly seen with strategies that make use of physical affordances
in products. These typically work by triggering associations in the user’s mind between a feature in a product and a particular behaviour, reminding him/her to perform a particular behaviour (Fogg & Hreha, 2010). For example, mouthwash companies encourage mouthwash use by bundling their products with toothpaste, suggesting to users that mouthwash should be used every time the user brushes his/her teeth.

2.3.5.5 MOTIVATION

Behaviour-change strategies that focus on influencing the antecedents of behaviour typically aim to alter user motivation for performing a behaviour. For example, the Social Proof strategy promotes a behaviour by showing the user examples of his/her peers performing the desired behaviour (Fogg & Hreha, 2010).

2.3.5.6 CONTROL

Finally, many behaviour-change strategies work by increasing or decreasing the amount of control the user has when performing a behaviour. For example, the Defaults strategy (Lockton et al., 2010) sets the designer-intended mode of use as the default setting and takes away some control from the user to encourage a particular behaviour. People can be encouraged to reduce their energy consumption if the low-energy mode of a device is set as the default.

2.3.6 APPLICATIONS

The applications class contains the examples that show where the behaviour-change strategies and principles have been used. This is helpful to designers looking for suggestions relevant to a particular product or behaviour domain.

2.3.7 AUTHORS

The authors class lists the researchers responsible for reporting each concept.
2.4 NAVIGATING THE ONTOLOGY

Information stored in the BCO as well as the relationships between concepts of the BCO can be accessed through queries. The data for the BCO is stored in an OWL 2 file and can be queried using a web-query language such as SWI Prolog. Designers can create queries such as ‘find applications that employ the mechanism of changing user control.’ The logic processing ability of SWI Prolog also allows designers to ask more complex questions with multiple conditions such as ‘find applications that overcome the barrier of lack of money, and are also relevant to cases where the user wants to intensify an existing behaviour.’ The ontology is available for download under the title Behaviour-Change Ontology, at [http://webprotege.stanford.edu](http://webprotege.stanford.edu).

2.5 PLANNED BENEFITS OF THE ONTOLOGY

The BCO has been designed to provide benefits to both academics and design practitioners. The benefits to researchers in the field of behaviour change are meant to be the ability to: unify and add to existing literature in the field, find similarities between different proposed theories, analyze behaviour-change literature, and synthesize insights.
The BCO presents a flexible and open structure that is meant to be easy to append or modify by researchers as they collect additional relevant work. Many studies in the area of behaviour-change research are reviews of case studies. The BCO offers a standardized way of collecting and storing the data that describe a case study. Doing so also makes the case studies comparable with existing data in the ontology. The seven main classes in the BCO are able to explain the concepts and relationships from the literature cited. If future studies produce information that cannot be properly stored in this ontology, new classes can also be added easily. The ontology has enabled the description and transfer of over 100 behaviour-change interventions between application areas. For example, using the class framework, interventions used in advertising can be compared to interventions from public health programs.

The BCO also allows researchers to identify overlaps among research findings by comparing the properties of concepts. As an example, if I was to review the Defaults strategy (Lockton et al., 2010) in the ontology, it would become apparent that it shared similarities with the OptOuts strategy (Lockton et al., 2010). Both are connected to the principle of Steering. Both use the mechanism of changing user control. Both were also relevant to the Software Installation Wizard application. Thus, the BCO reveals that the two strategies can be used interchangeably and can be linked together.

Finally, the BCO is meant to help organize behaviour-change research in a way that facilitates analysis and development of insights. By examining relationships between concepts, researchers can find new connections. For example, one could notice that the Bundling strategy is often applied to medical/drug related behavioural interventions. Further analysis could reveal some attributes of the strategy that make it well suited that type of intervention.

For designers, the networked nature of BCO allows them to quickly identify the strategies that are relevant for the type of behaviour-change problem on which they are working. The main classes relevant to designers are problem type, barriers, strategies and applications, as these are most important for problem solving. Designers can avoid becoming trapped in the multiple levels of abstraction that result from the categorization of ideas and the induction of principles, by avoiding the principles and mechanisms classes all together. Designers can enter into the ontology what they know based on the work they have done to that point (e.g., the problem type, the barriers faced by their user
or even the type of application) and navigate their way towards relevant strategies for that problem. Regardless of the starting information the designers possess, they should be able to find their way to applicable strategies. The principles and mechanisms classes can be used by researchers to explain how behaviour-change interventions work.

2.6 EXAMPLE

I present a scenario to demonstrate how a designer could use the BCO as a tool for generating ideas. Green scheduling, i.e., optimizing the scheduling of when plant machinery is on or off, is a goal for sustainable manufacturing (Fang et al., 2011). The traditional approach has been to employ technologies that automatically detect and power down machines that are not required (Fang et al., 2011). This problem can also be tackled through behaviour change of machine users, who would be tasked with powering down machines when they are not required. I will illustrate using the BCO to devise solutions for this problem.

Beginning with Problem Type, this falls under the category of adopting a behaviour that the user knows how to perform, but for some reason does not perform regularly. The ontology can then be queried for strategies that relate to starting familiar behaviours. In SWI Prolog syntax, the query is: *find_strategies_from_problems (Needs_to_Maintain, X)

The function searches through barriers associated with the Needs_to_Maintain behaviour problem type, which include Lack_of_Cues and Lack_of_Interest (to perform behaviour). These barriers are then connected to principles Feedback, Encouraging, Guiding, Steering and Forcing. Those principles are in turn connected to the strategies of Mazes, Kairos, Hiding Things, Interlock, Did You Mean, Rewards, Unpredictable Reinforcement, Challenges and Targets, etc. We can select one or more of these strategies and generate ideas. The Kairos strategy could lead to a solution that involves giving feedback at the right time. This could be implemented as a simple indicator that lights up when the machine is idle or the machine upstream of a particular machine has shut down or is idle. The Challenges and Targets strategy could lead to a visual display that provides feedback on the current energy usage of the device, and compares it to a target value for energy consumption. We could also select more than one strategy and devise a multi-part solution. Using the Interlock and Rewards strategies together, we could create a system where machine users would not be able to perform their normal
use actions without first checking which machines in the vicinity were idle or otherwise candidates for powering down. There could also be a count of the number of machines that were idling at any one time for every user; the more efficient an user was, the more he/she would receive as a performance bonus.

2.7 LIMITATIONS OF THE BCO THAT BECAME APPARENT WITH REPEATED USE

Developing the BCO was helpful in the early stages of my research for drawing connections between disparate literature sources using a formal structure. Unfortunately, using the ontology to generate ideas was more cumbersome than expected and keeping the BCO up to date with more recent literature was also challenging.

2.7.1 USING THE ONTOLOGY CAN BE COMPLEX

The BCO is hosted online at www.webprotege.stanford.edu. The website also provides a rudimentary interface to help users navigate the ontology. The users’ view of the ontology is shown in Figure 2.3. Since the interface is mostly text based, users need to have some familiarity with the syntax of OWL based ontologies as well as the class/property structure to use it effectively. It was conceivable that designers could be frustrated using the online interface. Thus, it became important to either develop a set of training materials to help designers learn the interface or create a new web-based interface for the ontology that was more intuitive to use and did not require any knowledge of formal knowledge structures.
2.7.2 Updating the Ontology Has Limitations

I also found that adding new material to the ontology was easy or difficult depending on the type of content being considered. It was easy to add new case studies/applications as one has to simply select the relevant problem type, barriers, principles, strategies, and mechanisms for the particular case study. However, it was more difficult to incorporate theoretical literature that suggested the addition or deletion of properties from the ontology structure. For example, after reviewing more research, it became apparent that the Principles and Strategies categories could be combined in some cases, that certain strategies were similar enough to be considered redundant and that other strategies could be broken down into multiple strategies. Making such fundamental changes to the ontology would be cumbersome, as all the applications would have to be retagged with new labels. In addition, the theoretical literature is not always well organized. Thus, it takes work to translate an article and extract the principles, strategies, mechanisms etc. being referred to. Maintaining the ontology was therefore a daunting task in and of itself. Finally, making any fundamental changes to
the ontology would exacerbate the interface issue for designers as they would either have to be retrained in the new structure of the ontology, or the user-friendly interface would have to be recoded according to the new structure.

Ultimately, as a design researcher, I was primarily interested in developing methods that were easy to apply. As such, it was more important for the structure to be easily understood than to provide extensive detail. While the ontology helps deconstruct behaviour change problems based on many parameters, there is another class of design methods that are also powerful and offer a completely different approach. Affordance-based methods focus on the relationship between a user and a product and can be applied to many different types of problems. My research of efforts with affordances are detailed in the next chapter.
3 Changing User Behaviour through Affordances


3.1 INTRODUCTION

In this chapter, I describe my research into developing affordance-based methods for changing behaviour. The history of affordances was explained in section 1.2 of the first chapter. To recapitulate, I define affordances as potential uses of a product, regardless of user perception. When designing with affordances, we can focus on the relationship between the user and the product instead of looking through lists of strategies and principles as was described in the previous chapter. User behaviour can be changed in two ways using affordances. If we control the types of uses a product has, the user will also be curtailed in what he/she can do with the product and thus his/her behaviour will be changed or restricted. If we added uses to a product or made an existing use easier or more salient, users would be more likely to adopt the behaviour enabled by that use.

Affordance-based design has traditionally started by using affordances as a way to translate user needs (e.g., if users want a product to generate heat, the solution concept should have the affordance of supplying heat). Since functions have been more commonly used for this role (Pahl et al., 2007), it bears clarifying how affordances are different from functions. Affordances again represent potential uses of an object, whether intended by the designer or not. Functions relate more to the intended purpose of an object. For example, any flat horizontal surface affords the placing of items on it. Most devices have enclosures that may exist for specific functions, but if they provide a top flat surface, they would afford the placing of items on top. Such an affordance could compromise the device, e.g., by affecting heat dispersion.
3.2 AFFORDANCE BASED DESIGN

The utility of affordances as a basis for design is well documented. Maier & Fadel first developed a systematic method for affordance-based design (2006). Affordances were seen as attractive because, compared to functions, they could capture many more user needs. Affordances could also be more easily elicited from user needs than functions. In Maier & Fadel’s (2006) affordance-based design method, user needs were first converted to affordances and the designer would be tasked with generating solutions based on those affordances.

In addition to designing new products, affordance-based methods can be used to redesign and optimize existing products (Brown & Blessing, 2005). In this case, affordances of existing products are determined and compared with the needs of the user, and modifications made as needed.

3.2.1 CHALLENGES IN AFFORDANCE-BASED DESIGN

The two main challenges in affordance-based design are: 1) how best to translate user needs into affordances, and 2) how to determine what physical features afford which potential uses.

The first challenge is connected to the front-end of design. To devise a solution for users, designers must understand user needs in terms of the affordances that the solution must provide. Affordance-based design methods postulated thus far employ a variety of traditional needs analysis techniques such as interviews, questionnaires and user observation (Galvao & Sato, 2005; Maier & Fadel, 2006; Lim & Kim, 2009; Hsiao et al. 2011; Cormier et al., 2013; Kim et al., 2013). These needs are often defined as tasks the users would like to accomplish (e.g., users want to be able to use the product for drying clothes) (Galvao & Sato, 2005; Kim et al., 2013). The second challenge is addressed through ideation techniques that help designers think of product features which will afford certain product uses.

3.2.2 DESIGNING FEATURES TO AFFORD PRODUCT USES

To successfully devise product features that make certain product uses more or less obvious to the user, designers must understand how users perceive affordances. There are multiple theories that try to explain how affordance perception works. Borghi &
Riggio (2009) suggest that when affordances are perceived, they trigger particular motor areas of the brain associated with certain actions. Still & Dark (2012) posit that perceived affordances are a result of automatic perceptual processes that have been developed over time through consistent interactions with the environment. Lu & Cheng (2013) and Gläveanu (2012) postulate that the perception of affordances depends on two factors:

1. The cultural background and personal knowledge of the user (i.e., sociocultural norms)
2. The situation and intent of the user.

Changes in either factor affect the ability of users to perceive affordances. My observations in Bangladesh, described in the next section, shed some light on how these two factors can affect affordance perception. It also appears that the lack of resources may serve as a mechanism for the acquisition of sociocultural norms.

