EXPLORING AND COMMUNICATING USER DIVERSITY TO INFORM THE DESIGN OF PRODUCTS PROMOTING SUSTAINABLE BEHAVIORS

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submitted by **AYKUT COŞKUN** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Department of Industrial Design, Middle East Technical University** by,

Prof. Dr. Gülbin Dural Ünver _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Gülay Hasdoğan _____
Head of Department, **Industrial Design**

Assoc. Prof. Dr. Çiğdem Erbuğ _____
Supervisor, **Department of Industrial Design**

Examining Committee Members:

Prof. Dr. Gülay Hasdoğan _____
Department of Industrial Design, METU

Assoc. Prof. Dr. Çiğdem Erbuğ _____
Department of Industrial Design, METU

Assoc. Prof. Dr. Cem İyigün _____
Industrial Engineering Dept., METU

Assist. Prof. Dr. Yasemin Afacan _____
Interior Architecture & Environmental Design, Bilkent Uni.

Assist. Prof. Dr. Armağan Kuru _____
Department of Industrial Design, TOBB ETU

Date: 3 August 2015

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Aykut Coşkun

Signature:

ABSTRACT

EXPLORING AND COMMUNICATING USER DIVERSITY TO INFORM THE DESIGN OF PRODUCTS PROMOTING SUSTAINABLE BEHAVIORS

Coşkun, Aykut
Ph. D, Department of Industrial Design
Supervisor: Assoc. Prof. Dr. Çiğdem Erbuğ

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Promoting sustainable behavior through design has become an important and a relevant research area for the design community. As very few designers really know and very few design schools teach how to do this, any research in this field would provide guidance. Aimed at such guidance, this thesis proposes a method for exploring and communicating the diversity in users' orientations towards sustainable behaviors, an important but ignored topic for behavior change and sustainability. This method involves determining the dimensions of user diversity by using the theory of planned behavior as a theoretical framework, grouping users based on these dimensions through cluster analysis and constructing a diagram which visualizes identified groups in terms of their distribution in a sample, their relations to each other as well as recommendations for influencing their behavior. This process is illustrated with a user study on eco-friendly driving, which revealed that the proposed method can help design researchers systematically explore user diversity for promoting sustainable behaviors and communicate this diversity to designers in an inspirational way.

By combining the results of this study (user orientations) with a set of strategies achieved through synthesizing behavior change strategies from the literature, this thesis also offers a design tool to help design practitioners, researchers and students in generating solutions promoting sustainable behaviors. It investigates this tool's potential impact on idea generation through series of design workshops conducted with Middle East Technical University (METU) and Carnegie Mellon University (CMU) students. This idea generation study showed that the proposed design tool is

promising for helping designers in developing solutions promoting sustainable behaviors.

Keywords: Design for behavior change, user diversity, sustainability, idea generation

ÖZ

ÇEVRECİ DAVRANIŞLARI TEŞVİK EDEN ÜRÜNLERİN TASARIMINI BİLGİLENDİRMEK İÇİN KULLANICI ÇEŞİTLİĞİNİN İRDELENMESİ VE TASARIMCILARA AKTARILMASI

Coşkun, Aykut
Doktora, Endüstri Ürünleri Tasarımı Bölümü
Tez Yöneticisi: Doç. Dr. Çiğdem Erbuğ

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Tasarımı kullanarak çevreci davranışları desteklemek, tasarım dünyasında önemli bir araştırma alanı haline gelmiştir. Günümüzde çok az tasarımcının davranış değişikliği için tasarım yapmayı bilmesi ve çok az tasarım okulunun bu konuda eğitim vermesinden dolayı, bu alanda yapılacak herhangi bir araştırmanın bir rehber niteliğinde olması alana katkı yapması açısından gereklidir. Bu tarz bir katkıyı yapmayı amaçlayan bu tez de, önemli olmasına rağmen bu güne kadar çok irdelenmemiş bir konu olan 'çevreci davranışları teşvik eden ürünler tasarlanırken kullanıcıların bu tarz davranışlara yönelik eğilimlerindeki çeşitliliğin incelenmesini ve bu çeşitliliğin tasarımcılara aktarılmasını' kolaylaştıran bir yöntem önermektedir. Bu yöntem, planlanmış davranış teorisi kullanılarak kullanıcı çeşitliliğinin boyutlarının belirlenmesi, bu boyutlar temel alınarak kümeleme analizi yöntemi ile kullanıcı gruplarının oluşturulmasını ve bu grupların seçilen bir örneklem içindeki dağılımının, birbirileri ile olan ilişkilerinin ve nasıl ikna edileceklerini gösteren tasarım önerilerinin yer aldığı bir yönelim şemasıyla görselleştirilmesini içermektedir. Bu süreç, çevreci sürüş davranışı üzerinde yapılan bir kullanıcı çalışması ile de örneklenmektedir. Yapılan bu çalışma, önerilen yöntemin tasarım araştırmacılarının kullanıcı çeşitliliğini sistematik bir şekilde incelemelerine ve ilham verici bir şekilde tasarımcılara aktarmalarına yardımcı olabileceğini göstermektedir.