### 3.2.3 HOW SOCIOCULTURAL NORMS ARE ACQUIRED

Related to a person’s cultural background and past knowledge, sociocultural norms are usually acquired by training and demonstration. In fact, even young children, after being shown one use of a product, tend to think of that product as being for mainly that use (Casler & Kelemen, 2005). The effect of training on affordance perception is also evident in experts. Trained experts can perceive the affordances of specialized tools more easily than mainstream individuals. For example, dentists are extremely knowledgeable about the use and activity affordances of their tools. Fire-fighting professionals are able to discern the affordances of the multi-function tools they use in rescue situations, one of which is shown in Figure 3.1.
3.2.4 SOCIOCULTURAL NORMS AND AFFORDANCE PERCEPTION

A trip to Bangladesh provided me with an opportunity to study how differences in sociocultural norms can inform people’s perception of affordances in products. Over the course of a week, I made observations regarding how two groups of people in Bangladesh used objects. The purpose of my trip to Bangladesh was actually to learn about nutrition in peri-urban slums, for a course project. As such I took copious field notes, photographs and videos during my trip. Upon reviewing my observations while still on the trip, I noticed that there were some interesting uses of everyday products and artefacts that warranted further study. The first part of my trip I was able to observe a group of affluent Bangladeshis and their usage of objects during their everyday lives. Next, I observed how people living in urban and peri-urban slums performed activities using the objects available in their environment. Finally, I held informal interviews with subject matter experts on practices within the slums of Bangladesh.

These observations and interviews revealed that the sociocultural norms present were the result of not only cultural peculiarities but also differences in the availability of resources. In the first case, the norms of affluent Bangladeshis were differentiated due to cultural reasons. For example, it was customary to use a fork and spoon (rather than a fork and knife) as the main eating utensils. The fork would be used for moving food onto the spoon and the spoon itself would also be used for cutting food items. This is similar to the formal dining etiquette used in Southeast Asian countries such as Thailand and the Philippines (Roman & Russell, 2009). These users employed the cutting affordance of spoons more than Western users.
Conversely, most slum dwellers have very meager incomes and lack access to proper nutrition, health-care and materials for construction. As such, their sociocultural norms were a result of customs and traditions as well as a chronic lack of resources. Observed uses of materials include: sheets of fabric as room dividers, translucent plastic bags as windows, and rocks to weigh down pot lids. These groups therefore successfully perceived many affordances in objects that others may find surprising. Listed below in tables 3.1 and 3.2 are these and other observations. Thus, along with training, cultural background and personal knowledge, access to resources was a significant contributor to sociocultural norms.

3.2.5 INTENTIONALITY AND AFFORDANCE PERCEPTION

The time spent with workers in economically depressed areas of Bangladesh also revealed the power of intentionality in altering the user’s perceptual threshold for affordances. Due to the extreme poverty faced by slum dwellers, they are especially ingenious in making use of salvaged and scrap material. Houses in the slums were constructed with a combination of corrugated steel and salvaged items such as iron grates, wooden poles, plastic bags and tarps. When constructing makeshift housing in slum areas, the residents are evidently able to perceive the affordances of any scrap material.

3.2.6 SOCIOCULTURAL NORMS, INTENTIONALITY AND THE BENEFITS OF ABSENCE

Observing product use in Bangladesh revealed 5 insights:

1. Impoverished Bangladeshis may more easily perceive affordances of simple objects due to the absence of materials. They likely understood the many uses of stones, sticks and waste materials much better than those in wealthier communities.

2. How impoverished Bangladeshis accomplished functions in the absence of resources and specialized products may reveal much about how to design specialized products for those uses. For example, simple wooden sticks were used for many purposes, including as supports for walking, as pestles for grinding spices, and as rungs for hanging clothes. Each of those uses has a dedicated object or tool in more developed countries. Based on how the stick was used and modified for each use, I could determine
the key affordances, e.g., a walking support product or grinding product should provide its users.

3. In a few cases, there was little or no loss in performance when a simpler product was employed. For example, simple pieces of wood made effective walking sticks.

4. It was even possible that the simple product had affordances that its specialized alternative did not possess. For example, a bamboo stick as a shoulder pole for conveying goods offers more flexibility than a wheelbarrow. Even irregularly shaped items can be carried on a shoulder pole as long as they are properly balanced, whereas a wheelbarrow may be more limited in what it can be used to carry.

5. These simple products were also configurable to the situation by the user, i.e., users can change the affordances. For example, a bamboo stick could be repurposed from an oar to become a walking stick by cutting it to a new size.
### Table 3.1: Object usage observed in Bangladeshi Groups

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>AFFORDANCE</th>
<th>ABSENT OBJECT</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo poles</td>
<td>Carrying pole for firewood, food, grain, other items</td>
<td>Wheelbarrow</td>
<td>Different shape and material properties, same performance</td>
</tr>
<tr>
<td></td>
<td>Oars</td>
<td>Wooden paddles</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Suspension arm for fishing net</td>
<td>Metal fishing net supports</td>
<td>Same shape, same performance</td>
</tr>
<tr>
<td>Baskets</td>
<td>Carrying books</td>
<td>Book cart</td>
<td>Same shape, reduced performance (less space)</td>
</tr>
<tr>
<td></td>
<td>Carrying buckets</td>
<td>Cart</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Carrying bags of rice</td>
<td>Cart</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Carrying food, tea leaves and irregular items</td>
<td>Cart or box</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Holding pots/keeping heat away from hands</td>
<td>Pot holder, trivet</td>
<td>Same shape, same material property, same performance</td>
</tr>
<tr>
<td></td>
<td>Chicken cage</td>
<td>Metal cage</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>Newspaper</td>
<td>Starting a fire</td>
<td>Kindling</td>
<td>Same material, same shape, same performance</td>
</tr>
<tr>
<td>Plastic water bottles</td>
<td>Floats for fishing nets</td>
<td>Specialized floating fishing nets</td>
<td>Same shape, same material property, reduced performance</td>
</tr>
<tr>
<td>Polyethylene bags</td>
<td>Rain poncho</td>
<td>Rain jackets</td>
<td>Same material property, same shape, reduced performance</td>
</tr>
<tr>
<td>Rocks</td>
<td>Weighing down a pot lid</td>
<td>Weighted pot lid</td>
<td>Same material property, reduced performance</td>
</tr>
<tr>
<td>Sloped roof</td>
<td>Drying clothes</td>
<td>Drying rack</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>Spoon</td>
<td>Cutting</td>
<td>Knife</td>
<td>Same material, reduced performance</td>
</tr>
<tr>
<td>Sticks</td>
<td>Churning milk</td>
<td>Butter churn</td>
<td>Same shape, same performance</td>
</tr>
<tr>
<td></td>
<td>Stoking fire</td>
<td>Fire iron</td>
<td>Same shape, same material property, varying performance (reduced heat conductance)</td>
</tr>
<tr>
<td></td>
<td>Walking support</td>
<td>Specialized walking stick</td>
<td>Same shape, same material property, same performance</td>
</tr>
<tr>
<td>Tires</td>
<td>Rescue devices on a boat</td>
<td>Lifebuoys</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Sitting</td>
<td>Chairs, lawn chairs</td>
<td>Same shape, reduced performance (comfort)</td>
</tr>
<tr>
<td>Wood pieces</td>
<td>Grinding grain</td>
<td>Stone</td>
<td>Same shape, same material properties, reduced performance</td>
</tr>
</tbody>
</table>

### Table 3.2: Building materials in Bangladesh

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>AFFORDANCE</th>
<th>ABSENT OBJECT</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo pole</td>
<td>Tying together to make scaffolding</td>
<td>Metal scaffolding</td>
<td>Similar shape, reduced performance</td>
</tr>
<tr>
<td>Bamboo (hollowed)</td>
<td>Blowing into fire</td>
<td>Bellows</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>Cardboard</td>
<td>Walls</td>
<td>Drywall</td>
<td>Same shape, reduced performance (durability)</td>
</tr>
<tr>
<td>Corrugated steel</td>
<td>Walls</td>
<td>Drywall</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td></td>
<td>Water Trough</td>
<td>Aluminum</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>Fabric</td>
<td>Dividing rooms/providing privacy</td>
<td>Walls/Doors</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>Grates</td>
<td>Wall material</td>
<td>Drywall</td>
<td>Same shape, reduced performance</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
<td>------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Polyethylene bags</td>
<td>Window covering</td>
<td>Blinds/windows</td>
<td>Same material property, decreased performance</td>
</tr>
</tbody>
</table>

### 3.3 THE AFFORDANCE OF ABSENCE

After studying how an absence of material or features affects the utility of products, I propose the affordance of absence as a potentially novel method to identify product affordances. I observed a multitude of ways that absences can affect the utility of products and identified three dimensions in which I can consider existing examples of affordance of absence. I describe one dimension in detail and the others more generally.

#### 3.3.1 MAJOR DIMENSION: PHYSICAL ABSENCE

The major dimension for affordance of absence appears to be related to the level at which physical absence occurs. The absence of material in a part, absence of a part in a product, and absence of a product in a system, may all lead to additional utility and affordances.

#### 3.3.1.1 ABSENCE OF MATERIAL AT THE PART LEVEL

**AidPod**

At the lowest level, the absence of material in, or the space unoccupied by, an object can itself afford uses. This phenomenon was utilized by Simon Berry, an aid worker in Zambia in the 1980’s, who wanted to employ Coca-Cola’s distribution system to deliver essential medicines to developing countries. In some locations, Coca-Cola can be more easily accessed than clean water. Berry recognized Coca-Cola’s ability to reach vast swaths of consumers around the planet. ColaLife, a UK charity, has since developed the AidPod, a wedge-shaped container for medicines that fits between the necks of bottles in a standard Coca-Cola crate as shown in Figure 2. Initial concepts for the product included side pouches and tubes that replaced bottles in the crate. However, such concepts reduced the space for Coca-Cola products, thereby making them less attractive for distributors. Berry’s wife had the idea to utilize the unused space in a Coca-Cola crate, leading to the packaging configuration of the AidPod.
3.3.1.2 ABSENCE OF PART AT THE PRODUCT LEVEL

The removal of a part or component, including those considered critical, could also add utility to a product.

**Tablet computers**

Although it cannot be claimed that the development of tablet computers was based on the affordance-of-absence method, such devices can serve as examples of its potential. Tablet computers can be thought of as laptop computers without keyboards. Laptops have long pre-dated tablets and provided most of the same functionality. Even so, the removal of a physical keyboard has enabled new affordances that make tablet computers more useful for certain situations. Tablet computers provide displays that can be more easily held with a single hand, and enable simple data entry or other interaction while standing. These affordances make them suitable for a wider variety of situations than the laptop computers that predate them. Despite reduced data entry capability compared to laptops as well as privacy issues, tablets are becoming increasingly adopted in applications, e.g., aviation and medicine, where laptops have not been as successful.

**Ultrabooks**

Closely related, ultrabooks are laptops that achieve significant size and weight reductions by forgoing components that traditional laptops have, e.g., drives for external
media. Such reductions enable ultrabooks to be carried much more casually, allowing their use in many more situations. The elimination of components also results in reduced power consumption and thus increased battery life in ultrabooks. Therefore, the absence of components may provide more relevant and regularly reaped benefits than their presence.

3.3.1.3 ABSENCE OF PRODUCT AT THE SYSTEM LEVEL

Finally, contrary to what might be expected, utility can be added to a system by the absence of a product altogether.

Mobile telephones

Mobile phones have become an intrinsic part of modern life, with users frequently checking their mobile phones for news updates, emails and text messages. As a result, the presence of mobile phones can be disruptive in many settings; alerts about text messages and other updates can prove distracting for those engaged in a task or in a meeting. Recognizing this, mobile phone platforms by Apple Inc., Google Inc., Microsoft Corp., Blackberry Ltd. and others include ‘do not disturb’ settings that effectively turn the phone off to stop receiving calls, messages and other alerts. Thus, turning off mobile phones, or physically leaving them behind when going into meetings or on vacation, fulfills needs that are otherwise unmet in their presence. Specifically, workers can better focus on tasks with fewer distractions. Vacationers can enjoy their holidays without being tempted to respond to messages. They can also avoid performing other nonessential tasks that compromise their mental presence, and likely the purpose of physical absence from their usual environment.

3.3.2 MINOR DIMENSION: USER CONTROL

The first minor dimension to discuss is that of user control. This dimension describes products that offer absence in a manner that is fully user controllable, to products that feature absence in a way prescribed by the designer.

3.3.2.1 USER-CONTROLLABLE ABSENCE

A product can be designed such that users can make material or product components absent as per their discretion.
Cooking vessels for camping

Handles facilitate carrying of the objects on which they appear, and may also communicate where to lift such objects. On cooking vessels, they allow users to manipulate and carry the vessels without burning their hands. Handles can also add bulk to objects and make them more difficult to store and transport. Their presence or absence therefore offers different benefits that are more or less important depending on the use context. Pots and pans made for camping often feature user-removable handles to optimize product performance in multiple use contexts. When a pot or pan is being used for cooking, users can attach a handle so it’s easier to carry and manipulate. After use, handles can be removed to minimize product bulk and enable easier storage and transport.

Figure 3.3: Pan with removable handle
(https://www.flickr.com/photos/orangebrompton/1192778180/ CC BY-NC-SA)

3.3.2.2 DESIGNER PRESCRIBED ABSENCE

The product designer can also designate the absence of material, components or whole products.

Search engines
In the late 1990's, many internet search engines competed for market leadership. Google, then a newcomer, drew attention in part due to its notably sparse landing page. Other contemporary search engines tended to feature much busier landing pages. AltaVista, one of the largest search engines of the time, had a landing page with news updates, links to non-search services and sponsor websites, options for searching by category, topic and language, and example queries to show users how to search. In contrast as shown in Figure 4, Google’s landing page contained a text box and two buttons. The absence of distracting material increases the ability of users to quickly perform a search, fulfilling their primary goal.

![Google's Landing Page](http://web.archive.org)

**Figure 3.4: AltaVista and Google landing pages from 1999**

### 3.3.3 MINOR DIMENSION: PERMANENCE OF ABSENCE

The second minor dimension describes whether an absence of material, component or product is permanent or temporary.

#### 3.3.3.1 PERMANENT ABSENCE

The absence of an affordance can be permanent, or at least require significant effort to change.

**Sloped top surfaces**
To discourage the placing of items on top, lockers, mailboxes and garbage bins can be configured with a sloped top surface. While the top surfaces of mailboxes and garbage bins are typically less easily changeable, lockers can often be procured with the sloped top as an option, as shown in Figure 5. The only function of this optional part is to prevent users from placing items that may constitute fire hazards on top of the lockers, thereby thwarting a common horizontal flat-surface affordance. The permanence of the absence of this affordance is related to the significant effort required to remove it.

![Image of sloped top of hallway lockers](https://www.flickr.com/photos/mag3737/7995036725 CC BY-NC-SA 2.0)

**Figure 3.5: Sloped top of hallway lockers**

### 3.3.3.2 TEMPORARY ABSENCE OR DELAYED PRESENCE

The presence of an affordance can also be purposely delayed to achieve a specific goal.

**Desire paths**

A compelling example that supports the temporary absence of a product or affordance involves desire paths. Suburban buildings are often surrounded by lawns, which are in turn surrounded by parking lots. Typically, architects determine the positions and locations of walkways before ever using the building themselves. An alternative is to postpone the paving of paths and simply surround the building with a lawn when occupants first move in. The building users will have to cross the lawn to travel between the building and parking lot, creating paths in the process. This allows the actual users of the building to determine the most convenient routes, which become marked by
trodden/worn areas in the lawn, and can be subsequently paved. Thus, the temporary absence of paved pathways allows the establishment of efficient paths that would be less likely to occur if the introduction of paved pathways were not delayed.

**Optimizing tool purchases**

Directly analogous to desire paths is advice from an expert on hand tools, who recommends that novice users begin with the cheapest tool kit they can buy. Novice tool users may not be familiar with the types of tasks for which they require tools. Because inexpensive tool kits tend to be of low quality and durability, tools wear quickly from repeated use. Therefore, the tools that break correspond to those actually used. Assuming that novices use the most task-appropriate tool, the ones that break are worth buying higher quality versions as replacements.

### 3.4 SUMMARY OF THE AFFORDANCE OF ABSENCE PHENOMENON

My review of object use in Bangladesh supports the idea of affordances being influenced by sociocultural norms and intentionality of users. For practitioners of design-by-affordance methods, this has several implications. First, when designing a product whose affordances should be apparent to the user, the importance of understanding the user’s perceptual norms cannot be overstated. Designers must engage in anthropological research to gain a thorough understanding of the kinds of perceptive norms their users are likely to have. As I saw, even the perception of how dining utensils can be used cannot be assumed to be common across cultures. Affordances perceived in a product will also vary depending on the intent of the user. Therefore, it is important to know how and what users are thinking during their interaction with the product.

### 3.5 APPLYING AFFORDANCE OF ABSENCE

In this section, I present proposed concepts along the major, physical dimension of affordance of absence.

#### 3.5.1 ABSENCE OF MATERIAL AT THE PART LEVEL

**Blenders**
Galvao & Sato (2005) identify affordances for a blender. By starting with affordance of absence at the product level, the removal of a blender may reveal increased kitchen-counter or cabinet-storage space whose value exceeds the occasional blending required. Thus, blenders (and other small kitchen appliances) could be improved by

1. Reducing its footprint and thus counter space occupied
2. Consolidating kitchen appliances, e.g., a blender could easily be combined with a food processor.
3. Improving its ease of storage in kitchen cabinets.

Given the necessity of the blender and each of its parts, one could better exploit existing absence of material in parts as demonstrated by the AidPod concept. For example, one could configure the blender container, attachments, accessories and power cord, to nest optimally and reduce needed storage space and effort. In related examples, storage containers and cooking vessels often nest and reduce the space required when not in use. In addition, many clothing irons and laptop power adaptors have geometries that informally or formally afford the wrapping of the cord around them. Therefore, occasionally used and/or frequently stored and carried items could be configured to optimize their use of space, as well as their setup and storage, by exploiting absence of material at the part level.

3.5.2 ABSENCE OF PART AT THE PRODUCT LEVEL

Projection-based personal computers

Building on my previous discussion of tablet computers and ultrabooks, even more utility in computing devices may be enabled by the further removal of components. One of the largest components in tablets and ultrabooks is the display screen. If the screen were removed and replaced with an augmented projector, it would provide other affordances to users. In addition to projecting images, augmented projectors also have IR sensors that can detect the motions of the user’s hand(s) in front of the projected image. Replacing screens with augmented projectors could further reduce the size of personal computing devices. Having a projector instead of a screen would also provide much greater flexibility to users, as they could increase or decrease projection size to suit their need. They could project onto a sheet of paper for individual tasks or onto a wall for group tasks. Performance in activities like typing would likely be reduced, but the
popularity of tablet computers suggests a large demand for devices designed primarily for consuming media, browsing the Internet and performing simple tasks. Microsoft Research has been working to develop a computer with an absent screen for many years (Molyneaux et al., 2012).

**Resilient House**

Another demonstration of affordance of absence at the component level is the award-winning design of the Resilient House (http://www.sustainable.to/portfolio/resilient-house). The Resilient House is proposed as a “disaster-resistant, environmentally responsible, and affordable single family home” for regions that encounter extreme weather and natural disasters. The architects behind the design eliminated the basement that is problematic in regions prone to storms and floods. The absence of a basement provides valuable new uses, such as sheltered parking and outdoor space, which are especially restricted in dense urban areas. As the Resilient House is not yet completed, the actual benefits and limitations may only be fully realized once implemented.
3.5.3 ABSENCE OF PRODUCT AT THE SYSTEM LEVEL

Seating surfaces

Maier and Fadel (2009a) discuss the value of affordances in the design of stackable chairs, as neither stacking nor stack-ability is strictly a function by many definitions. Applying the affordance of absence, certainly the absence of chairs would encourage users to sit on other items. Observation of such behaviour could perhaps lead to the modification of the corresponding other items to also support the occasional sitting that is usually served by stacking or folding chairs. For example, in domestic settings, coffee tables are increasingly replaced with ottomans that support both typical coffee-table items and the occasional sitting.

Climbing supports

Maier and Fadel (2009b) discuss the affordances versus function for a ladder, identifying the value of affordances in creating a safer ladder. I had noticed in Bangladesh that trapezes were used to get in and out of top bunk beds. Such trapezes are also used to hang laundry. One could hypothesize that the absence of ladders led to the use of the trapeze for similar, as well as other purposes. The use of a trapeze to
substitute for a ladder may be driven by the reduced resource requirement of a trapeze (one rung) versus ladder (several rungs).

The absence of a ladder in domestic and office environments will likely lead to people moving if possible, and climbing furniture, e.g., chairs, tables, counters, to reach up to typical-height ceilings. As such objects were not created for this use, nor should they be, one could consider what other objects could make such use safer. For example, perhaps a variable-length stick, similar to a walking stick, could help stabilize ascent and descent from such existing items.

**Wrinkle removal**

Kim et al. (2013) discuss the affordances of a steam iron. Applying affordance of absence to this example, one could first consider either buying less wrinkle-prone material, or being less concerned with such details.

Barring that, i.e., for business attire when traveling, one may resort to using the steam from a shower to remove wrinkles from clothes. A frequent challenge is to find an optimal location to hang clothes for this purpose. Ideally, clothes are close to the source of the steam (the shower), but should not be so close that they become wet. Also, both the front and back sides of the garment are ideally exposed simultaneously, which is not the case when hanging on most door hooks. Therefore, a potential alternative solution that is at least more portable than an actual steam iron is an artefact that would facilitate the use of steam from the shower. For example, a collapsible bracket that would enable one to hang the non-standard, anti-theft, hotel-room hangers at a distance from an existing door, wall or rack may be suitable.

### 3.6 DISCUSSION AND SUMMARY

The study of affordance of absence so far suggests that there is some degree of overlap between the main dimension of physical absence and the other two minor dimensions. The dimensions also relate to the type of problem to be solved. For example, when designers wish to provide users with a high level of personal customization, or when it is impossible for the designer to ascertain all relevant user needs, increasing user control may be a good strategy. Conversely, in cases where product performance is sensitive to small changes, taking away user control may be preferable. A permanent
absence may be advisable in cases where material or cost reduction is highly important. A temporary absence may be advisable in cases where the designers wish to wait and see how users will use the product before finalizing a design. I plan to expand this framework with future work. I now discuss some insights gained while applying affordance of absence towards a prescriptive methodology.

First, it may be both most impactful and simplest conceptually to start by considering the absence of the overall product. This could reduce functional fixedness by clarifying how the problem can be solved by other means in particular situations. For example, the use of a stacking chair could be avoided when altering products that already exist in a domestic environment can fulfill its function. When it is clear that the product, e.g., a house, is required, one can turn next to determining which parts, including those considered “critical” or at least typical, e.g., basement, can be removed. Finally, when it is clear that each part is required, e.g., the blender container as well as its attachments, one can determine how to best exploit existing or potential absences at the part level.

3.6.1 RELATION TO AFFORDANCE-BASED DESIGN

As Burlamaqui & Dong (2014) state in their extensive review, the concept of affordance has two relevant features for design: 1) to determine the kinds of utility to incorporate into products to meet user needs, and 2) to find ways to convey that utility to the user. On the first point, there has been a myriad of approaches that use the concept of affordances successfully to link user tasks or user needs to product features (Galvao & Sato, 2005; Kim et al., 2013; Maier & Fadel, 2006, 2009a, 2009b). The affordance-of-absence method integrates well into these approaches as a design heuristic. After identifying the needed affordances from product users, designers could consider whether user aims can be met by exploring the major and minor dimensions of absence. Affordance of absence as a method is especially applicable to product redesign and optimization, to find ways of adding utility to a product by removing material and/or components.

Reviewing products where affordance of absence is present also helps designers work on the secondary benefit of affordance-based design: how best to convey affordances. By seeing how users interact with products when certain features are missing, designers can infer how users perceive and understand those features. The mental exercise of
thinking about how the removal of features affects the user’s perception of the product can be revealing for the designer. Specifically, one could explore the product’s attributes more thoroughly and be open to new ideas for manifesting affordances. Designers can also consider knowledge of the user and how much control they would like the user to have over product affordances. As a method of ideation, it prompts designers to explicitly plan design aspects that may be otherwise ignored or forgotten.

Once designers have described their problem in terms of user tasks, as existing methods prescribe, they can study simpler versions of products that afford the performing of those tasks for inspiration. Studying simpler, more primitive versions of specialized products may provide designers with information about prioritizing the affordances relevant to a user task. In addition, it may provide a way of thinking about how affordances can be combined together in one embodiment.

The affordance-of-absence method may also serve as a way for designers to think of reducing material and resource consumption in products. Multi-functional products are increasingly common, but rather than making tasks more efficient, they can cause more confusion for the user. They are also often the product of complicated manufacturing supply chains with large environmental impacts. Paring down product features, exploring the use-cases of simplified products and developing affordances that change depending on context or user experience, are all ways of producing product concepts that may offer reduced environmental impact.

3.6.2 LIMITATIONS OF THE AFFORDANCE OF ABSENCE METHOD

The affordance of absence method also has some drawbacks, especially when applied to behaviour-change problems. The method makes it difficult to account for differences between user preferences as all of the intended product users are assumed to have the same perception of affordances. Whereas the behaviour-change ontology of chapter 2 could be difficult to use because of too many options, the affordance of absence method relies on user perceptions being almost universal. Based on these experiences, I developed a third method for behaviour change that aimed to address the heterogeneity of problems and users while also being easy to apply. This is discussed in the next chapter.
4 Persuasion, User Heterogeneity and Motivation


4.1 RECAPITULATING BEHAVIOUR LITERATURE

As described in chapter 1, behaviour theories are helpful for identifying the antecedents of behaviour and providing a model for the process of behaviour change. Behavioural antecedents that many different theories agree on include personal and social norms, individual personality differences, external factors and the mapping between the attributes of the person and the behaviour. Behaviour itself is well explained with a two-style processing system. One style of mental processing is reactive and quick while the other is deliberative and slow.

In addition, designers are faced with three challenges when devising behaviour-change solutions: the heterogeneity of behaviour-change problems, the heterogeneity of users and typically a lack of experience in working with formal behaviour-change methods.

4.2 THE MULTI-MOTIVE FRAMEWORK: A DESIGN FRAMEWORK AND METHOD FOR GENERATING CONCEPTS TO BEHAVIOUR-CHANGE PROBLEMS

In this chapter, I discuss a design method I developed which helps designers address user heterogeneity, allows designers to think about two additional dimensions of behaviour change and helps them try different strategies to the same problem. The framework can best be explained by describing its associated design tool. The design tool is in the form of a matrix with six rows and seven columns. Like many of the other
behaviour-change methods discussed in chapter 1.3, the multi-motive method helps
designers find strategies that provide inspiration for idea generation. The strategies
have been gathered from existing research and grouped into three dimensions: Motive,
User Control and Concept Polarity. Each of these terms is now discussed in more detail.
### Figure 4.1: The multi-motive framework

<table>
<thead>
<tr>
<th>INFORMATION General Messages</th>
<th>FEEDBACK Data reflecting user performance</th>
<th>ENABLING Generally makes the behaviour easier to do</th>
<th>ENCOURAGING Advises user on which behaviour to perform</th>
<th>GUIDING Recommends an action to user through messages/cues</th>
<th>STEERING Selects best action and then uses cues and instructions to make user do that action</th>
<th>FORCING/AUTOMATION User has no choice but to do action/product does action without user</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGOISTIC MOTIVES</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
</tr>
<tr>
<td></td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
</tr>
<tr>
<td>SOCIOCULTURAL MOTIVES</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
</tr>
<tr>
<td></td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
</tr>
<tr>
<td>ALTRUISITIC MOTIVES</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
<td>Reward</td>
</tr>
<tr>
<td></td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
<td>Penalty</td>
</tr>
</tbody>
</table>

**EGOISTIC MOTIVES**
- Minimize cost, time, steps, failures;
- Increase fun;
- Increase efficiency;

**SOCIOCULTURAL MOTIVES**
- Increase prestige;
- Sense of belonging;
- Join trends;

**ALTRUISITIC MOTIVES**
- Minimize environmental impact;
- Improve lives of others;
4.2.1 MOTIVES: STRATEGIES GROUPED BY HOW THE USER PERCEIVES THE BENEFIT OF THE BEHAVIOUR

The three motive categories used in my framework correspond to well-discussed concepts in existing behavioural research. Many of the strategies from the design methods for behaviour-change can be grouped in terms of the incentives they recommend to designers. Users can be motivated to perform a behaviour because of its convenience, direct financial or other rewards, or its ability to provide enjoyment; because the behaviour helps the users fit in or stand out from their peers; or because performing the behaviour benefits others in society or the environment. These categories have been called Egoistic, Sociocultural and Altruistic motives.

4.2.1.1 EGOISTIC MOTIVES

Strategies relating to meeting the self-interest of the user (reducing their effort, increasing their convenience etc.) are well understood by product designers. Social psychologists have termed these as hedonic or utilitarian benefits (Babin et al., 1994).

4.2.1.2 SOCIOCULTURAL MOTIVES

Strategies that recommend taking advantage of users’ desire to fit in with peers or follow other social norms can be grouped under the sociocultural category. There is much evidence from the social psychology literature suggesting that the need to belong is a “powerful, fundamental, and extremely pervasive motivation” (Baumeister & Leary, 1995). The need to belong relates both to people’s desire to appear as a part of a group or as distinctive from a group. Baumeister & Leary (1995) showed that the impulses to show one’s distinctiveness from or one’s commonality to an external group are aspects of the same phenomenon. Social attitudes and norms are also one of the determinants of behaviour in Ajzen’s (1991) Theory of Planned Behaviour. Sociocultural motives have been shown to influence many environmentally conscious behaviours, such as whether people waste food (Evans, 2011), dispose of old possessions (Phillips and Sego, 2011), adopt energy-saving home innovations (Christie, 2010), and reduce water consumption (Corral-Verdugo et al., 2002). These motives are also manifested as the social-risk and potential image enhancement users assess in new products (Burton and Easingwood, 2006).
4.2.1.3 ALTRUISTIC MOTIVES

Strategies that recommend motivating behaviour-change by making users aware of the environmental and social costs of their actions. Altruistic motives are well documented as an influence on behaviour in psychology research. Related to Schwartz’s (1994) values of self-transcendence, Greiner & Gregg (2011) found that many Australian farmers were motivated primarily by a desire to conserve the land and be good stewards. De Groot and Steg (2007, 2008) & Bockarjova and Steg (2014) studied environmentally related behaviour change, and differentiated between specifically altruistic values (concern for others) and biospheric values (concern for the environment). As I am uncertain of this distinction’s benefit in non-environmental applications, I use the term altruistic to refer to both types of values. Traditional definitions of altruism from social psychology also do not make this distinction as both environmental and social concern can be generalized as having the goal of increasing the welfare of others (Batson, 2014).

4.2.2 THE DIMENSION OF USER CONTROL: STRATEGIES GROUPED BY HOW MUCH CONTROL THE USER HAS

Many existing methods used strategies that provide a range of user control. At one extreme, strategies can recommend leaving the behaviour in the hands of the user entirely (e.g., using informational campaigns). At the other extreme, strategies can recommend taking all control away from the user (e.g., make the desired behaviour the only possible choice). The methods proposed by Lidman & Renström (2011), Bhamra et al. (2012) and Daae & Boks (2014) explicitly organize some or all of their presented strategies along a scale of user control. Our method uses a condensed version of Daae & Boks (2014) nine-level scale of user control, which ranges from informing the user of the need to change behaviour, to automating the desired behaviour completely so that the user does not have any choice. Daae & Boks (2014)’s scale has the following nine levels: Information, Feedback, Enabling, Encouraging, Guiding, Seducing, Steering, Forcing, and Automatic. We combined Seducing and Steering, as well as Forcing and Automatic, for a total of seven categories to make the scale easier to apply.
4.2.3 CONCEPT POLARITY: THE NOTION OF POSITIVE AND NEGATIVE CONCEPTS

A dimension was added to capture the fact that strategies can use either rewards or penalties to effect behaviour change. Behaviour-change problems can be approached from two perspectives: Persuading the user to perform a desired behaviour, or persuading the user away from performing undesirable behaviours. This notion of polarity has been articulated in existing research. Daae & Boks (2014) categorized strategies along the dimension of Encouragement (i.e., whether to promote or discourage a behaviour) in their design method to capture this aspect of design for behaviour-change. Lockton et al.’s (2010) revised Design-with-Intent tool has categories of strategies that privilege either positive or negative interventions (e.g., the Ludic lens contains mostly reward-type strategies while the Security lens has mostly strategies that recommend imposing penalties for performing undesirable behaviours). The three dimensions of Motive, User Control and Concept Polarity constitute the building blocks of the multi-motive framework.

4.3 EXPERIMENTAL VALIDATION OF THE MULTI-MOTIVE FRAMEWORK

I next aimed to empirically validate multi-motive framework and its ability to predict user appeal for behaviour-changing products and services. Specifically, I wanted to determine whether there was a relationship between motive types and product appeal among different users. To do so, I created product concepts targeting the 3 motive types using the design tool based on the framework, and sought user responses to these concepts through an online survey. In behavioural research, a psychometric construct is an instrument (usually a survey) that assesses the type or category to which a person belongs. After formulating and refining a construct (Harrington, 2008), it is tested with users to determine whether the hypothesized model explains relationships in the collected data. I developed a survey consisting of product concepts and examined the following hypotheses empirically:

- H1: Concepts devised to appeal to the same motive type would be rated similarly by respondents
• H2: Respondents’ self-assessed level of egoistic, sociocultural, and altruistic motives would relate to their rating of concepts intended to appeal to those motives

I conducted several pilot surveys to refine the survey design. The concepts were generated using the aforementioned design tool. To keep the experimental factors at a reasonable number, I focused on validating the differences between the three motive groups. Thus, all of the concepts were at the enabling or encouraging level of persuasion. The concepts were also kept as similar as possible so that their intended motive-appeal would be the main differentiator. All concepts were presented as black-and-white line drawings of a similar size and all featured a similar level of detail. All of the reusable bag concepts (except for the control concept) had exactly the same shape and size.

4.3.1 METHODS

Participants were given a survey with interventions aimed to enable 2 pro-environmental behaviours: 1) using reusable over disposable shopping bags and 2) taking stairs instead of elevators in a small office building. Each behaviour had 6 associated concepts, 2 targeted to each motive type. Also present were 2 control concepts describing existing solutions not tailored for any particular motivation type. All concepts were described as being similar in cost and safety.

Using a 4-point Likert scale, respondents were asked to 1) rate how likely the concept would persuade them to perform the behaviour, and 2) provide reasons for their ratings. Respondents were allotted 10 minutes to complete the survey, which contained the concepts in randomized order. At the end of the survey, respondents were asked to quantify the relevance of each motive type to themselves by distributing 10 points over the motive-type descriptions. The motive types were described by the statements:

- I do things because they save me effort, save me time or save me money
- I do things because they fit the image or lifestyle I want
- I do things because they benefit the environment and/or improve the lives of others, even if they are perfect strangers to me
One hundred (100) respondents were recruited through Amazon Mechanical Turk. 100 is an acceptable number of participants for a confirmatory factor analysis with a small number of variables (14) (MacCallum et al., 1999). I aimed to poll a representative sample of average users and consumers, and thus attributes such as technical aptitude did not comprise a selection criterion. Care was taken to follow guidelines to ensure equitable treatment of workers (http://wiki.wearedynamo.org/index.php/Guidelines_for_Academic_ Requesters). The survey was posted through a service specializing in academic-research-related Human Intelligence Tasks (HITs)-Mturk Data Consultants (http://mturkdata.com). The service has a positive reputation on Turkopticon which is an independent Turker rating system. The name of the first author, his contact information, and the affiliation with the University of Toronto were provided to respondents. Participants were allotted 10 minutes for the survey and paid $1.50. Work was approved within a few hours of posting of the HIT. Worker privacy was also maintained. The only identifying detail available to the authors was each worker’s MTurk ID. The MTurk ID was only used to check whether respondents had been involved with previous survey iterations. All information was stored on a password-protected cloud account. The data was then transcribed and analyzed. The ratings and reasons submitted by respondents were reviewed to screen out non-attentive respondents. One respondent’s responses were discarded for this reason. English language proficiency was a selection criterion, but reviewing the “reason” statements suggested that all participants were satisfactory communicators. Familiarity with visual representation was also not tested, again since I wanted to present the task as a product choice scenario, expertise in this task was not required to perform it correctly. I had one instance of a person doing the task when they had also previously been part of a pilot study; this was identified early on and their results were removed. The survey data was collected in two batches. Thirty-three (33) respondents completed the survey on January 6th, 2015, 67 respondents completed the survey on January 13th, 2015. In terms of demographics, 11 respondents were between 18-24 years old, 17 were between 25-29, 23 were between 30-34, 18 were between 35-39, 15 were between 40-49, 10 were between 50-59 and 6 were between 60-69 years old.
<table>
<thead>
<tr>
<th>Control</th>
<th>Concepts to increase reusable over disposable bag use</th>
<th>Concepts to increase stair over elevator use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geckskin Strip Bag</td>
<td>This bag has a strip of a novel material that sticks to hard surfaces. Users can stick the bags to walls / doors and the message on the bag will remind them to take it with them when they leave.</td>
<td>Paystub-Reminder Program</td>
</tr>
<tr>
<td>MyCause Bag</td>
<td>This bag promotes one of several non-profit organizations as chosen by the user. The logo of the organization is prominently displayed on the bag.</td>
<td>Fitness-Tracking Incentives</td>
</tr>
<tr>
<td>Statement Satchel</td>
<td>Every time this bag goes through a retail checkout, it automatically posts a congratulatory message on the one of the user’s social media accounts.</td>
<td>GearVator</td>
</tr>
<tr>
<td>Fitness Fasttrack</td>
<td>The stairs would be painted in a racetrack theme and staff would scan their ID badges to keep track of how often they took the stairs. The names of the most prolific stair users would be displayed on a public scoreboard as “winners.”</td>
<td>GlassVator</td>
</tr>
</tbody>
</table>
**H1 – Relatedness of concepts**

Researchers who wish to test the existence of underlying behavioural traits (also called factors) often develop surveys where each question relates to a single factor. They then perform a Confirmatory Factor Analysis (CFA) to see if the questions that address the same factor cluster together. They also test whether the combination of all the behavioural factors explains the survey results generally (Harrington, 2008). In their comprehensive review of pro-environmental behaviour research, Steg and Vlek (2009) list factor analyses (including CFAs) as one approach for studying the dimensions of environmental behaviour. Milfont and Duckitt (2004) discuss how factor analyses have been used in research about environmental attitudes. Factor analyses have been used to study the New Environmental Paradigm scale (Dunlap & Van Liere, 1978), environmental values (Thompson & Barton, 1994), environmental concern (Schultz, 2001), Model of Ecological Values (Wiseman & Bogner, 2003) among many others. In my study, I used a CFA to check whether the concepts intended to address the same motivation type would elicit similar ratings.

I used the software package R to perform the CFA and defined a model with three latent variables to represent egoistic, sociocultural and altruistic motives. Multiple fit indices were used to evaluate the model: comparative fit index (CFI), Tucker-Lewis or non-normed fit index (TLI or NNFI), and root mean square error of approximation (RMSEA). For the TLI and CFI indices, a higher value indicates better fit, whereas the RMSEA is a measure of error and thus a lower value indicates better fit.
H2 - Relationship between respondents' self-assessment of motivation and concept ratings

I performed two tests to see if there was a relationship between the egoistic, sociocultural and altruistic components of respondents' motives and the way they rated products intended to address one of those motives.

The simplest way to check for a relationship was to study the correlations between respondents' self-assessed scores of egoistic/sociocultural/altruistic motives and their ratings of concepts intended to address these motives. I thus assessed the Pearson correlations between the motive and concept rating scores.

In the second analysis, I examined whether the ratings for egoistic concepts taken together could be used to predict the egoistic component of respondents' motivation, ratings for sociocultural concepts to predict the sociocultural motivation component and ratings for altruistic concepts to predict the altruistic motivation component.

4.3.2 RESULTS

H1 – Relatedness of concepts

Based on the indices of fit, the initial model showed a poor fit (CFI=0.63, TLI=0.52, RMSEA=0.10). I removed the worst performing concepts based on respondent comments from each factor and performed another analysis. These concepts (Statement Satchel, Fitness-Tracking Incentives and Wait-Reduction Tracker) are discussed in detail below. The revised model, shown in Table 4.1, showed an improved fit with the data (CFI=0.80, TLI=0.70, RMSEA=0.08).
Table 4.1: Confirmatory Factor Analysis (CFA)

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geckskin Strip Bag</td>
<td>1.00 (-)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Clean Sac</td>
<td>0.73 (0.24)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GearVator</td>
<td>0.86 (0.27)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MyCause Bag</td>
<td></td>
<td>1.00 (-)</td>
<td></td>
</tr>
<tr>
<td>GlassVator</td>
<td></td>
<td>1.58 (0.86) ‡</td>
<td></td>
</tr>
<tr>
<td>FitnessFasttrack</td>
<td></td>
<td>1.99 (1.08) ‡</td>
<td></td>
</tr>
<tr>
<td>Carbon-Capture Sac</td>
<td></td>
<td></td>
<td>1.00 (-)</td>
</tr>
<tr>
<td>TreePlanting Bag</td>
<td></td>
<td></td>
<td>0.40 (0.23) ‡</td>
</tr>
<tr>
<td>Piezo Stepper</td>
<td></td>
<td></td>
<td>0.80 (0.23)**</td>
</tr>
</tbody>
</table>

‡ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

**H2 - Relationship between respondents' self-assessment of motivation and concept ratings**

Table 4.2 shows Pearson correlations between the self-ratings of each motivation type and normalized ratings for each concept. Ratings were normalized by subtracting each respondent’s rating of the control concept from that respondent’s rating of other concepts.

Table 4.2: Correlation between motive and concept ratings

<table>
<thead>
<tr>
<th>Reusable-bag concepts</th>
<th>Egoistic Rating</th>
<th>Sociocultural Rating</th>
<th>Altruistic Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egoistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geckskin Bag</td>
<td>0.020</td>
<td>-0.065</td>
<td>0.024</td>
</tr>
<tr>
<td>Self-Clean Sac</td>
<td>-0.088</td>
<td>-0.087</td>
<td>0.156</td>
</tr>
<tr>
<td>Sociocultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MyCause Bag</td>
<td>-0.073</td>
<td>-0.020</td>
<td>0.095</td>
</tr>
<tr>
<td>StatementSatchel</td>
<td>0.051</td>
<td>-0.053</td>
<td>-0.021</td>
</tr>
<tr>
<td>Altruistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon-Capture Sac</td>
<td>-0.168‡</td>
<td>-0.020</td>
<td>0.199*</td>
</tr>
<tr>
<td>TreePlanting Bag</td>
<td>-0.254*</td>
<td>-0.020</td>
<td>0.294*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Increase-stair-use concepts</th>
<th>Egoistic Rating</th>
<th>Sociocultural Rating</th>
<th>Altruistic Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egoistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Tracking</td>
<td>-0.080</td>
<td>0.163</td>
<td>-0.024</td>
</tr>
<tr>
<td>GearVator</td>
<td>0.039</td>
<td>0.031</td>
<td>-0.064</td>
</tr>
<tr>
<td>Sociocultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Fasttrack</td>
<td>-0.117</td>
<td>0.295*</td>
<td>-0.074</td>
</tr>
<tr>
<td>GlassVator</td>
<td>-0.069</td>
<td>0.159</td>
<td>-0.033</td>
</tr>
<tr>
<td>Altruistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo Stepper</td>
<td>0.038</td>
<td>0.037</td>
<td>-0.067</td>
</tr>
<tr>
<td>Wait-Reduction Tracker</td>
<td>-0.014</td>
<td>0.055</td>
<td>-0.022</td>
</tr>
</tbody>
</table>

‡ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 4.3 summarizes the second way I studied this relationship, using multiple linear regression
Table 4.3: Multiple Regression Analyses to Test Relationships between Concept Ratings and Motivation-Type Assessments

<table>
<thead>
<tr>
<th>Model: Egoistic Rating</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$R^2$</th>
<th>Adj. $R^2$</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeckSkin Bag</td>
<td>0.06</td>
<td>0.36</td>
<td>0.08</td>
<td>0.04</td>
<td>4, 95</td>
<td>2.02‡</td>
</tr>
<tr>
<td>Self-Clean Bag</td>
<td>-0.30</td>
<td>-1.55</td>
<td>0.03</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GearVator</td>
<td>-0.38</td>
<td>-2.20</td>
<td>0.07</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Tracking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model: Sociocultural Rating</td>
<td>0.10</td>
<td>0.06</td>
<td></td>
<td></td>
<td>4, 95</td>
<td>2.51*</td>
</tr>
<tr>
<td>Statement Satchel</td>
<td>0.07</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MyCause bag</td>
<td>0.02</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GlassVator</td>
<td>-0.02</td>
<td>-0.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Fasttrack</td>
<td>0.30</td>
<td>2.93**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model: Altruistic Rating</td>
<td>0.17</td>
<td>0.13</td>
<td></td>
<td></td>
<td>4, 95</td>
<td>4.72**</td>
</tr>
<tr>
<td>Carbon-Capture Bag</td>
<td>0.16</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TreePlanting Bag</td>
<td>0.39</td>
<td>3.09**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo Stepper</td>
<td>0.05</td>
<td>0.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wait-Reduction Tracker</td>
<td>0.16</td>
<td>1.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‡ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.3.3 Discussion

**H1 – Relatedness of concepts**

The fit indices suggested that my survey produced a poor-to-acceptable 3-factor model. Reasons provided by respondents for their ratings were reviewed to determine why some concepts performed poorly.

The Statement Satchel, the lowest scoring concept (1.16/4), posts to social media when users shop with the bag. Respondents were incensed by possible privacy violations, did not wish their shopping habits broadcast, and felt this type of information would clutter others’ social-media accounts. Rather than be the point of pride intended, most respondents felt this type of messaging would harm their privacy and reputation.

I developed this concept because posting on social media appears to be a successful strategy for existing mobile phone applications, e.g., those that post users’ exercise statistics. Similarly, users routinely allow music-streaming applications to inform others of the songs on their playlists. Shopping behaviour is perhaps more private than exercise habits or music listening. Conversely, perhaps many users do not know that their apps are already broadcasting information about them. On the other hand, existing apps can be configured to post messages to a smaller group of individuals. The Statement Satchel
concept did not specify this control, and was almost universally disliked by all respondents.

The Fitness-Tracking Incentives concept to increase stair use, on the other hand, was the highest rated (2.97/4). The concept provides incentives to use fitness phone apps; the building staircases become official app routes and users would be able to track how the stairs help them meet their fitness goals. The concept’s almost unanimous appeal could be because the best-known benefit of stair usage is physical fitness, which this concept explicitly supports.

The Wait-Reduction Tracker concept to reduce elevator use, was also one of the highest rated concepts (2.57/4). My inability to discriminate its ratings is more difficult to explain. Even egoistically motivated respondents felt that public display of increased wait times for those needing the elevator more would trigger shame within them, and be effective in reducing their elevator use. Conversely, some altruistically motivated respondents questioned the concept’s feasibility, i.e., whether showing wait times as percentages was meaningful or possible to measure accurately. Doubts of the altruistically motivated respondents combined with praise of the egoistically motivated respondents made differences between them harder to discern.

**H2 - Relationship between respondents' self-assessment of motivation and concept ratings**

The results for this analysis is mixed. In terms of direct correlations, Table 2 shows that in 5 cases (bold text in grey cell), concept ratings correlated best with the types of motives they targeted. The statistically significant results (2 altruistic and 1 sociocultural concept) also correlated best with their intended-motive type. In the regression analysis, the strength of the relationship between concepts and motivation components varied by motivation type. The egoistic concepts only explained about 8% of the variance in egoistic self-ratings, sociocultural concepts explained 10% of the variance in sociocultural self-ratings, while altruistic concepts accounted for a much higher 17% of the variance in altruistic self-ratings. Only two of the concepts (Fitness Fasttrack and TreePlanting Bag) contributed significantly to their respective motive types.
Respondent comments provided better support for correlations between concept ratings and motive types. Respondents with high-rated egoistic motives tended to easily understand the benefits of the GearVator concept, which transports items in a smaller elevator system to reduce passenger-elevator use. One respondent stated that wearing a heavy coat was a major deterrent for climbing stairs, which this concept addresses. Conversely, respondents with low-rated egoistic motives focused on the drawbacks, e.g., the energy wasted by an additional elevator system. Similarly, high-sociocultural motivated respondents identified the benefits of the Fitness Fasttrack concept, with one describing it as a “fun competition.” Less socioculturally motivated respondents were more likely to discuss pitfalls, e.g., reduced productivity in the company if staff became distracted by the competition. Finally, high-rated altruism motive respondents appreciated the TreePlanting bag concept, stating reasons such as “it allows me to see the impact I’m making.” Low-rated altruism motive respondents focused on concept limitations, i.e., one respondent was unimpressed with the concept, as it did nothing to alleviate the main problem of forgetting to take reusable bags along.

Table 2 also shows that reusable-bag concepts all correlated best with altruistic motives, while the increase-stair-use concept correlations showed more differences. This may suggest that the appeal of reusable bags is generally tied to altruistic motives. Indeed, when asked how frequently they used reusable bags, respondents’ answers correlated with their altruistic motive ratings. I do not suggest that reusable bag concepts should focus on altruistic motives, but rather, designers of reusable bags should target other motive types.

4.3.4 GENERAL FINDINGS

When I reviewed the reasons respondents provided for their ratings, I found that some of the concepts had poor diagnosticity because they were perceived in unexpected ways by respondents. I had devised each concept with features targeting one motive type. In some cases, the concepts’ motive-targeting features were misunderstood, completely missed or ignored in favor of extraneous attributes. This meant that the ratings of these concepts were not based on a consideration of the motive-targeting feature(s). To improve the survey instrument overall, I revised the concepts to make the motive-targeting feature clearer and to remove any distracting extraneous elements. For example (as shown in Table 4), while the Geckskin bag was well liked by respondents
with high egoistic motives, altruistic respondents rated it poorly. Some respondents believed the bag material had the texture of lizard-skin. My use of the name Geckskin was to more easily convey the stickiness of the strips. Since the feel of the material was not a feature intended to be appraised (whether positively or negatively), I replaced the Geckskin bag with the Post-It bag featuring the same benefit, but under the guise of an adhesive material developed by 3M, as shown in Figure 4.3.

I made several such modifications to the survey concepts. The Self-Clean Sac concept was similarly appealing to respondent types other than the intended egoists, who did not appreciate the concept’s benefits. These users did not consider getting a bag dirty a significant problem, as it was already easy to wash reusable bags. To better target egoistic motives, I replaced the Self-Clean Sac with the Dura-Light Bag, which features a reflective strip to help shoppers be more visible to cars in parking lots and on roads. The bag, shown in Figure 4, is also made using a ripstop material that prevents tearing.

![Figure 4.3: Modifications to the egoistic bags](image)

Figure 4.4 shows how both sociocultural bag concepts were modified. The Statement Satchel concept was seen to violate privacy concerns by publicizing the shopping habits of users. In its place, I devised the Seeing Green Bag to highlight the user’s interest in environmentally conscious causes without revealing personal details. While respondents identifying as socioculturally motivated generally liked the MyCause bag, it was very similar to the new Seeing Green concept. In addition, respondent comments revealed that affiliation with a charitable cause aligned with the interests of many altruistically
motivated respondents. Therefore, the MyCause bag was replaced with the Design-First Bag, which allowed respondents to select a bag associated with a luxury-goods brand.

Figure 4.4: Modifications to the sociocultural bags

Figure 4.5 shows the replacement of an increase-stair-use concept that targeted altruistic motives, but was difficult to understand as presented. Specifically, for the Wait-Reduction Tracker concept, respondents struggled with the meaning of the wait-time percentage information proposed. Therefore, I replaced the wait-time display with the universal accessibility symbol that would light up when someone with a specialized key-card uses it to hail the elevator. This is intended to have the same effect of reminding that those with greater needs for the elevator have higher priority. Finally, I also revised some of the instructional wording to increase clarity to respondents.

Figure 4.5: Modifications to the altruistic elevator concept

4.3.5 RESULTS

To test the next iteration of the survey, 101 new Amazon Mechanical Turk respondents were recruited through the same service. Respondents were identified by
their Mechanical Turk ID to ensure that they could not participate in more than one trial of my experiment. The survey was posted on March 25th, 2015. In terms of demographics, 14 respondents were between the ages of 18-24 years, 16 were between 25-29 years, 24 were between 30-34 years, 12 were between 35-39 years, 24 were between 40-49 years, 9 were between 50-59 years, 1 was between 60-69 years and 1 was over 70 years old.

**H1 – Relatedness of concepts**

I performed another Confirmatory Factor Analysis (CFA). Again, 3 underlying factors, or similar groups, were verified, as shown in Tables 4. The initial model with all the variables included had fit statistics were as follows: CFI=0.69, TLI=0.60, RMSEA=0.09). The model was revised by removing the worst performing concepts (Post-It Bag, Fitness Fasttrack, and Accessibility Reminder), discussed in detail below. The resulting CFA yielded improved fit over all previous iterations (CFI=0.88, TLI=0.82, RMSEA=0.06). The final model statistics are shown in Table 4.4.

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dura-Light Bag</strong></td>
<td>1.00 (-)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fitness Tracking</strong></td>
<td>0.72 (0.43)‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GearVator</strong></td>
<td>1.39 (0.53)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design-First Bag</strong></td>
<td></td>
<td>1.00 (-)</td>
<td></td>
</tr>
<tr>
<td><strong>Seeing Green Bag</strong></td>
<td></td>
<td>2.27(0.92)*</td>
<td></td>
</tr>
<tr>
<td><strong>GlassVator</strong></td>
<td></td>
<td>1.12(0.56)*</td>
<td></td>
</tr>
<tr>
<td><strong>TreePlanting Bag</strong></td>
<td></td>
<td></td>
<td>1.00 (-)</td>
</tr>
<tr>
<td><strong>Carbon-Capture Bag</strong></td>
<td>1.16(0.31)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Piezo Stepper</strong></td>
<td></td>
<td></td>
<td>0.67(0.26)*</td>
</tr>
</tbody>
</table>

‡ p< 0.1, * p< 0.05, ** p< 0.01, *** p< 0.001
**H2 - Relationship between respondents' self-assessment of motivation and concept ratings**

Table 4.5 shows Pearson correlations between the self-ratings of each motivation type and normalized ratings for each concept. Table 6 shows a multiple linear regression.

**Table 4.5: Correlation between motive and concept ratings – Trial 2**

<table>
<thead>
<tr>
<th>Reusable-bag concepts</th>
<th>Egoistic</th>
<th>Sociocultural</th>
<th>Altruistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egoistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dura-Light Bag</td>
<td>-0.006</td>
<td>-0.035</td>
<td>0.049</td>
</tr>
<tr>
<td>Post-It Bag</td>
<td>-0.067</td>
<td>-0.023</td>
<td>0.115</td>
</tr>
<tr>
<td>Sociocultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design-First Bag</td>
<td>-0.101</td>
<td>0.160</td>
<td>-0.052</td>
</tr>
<tr>
<td>Seeing Green Bag</td>
<td>-0.236*</td>
<td>0.179</td>
<td>0.104</td>
</tr>
<tr>
<td>Altruistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon-Capture Sac</td>
<td>-0.185‡</td>
<td>-0.030</td>
<td>0.280*</td>
</tr>
<tr>
<td>TreePlanting Bag</td>
<td>-0.132</td>
<td>-0.075</td>
<td>0.262*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Increase-stair-use concepts</th>
<th>Egoistic</th>
<th>Sociocultural</th>
<th>Altruistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egoistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Tracking</td>
<td>0.171</td>
<td>-0.079</td>
<td>-0.134</td>
</tr>
<tr>
<td>GearVator</td>
<td>0.032</td>
<td>-0.052</td>
<td>0.017</td>
</tr>
<tr>
<td>Sociocultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Fasttrack</td>
<td>0.246*</td>
<td>-0.196‡</td>
<td>-0.098</td>
</tr>
<tr>
<td>GlassVator</td>
<td>-0.046</td>
<td>0.100</td>
<td>-0.055</td>
</tr>
<tr>
<td>Altruistic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo Stepper</td>
<td>0.076</td>
<td>-0.242*</td>
<td>0.181‡</td>
</tr>
<tr>
<td>Accessibility Reminder</td>
<td>0.100</td>
<td>-0.161</td>
<td>0.055</td>
</tr>
</tbody>
</table>

† p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

**Table 4.6: Multiple Regression Analyses to Test Relationships Between Concepts and Motivation Type Ratings- Trial 2**

<table>
<thead>
<tr>
<th>Model: Egoistic Rating</th>
<th>β</th>
<th>t</th>
<th>R²</th>
<th>Adj. R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dura-Light Bag</td>
<td>-0.07</td>
<td>-0.26</td>
<td>0.04</td>
<td>0.005</td>
<td>4, 96</td>
<td>1.12</td>
</tr>
<tr>
<td>Post-It Bag</td>
<td>-0.20</td>
<td>-0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GearVator</td>
<td>-0.31</td>
<td>-1.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Tracking</td>
<td>0.08</td>
<td>0.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model: Sociocultural Rating</th>
<th>β</th>
<th>t</th>
<th>R²</th>
<th>Adj. R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-First Bag</td>
<td>0.45</td>
<td>2.43*</td>
<td>0.20</td>
<td>0.17</td>
<td>4, 96</td>
<td>6.18***</td>
</tr>
<tr>
<td>Seeing Green Bag</td>
<td>0.35</td>
<td>2.01*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GlassVator</td>
<td>0.28</td>
<td>2.01*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Fasttrack</td>
<td>-0.35</td>
<td>-2.37*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model: Altruistic Rating</th>
<th>β</th>
<th>t</th>
<th>R²</th>
<th>Adj. R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-Capture Sac</td>
<td>0.28</td>
<td>1.77‡</td>
<td>0.23</td>
<td>0.19</td>
<td>4, 96</td>
<td>7.01***</td>
</tr>
<tr>
<td>TreePlanting Bag</td>
<td>0.30</td>
<td>2.13*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo Stepper</td>
<td>0.31</td>
<td>2.56*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility Reminder</td>
<td>0.11</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
4.3.6 DISCUSSION AND SUMMARY FOR SECTION 4.3

The results yielded some interesting insights. The two hypotheses were better supported by the revised survey. Table 4.4 shows that the concepts clustered together much better, with almost all remaining concepts making a statistically significant contribution. Respondents evaluated egoistic, sociocultural and altruistically targeted concepts similarly in both problems. This supports my expectation that the motive categories are the same in both the elevator and reusable bag problem. Table 4.5 shows that the correlations between motive and concept type were improved overall with 8 (bold font in grey cell) showing expected correlations. The statistically significant results (3 altruistic, 1 of which was significant to 0.10) also correlated best with their intended-motive type. Table 4.6 shows an improved regression model for the sociocultural and altruistic concepts, each explaining 20% and 23% of the variance in the sociocultural and altruistic self-ratings respectively. Egoistic concepts explained only 4% of the variance in the egoistic self-ratings.

4.3.6.1 UNEXPECTED PERCEIVED CONCEPT ATTRIBUTES

Reviewing the comments associated with the poorly performing comments, I discovered that participants often perceived concept attributes differently from what I intended. The egoistic concepts either had unintended limitations or broader appeal than intended because respondents perceived additional unstated benefits. Table 6 shows that the Dura-Light Bag was generally well liked by all types of respondents, making it difficult to discern motive types. On the other hand, the Post-It Bag was generally disliked. Many respondents too literally transferred the adhesive properties of Post-It notes, and did not trust that the same adhesive strength would hold up even an empty bag. In hindsight, I also neglected to include the “reminder” message of the GeckSkin Bag; thus the Post-It Bag’s intended benefits were not apparent.

For the sociocultural concepts, the Fitness Fasttrack had sociocultural pitfalls I had not anticipated. This concept was generally disliked because respondents worried about their performance being on display in front of their colleagues. In terms of altruistic concepts, the Accessibility Reminder, did fit the clustering model well. Respondent comments revealed that the concept had broad appeal across different motivation types. Respondents perceived egoistic benefits such as being able to know explicitly when they
should not call the elevator. Respondents also recognized the efficacy of the sociocultural shame associated with hailing the elevator when the accessibility sign was lit. There were also altruistic benefits for those respondents who were happy to leave the use of the elevators to those who needed it most. Thus, in many cases, it proved difficult to precisely target concepts to only one motive type. Overall, respondents often found unexpected ways to see unintended benefits or pitfalls in the descriptions. However, my experiments confirm the importance of user testing, as many concepts were not received as expected. One explanation is that the motive categories (particularly the egoistic category, which was especially difficult to predict responses to) are still too broad and may need to be divided further. A reassessment of the categories can be considered in future tests. Self-assessments of personality traits are known to be difficult to perform. Respondents to surveys often have a tendency to give positive self-descriptions (Edwards, 1957). This can be intentional, as people want to be perceived as being better than they are (impression management) or it can be unconscious as people may not want to acknowledge their own personality traits (self-deception) (Paulhus, 1984). A more sophisticated questionnaire should be developed for that purpose.
<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>FEEDBACK</th>
<th>ENABLING</th>
<th>ENCOURAGING</th>
<th>GUIDING</th>
<th>STEERING</th>
<th>FORCING/ AUTOMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Messages</td>
<td>Data reflecting user performance</td>
<td>Generally makes the behaviour easier to do</td>
<td>Advises user on which behaviour to perform</td>
<td>Recommends an action to user through messages/cues</td>
<td>Selects best action and then uses cues and instructions to make user do that action</td>
<td>User has no choice but to do action/product does action without user</td>
</tr>
<tr>
<td>A sign saying “Taking the stairs helps you stay fit”</td>
<td>Smartphone app that tells user calories burned for taking the stairs</td>
<td>Provide running shoes for free to employees</td>
<td>Employees who take the stairs get entered into a draw for prizes like coffee</td>
<td>An employee’s stair taking is considered positive during annual reviews</td>
<td>Employees are given a monetary bonus for each time they take stairs</td>
<td></td>
</tr>
<tr>
<td>A sign saying “Sitting for long hours is bad for your health; take the stairs”</td>
<td>Smartphone app that tracks the amount of time the user is sedentary</td>
<td>Relocate meeting rooms to be as far as possible from the elevators</td>
<td>Hailing the elevator requires remembering and entering a ten-digit code</td>
<td>Elevator access has quotas based on an appraisal of their need for it</td>
<td>Employees must pay a small amount each time they use the elevators</td>
<td></td>
</tr>
</tbody>
</table>

**EGOISTIC MOTIVES**  
Minimize cost, time, steps, failures; increase fun; increase efficiency;

**SOCIOCULTURAL MOTIVES**  
Increase prestige, sense of belonging; join trends;

**ALTRUISTIC MOTIVES**  
Minimize environmental impact; improve lives of others;
4.4 EVALUATING AND REFINING THE MULTI-MOTIVE METHOD

After formulating the multi-motive method, I wanted to see how it would affect designers' design performance. First I wanted to see how the multi-motive method compared to existing idea-generation methods.

4.4.1 STUDY 1: STUDENT DESIGNERS USING THE MULTI-MOTIVE DESIGN METHOD VS. 6-3-5 METHOD.

Thirty-two 4th-year undergraduate students were recruited from a mechanical design course at the University of Toronto. The students had already selected a behaviour-change problem as their course project and were organized into groups of 4. The behaviours selected by the students hailed from a range of industries, including healthcare (encouraging patients to complete their antibiotic courses), transportation (encouraging cyclists to merge into traffic and make right turns at intersections correctly), sustainability (encouraging urban gardening) and exercise (encouraging office workers and students to stand up regularly during work/study sessions). At the time of the study, the students had already done research into their problems and identified user needs, and were thus prepared to enter the concept generation phase of their projects. Traditionally, the students in the course use one of several ideation methods to generate concepts, including brainstorming, TRIZ and Rohrbach’s 6-3-5 method (1969). I decided to compare student performance with the 6-3-5 method, which is structured and usually leads to many ideas, to the multi-motive method. The 6-3-5 method is meant to be performed with a team of six people who each get a sheet of paper that is divided into three columns. The team is given five minutes to generate three ideas (one for each column on the page). After five minutes, each team member passes his/her sheet of paper to the person beside him/her. Each member then has five minutes to add to the ideas of his/her teammate, or generate up to three new ideas. This cycle of ideation and sheet-passing continues for six rounds until everyone has their original sheet returned to him/her. This method helps teams generate a large number of ideas (if each member generates three new ideas every round, 90 ideas will be generated in total by the team) and also reduces any one group member’s ability to dominate the group activity.

Both the 6-3-5 and multi-motive methods were used in a 2-hour idea generation session. First, 6-3-5 was explained in a short presentation. The students then applied the
method to their course project problems. Since the student groups were composed of 4 instead of 6 members, they used a modified form of the method which we will call 4-3-5. Students were given 25 minutes to complete ideation (4 rounds, each 5 minutes long, with an additional 5 minutes at the end for discussion and clarification). In the second half of the idea generation session, we explained our multi-motive method in a 15-minute presentation. The students were also shown an example of the method applied to a behaviour-change problem, and then were given 30 minutes to generate concepts using the multi-motive method in their groups.

4.4.1.1 COMPARISON OF DESIGN PERFORMANCE BETWEEN THE TWO METHODS

I collected the student-generated concepts from both methods used during the session. For each project, I counted the number of unique concepts generated and then also categorized the concepts in terms of the strategies they applied. There were two results of note:

1. The multi-motive method consistently yielded more concepts per group member than the 4-3-5 method
2. Students consistently applied more strategies when using the multi-motive method than the method 4-3-5 method
4.4.1.2 COMPARISON OF THE AVERAGE NUMBER OF CONCEPTS GENERATED

The consistently higher number of concepts generated when using the multi-motive method is illustrated in Figure 4.7 below.

**Figure 4.7: Average Concepts generated per group member**

I performed a Wilcoxon-signed-rank test to statistically evaluate the difference between the average number of ideas generated per group member. The Wilcoxon-signed-rank test is similar to a paired t-test but is used with non-parametric data from dependent samples (Randles, 1988). The difference in the number of ideas generated was statistically significant at p<0.05. All of the assumptions of the test were also met.
4.4.1.3 COMPARISON OF THE NUMBER OF STRATEGIES APPLIED BY GROUPS

In order to compare how many strategies each group explored during their ideation process, I reviewed all the generated concepts and grouped them based on the strategy they represented. For example, the group working on encouraging reusable coffee-cup use applied the strategy of providing users with personal rewards in several concepts (e.g., create a separate coffee line for reusable coffee cup customers, give away stickers and redeemable points to reusable coffee cup customers).

![Figure 4.8: Number of strategies explored by each group](image)

A Wilcoxon-signed-rank test again showed a statistically significant difference between the two methods at p<0.01.

4.4.1.4 DISCUSSION AND APPROPRIATENESS OF CONCLUSIONS

The results of the first study were positive but also somewhat expected. The multi-motive method has many advantages over the 4-3-5 method. The 4-3-5 method is very general while the multi-motive method offers guidance tailored to behaviour-change idea generation. Secondly, in a group of four people, the 4-3-5 method can only generate 60 unique ideas (if every group member has three new and unique ideas each round). The
number of cells in the multi-motive tool enables a group to produce a maximum of 148 ideas if every group member generates completely unique solutions. Third, the multi-motive model explicitly gives designers suggestions about strategies to apply, whereas the 4-3-5 method only has previous rounds of idea generation as stimuli for ideation. Nevertheless, the results of this study validated our intent for the multi-motive method: namely that it should help designers generate many ideas and apply a broad set of strategies so that the heterogeneity in users and problems can be better addressed.

The results also offered an unexpected benefit. All of the student-designer groups used the multi-motive method after the 4-3-5 method. We would normally expect designers to become fatigued after ideating for 25 minutes and therefore perform worse using the second method. Nevertheless, all of the groups generated many more ideas and generally applied more strategies when using the multi-motive method. Based on the results of the experiment and comments from students, I made some revisions to the method and performed a second study.

4.4.2 STUDY 2: PROFESSIONAL DESIGNERS USING THE MULTI-MOTIVE METHOD

I contacted a local design consultancy that currently works in the area of behaviour change. These projects are in a multitude of industries and with solutions taking the form of consumer products, services or software and mobile applications. While the designers at the consultancy had experience working on behaviour-change problems, they did not yet have a preferred method that could be used across projects for applying behaviour-change strategies. Thus, they represented an excellent test case for studying how the multi-motive method would fare in a professional design setting.

4.4.2.1 PLANNING AN IDEATION SESSION AND MAKING THE METHOD ACCESSIBLE TO PROFESSIONALS

I first presented the multi-motive method to a small group of designers and solicited their expert appraisal of the method. Over the course of several discussions, they recommended two changes which were incorporated into the method.

1. The designers felt that the number of columns (i.e., the levels of user control) was too high. It was difficult for them to see meaningful distinctions among the seven levels. Having seven discrete levels also caused the designers to debate where to
place a concept, which detracted from the task of idea generation. Thus, I
combined the Enabling and Encouraging levels and the Guiding and Steering
levels. The designers also recommended that I combine the Information and
Feedback levels. This was the result of their desire to maximize the number of
viable concepts. Based on their experience, the designers were not optimistic
about the efficacy of products and services that simply gave users information
about behaviour change. The very minimum they would expect from a behaviour-
changing product or service would be to track the user’s performance and give
appropriate feedback. Thus, the seven discrete levels of user control were
transformed into a spectrum with four levels, each with titles that explicitly
describe the level of user control:

**Full User Control** (formerly Informing/Feedback) → **Some User Control** (formerly
Enabling/Encouraging) → **Little User Control** (formerly Guiding/Steering) → **No
User Control** (formerly Forcing/Automation).

2. The second recommended change was related to the form of the design method. I
had noticed in study 1 that the student designers were reluctant to think of more
than one concept for a particular combination of motive and level of control
because there was only one cell available for it on the matrix. The consultants
recommended that matrix instead be drawn on a large whiteboard and then I
could ask designers to sketch or write ideas on post-it notes, which could then be
stuck in the appropriate area. This would allow for more than one idea to occupy
the same region of the table. This change also meant that the concept generation
took place as both a collective and a personal activity. Designers could think of
concepts independently, sketch them or write them on a post-it and then place it
on the whiteboard for the group to see. They could also call out their idea before
sketching, and their colleagues could build on it before an idea was sketched or
written down. Figure 4.9 shows a whiteboard used to support the multi-motive
method.
4.4.2.2 STRUCTURE OF THE IDEATION SESSION

We recruited 11 professional designers who came from three project teams inside the company. Each group was already working on a behaviour-change related project. The projects had been underway for different lengths of time, but each team had enough background knowledge about their project to generate concepts. The designers were first given a ten-minute presentation on the multi-motive method. The teams then performed ideation for their respective behaviour-change problems for one hour. To improve focus for the group ideation process, the teams only worked on one motive group at a time for concept generation. They spent 30 minutes generating concepts that related to egoistic motives, 15 for sociocultural motives and 15 for altruistic motives. To quantitatively measure performance of the design method during the session, we counted the number of unique concepts generated for each motive type.


4.4.2.3 IDEATION SESSION RESULTS

Figure 4.10: Number of strategies explored by each group

Each team generated between 29 and 33 unique ideas for their projects. The ideas included software applications, physical products and services. The teams generated the most concepts for Egoistic strategies, in part due to the additional time allocated to that motive type.

4.4.2.4 QUALITATIVE ASSESSMENT OF THE MULTI-MOTIVE METHOD BY PROFESSIONAL DESIGNERS

After the idea generation was complete, the teams answered survey questions to evaluate the multi-motive method. Daae & Boks (2014) postulated 12 metrics for assessing the quality of a behaviour-change design method. The metrics were developed after a review of goals for behaviour-change literature as well as several workshops with designers and design researchers. The metrics are organized into three groups (what a good design method MUST do, what a good design method SHOULD do and what a good design method COULD do). Table 4.7 shows the average ratings provided for each of Daae & Boks’s metrics.
Table 4.7: Qualitative ratings of the multi-motive method (n=10)

<table>
<thead>
<tr>
<th>MUST</th>
<th>Rating (/5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help designers to design products that are more likely to be used in the desired way by using the tool, than without the tool.</td>
<td>4.4</td>
</tr>
<tr>
<td>Help designers understand which design principles they should apply to change the behaviour of their target group.</td>
<td>3.1</td>
</tr>
<tr>
<td>Increase the designers understanding of different aspects of how the product affects the behaviour of the user</td>
<td>4.4</td>
</tr>
<tr>
<td>Be easy to use for product designers, fit into designerly ways of working</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SHOULD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Be possible to understand how to use in 15 minutes</td>
<td>4.1</td>
</tr>
<tr>
<td>Be inspiring for designers</td>
<td>4.4</td>
</tr>
<tr>
<td>Be in a format that makes it suitable for discussion and collaboration</td>
<td>4.9</td>
</tr>
<tr>
<td>Should be experienced as suggesting rather than dictating</td>
<td>4.5</td>
</tr>
<tr>
<td>Remind the designers of the aspects of a product that affect the way users interact with it</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COULD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Be suitable to bring to meetings with clients to help the designers explain their decisions</td>
<td>3.6</td>
</tr>
<tr>
<td>Be experienced as primarily visual</td>
<td>3.7</td>
</tr>
<tr>
<td>Be written in non-scientific language</td>
<td>4.2</td>
</tr>
</tbody>
</table>

The multi-motive method was generally well-rated by the designers. There were particular insights I gleaned from designers’ appraisals which I will now discuss.

4.4.2.5 QUANTITATIVE ASSESSMENT OF THE MULTI-MOTIVE METHOD BY PROFESSIONAL DESIGNERS

When reviewing the quantitative results of the study, I was surprised by the relatively low number of concepts the professional designers generated. The designers produced an average of 8-10 concepts per team member, compared to 35 or so concepts per student team member in Study 1. When this was brought up in discussion, the designers gave several explanations. Firstly, they liked to generate ideas in one area of the table (i.e., at or near the middle levels of user control) because they felt that concepts in this region had the optimal balance of being effective, feasible to execute and also desirable to the user. Concepts at higher levels of user control were thought to be less feasible and concepts that took away most of the user control were thought to be unappealing to users. While the designers’ perspective is logical, the method is not used to its fullest if the designers take some strategies less seriously than others. The relatively low number of concepts was also due to the fact that designers deliberately avoided solutions that penalized their users for performing the wrong behaviour. For one
of the projects (in the healthcare industry), penalizing the user would be unethical and in the other two projects, restricting user control could make users unsatisfied.

4.4.2.6 QUALITATIVE ASSESSMENT OF MULTI-MOTIVE METHOD BY PROFESSIONAL DESIGNERS

Qualitatively the multi-motive method was well received by the professional designers. The designers generally gave the method high scores on the metrics shown in Table 4.7. They were successfully able to apply it to problems from three different industries and three different applications (one project required designing an app, a second project required designing a product and the third required designing a service or service system). Designers also reported that applying sociocultural and altruistic strategies allowed them to think of much more novel solutions than they otherwise would have.

4.4.2.7 USING THE MULTI-MOTIVE METHOD IN NEW WAYS

Finally, the designers also proposed new uses of the method beyond concept generation. One use is to better determine how receptive end users will be to various strategies or to various levels of user control. The designers envisioned creating a set of concepts, varying the amount of user control and testing them with users. Similarly, they also imagined generating six concepts (two using egoistic strategies, two sociocultural and two altruistic), and testing the concepts’ user appeal to find out more about the preferences of their users.

4.4.3 SUMMARY FOR SECTION 4.4

The multi-motive method guides designers into applying strategies to appeal to egoistic, sociocultural and altruistic user motives. I performed two studies to test the usefulness of the method. In the first study, student designers used the multi-motive method in addition to the 6-3-5 idea-generation method. The student designers generated more concepts and explored more strategies using the multi-motive method than they did using 6-3-5. To test the method for idea generation with real-world behaviour-change projects, I then worked with professional designers, who recommended some changes to make the method better suited to their processes. The designers generated fewer ideas than the students had in Study 1, but were qualitatively
satisfied with the method, recognizing its benefit in providing new perspectives to their idea generation process.

Some challenges remain. First, the physical embodiment of the method can still be refined. The pen-and-paper version encouraged designers to generate more concepts and apply more strategies, but implied that only one concept was sufficient for every cell of the matrix. The whiteboard version of the method used was more flexible but may lead to designers generating fewer concepts overall. A logical follow up would be to find a suitable middle ground between the two.

Finally, the next stage of the research would be to prototype and test the concepts generated by using the method. We would then be able to follow the merits of the method to their logical conclusion and determine how well they change user behaviour.
Conclusion

In this dissertation, I described my efforts in studying the problem of design for behaviour change and my efforts in developing methods to aid designers in generating ideas for products and services that change behaviour. In addition to the conclusions and insights specific to each of the chapters, I gleaned more general insights after reflecting on the totality of my thesis work. In this chapter I also describe directions for future research based on my assessment of my work.

**Studying designers more than users**

My initial research goal was to find ways of changing user behaviour through product cues. Towards this goal, I designed products that would change behaviour and developed theories and methods that designers could use to change behaviours. Though the products I developed applied principles derived from behaviour-change case studies and tests, I was not able to do enough testing of the products to validate their effectiveness in changing user behaviour. Therefore, my main research contributions are better stated as:

1. Making insights from behaviour-change case studies and social psychology research usable for designers
2. Enabling behaviour-change designers to be more creative and productive during idea generation

Nevertheless, there still remains a need to test whether the insights that come from the behaviour-change literature are effective in changing behaviour, particularly over the long term. The paucity of literature investigating the long term effects of behaviour-change interventions seems to arise from two factors. The first is that students of behaviour-change research often do not have enough time to design, prototype and test interventions. This is partly because they have to spend significant time reviewing existing literature and devising a unique approach before any products are developed. I hope that work such as this dissertation will help alleviate the time limitation by providing an overview of the literature as well as validated methods for generating behaviour-change interventions. The second factor is the difficulty inherent in performing long-term studies. Participants of a large enough sample size have to be
recruited to stay in the study for months or years, which requires significant financial investment by investigators. The results of such studies also require time to analyze and report, which can reduce the publication rate of doctoral students, a concern for those seeking future academic employment. Increased collaboration between relevant faculties could help overcome this challenge. Collaborative studies that included researchers from applied psychology, engineering design, human factors and behavioural economics would have access to many more resources for recruiting participants and funding research. Individual students could also focus on singular aspects of the studies (e.g., an engineering design student studying the installation and maintenance of a behaviour changing product in participant houses) which can be reported on more quickly while the full study is still ongoing. In this way I hope future design students will be able to better study how products can be used to change behaviour and whether the behaviour change persists over time.

**Though this be madness, yet there is method in it**

Upon first glance, the main topics of the of my research can appear as a farrago of disjoint projects (an ontology, a study of affordances, and a study of motivation). Because of my past experience as a design engineer, I chose to take a designerly approach to my research. This meant that for each of the topics studied, I employed the following steps:

1. Performing research to learn about the problem
2. Defining problem parameters
3. Generating solution concepts
4. Prototyping and testing solutions

Each of the topics were studied using the approach described above (e.g., the behaviour-change ontology chapter began with research on formal methods of representing knowledge, followed by a defining of the types of behaviour-change literature to be studied, the generation of a categorization scheme and then finally the coding of the ontology in an online database). More interestingly, the three topics discussed in this dissertation can also be seen as iterations of a larger design project aiming to develop behaviour-change design methods. The behaviour-change ontology represented the research and parameter defining steps of the design process. In building the ontology I learned about many aspects of the problem of design for behaviour-change (Step 1). The structure of the ontology then led to the statement of the research goal (i.e.,
the problem parameters): to help designers apply behaviour-change strategies (Step 2). The affordance-of-absence phenomenon and the multi-motive model there were concepts for behaviour-change theories that I generated (Step 3). Finally, the design methods that instrumentalized these two theories were the application prototypes for the solutions. Thus the different topics discussed in the preceding chapters could be looked at as iterations of a design process.

In addition, the insights gained from the three topics I explored in my doctoral work were also directly cumulative. That is, the multi-motive model and associated design method incorporated insights from the ontology as well as my work with affordance of absence. When creating the behaviour-change ontology I noted that looking at the amount of control given to the user (under the Principles category) was a meaningful way to categorize case studies. This level of control eventually became one of the three dimensions of the multi-motive model. Next, I studied how affordances could be used as cues for influencing user behaviour. These relate to the middle levels of control in the user control dimension of the multi-motive model. Behaviours can be encouraged/enabled/guided through the use of product affordances. Also, because of what I noted about the difficulty in using the behaviour-change ontology and the difficulty in teaching the affordance-of-absence method to design students, I particularly focussed on making the multi-motive design tool easy to understand and use. The results of these efforts was validated in the testing of the tool with student and professional designers. The multi-motive method is also more comprehensive than the affordance-of-absence method. The multi-motive method was productively applied to many different types of problems, testing with the affordance-of-absence method suggests that it is better suited to being an inspirational tool (i.e., intended to give designers a novel perspective on the problem, intended to be used in conjunction with other idea generation methods and not a method that is applicable to every problem). Therefore, the development of the multi-motive model and tool was the final iteration of a larger design process.

**The ethical ambivalence of design methods**
In the first chapter I discussed the ethical considerations of designing for behaviour change. At the end of my research process I still feel that designers should think about whether users will suffer any deleterious effects from behaviour-change interventions. Nevertheless, my experience in testing design methods with professional designers suggests that ethical considerations will be very difficult to enforce. Professional product designers are typically consultants working for clients. The clients tend to be companies who wish to alter their customers’ behaviour. Thus, the designers’ main responsibility lies in satisfying their client (the company) rather than the final user affected by the behaviour-change intervention. My experience working with professional designers suggests that they do want to help the end user, but the profit motive and structure of their business dictates that their client’s needs will always trump those of the end user. It seems a difficult task to insert user concern over the designer’s desire to gain business. One potential solution might be that design associations explicitly state that their members should first have a fiduciary responsibility for minimizing deleterious effects for the user. This conundrum would be a good topic for future students to try and resolve.

**Avenues for future work**

Each of the topics in my dissertation can also be expanded upon in future research. The behaviour-change ontology can be improved by linking it to a higher order ontology. This would make it likelier to be used and disseminated in the ontological research community. The ontology can also be made more accessible by the programming of a new front-end interface that does not require the user to have any knowledge of formal ontology structures. The affordance-of-absence principle can be further validated by testing it in other impoverished settings. The method itself can be refined further to make it easier for designers to learn intuitively. Finally, the multi-motive model would benefit greatly from the development of a psychometric test for assessing a person’s motivational makeup in a particular situation. I sincerely hope that future students can use my work to move the field of design for behaviour change forward.
References


Farmar-Bowers Q, Lane R (2006). Understanding farmers decision systems that relate to land use School of Global Studies, Social Sciences and Planning, Report, RMIT University, Melbourne, Australia.


Weinert, N., Chiotellis, S., Seliger, G., 2011, Methodology for planning and operating energy-efficient production systems, CIRP Annals, 60/1:41-44.