Bu tez kapsamında ayrıca, tasarımcılara, tasarım araştırmacılarına ve tasarım öğrencilerine çevreci davranışları teşvik eden ürünler için fikir geliştirmelerine yardımcı olabilecek bir tasarım aracı önerilmektedir. Bu araç, kullanıcı çalışması

sonunda bulunan kullanıcı grupları ile tasarım yazınından derlenen davranış değişikliği tekniklerinin bir araya getirilmesi ile oluşturulmuştur. Önerilen bu tasarım aracının fikir geliştirme üzerindeki olası etkisi, Orta Doğu Teknik Üniversitesi ve Carnegie Mellon Üniversitesi öğrencileri ile düzenlenen bir dizi çalıştay ile incelenmektedir. Bu fikir geliştirme çalışması da, önerilen tasarım aracının çevreci davranışları özendiren ürünler için fikir geliştirmede ciddi bir potansiyele sahip olduğunu göstermiştir.

Anahtar kelimeler: Davranış değişikliği için tasarım, kullanıcı çeşitliliği, sürdürülebilirlik, fikir geliştirme

To my wife Deniz
and to my sister Ayça

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LIST OF ABBREVIATIONS

AIS	Attitude Intention Scale
BFI	Big Five Personality Traits Inventory
CADM	Comprehensive Action Determination Model
CMU	Carnegie Mellon University
HCI	Human Computer Interaction
ICT	Information and communication technologies
LCD	Liquid crystal display
LOHAS	Lifestyles of Health and sustainability
METU	Middle East Technical University
NEP	New Environmental Paradigm
OECD	Organization for Economic Co-operation and Development
TIB	Theory of Interpersonal Behavior
TPB	Theory of planned behavior
TTM	Trans-theoretical Model of Behavior Change

CHAPTER 1

INTRODUCTION

1.1.Problem background

Using design to promoting sustainable behavior, which is defined as the behavior that a person performs consciously in order to minimize his or her negative impact on the environment (Kolmuss & Agyemen, 2002), is a new design approach which aims to reduce products' negative environmental impact by influencing user behavior. This approach has become an important area for the design community within the last decade. Today, companies are increasingly investing in solutions promoting sustainable behaviors both in order to comply with the governmental regulations and in order to capture consumers who have a growing interest in being more sustainable. These solutions range from the products that invisibly drive people toward more sustainable behaviors to the products that help people see the impact of their actions in order to make better choices.

An example for such products meant to change user behavior for sustainability is Wattson energy monitor (DIY Kyoto, 2005), which designed to help people reduce their household energy consumption. Once connected with the energy meter of a household, it provides feedback on current and average electricity consumption, and encourages users to save energy by showing three consumption levels: below average, average and excessive. Another example is Velogic Bike Dispenser (Velopa, 2012) designed to facilitate bike use in The Netherlands. Situated near train stations, it offers a low cost and easy to use automated bike rental system that encourages frequent train users to continue their trip by hiring a bike. Nest (Nest, 2012) is a smart thermostat designed to help people reduce their household electricity consumption pertaining to domestic heating and cooling. It learns users' heating and

cooling habits, and adapts itself to these habits with the intention of optimizing energy consumption and comfort (Figure 1).

Figure 1. Product examples designed to promote sustainable behaviors, from left to right: Wattson energy monitor (DIY Kyoto, 2005), Velogic bike dispenser (Velopa, 2012) and Nest thermostat (Nest, 2012)

Promoting sustainable behavior through design has a very important and relevant design goal for achieving a sustainable society. One of the underlying reasons for this importance and relevance is that this approach can contribute to greater environmental benefits by complementing the traditional sustainable design approaches like eco-efficiency, which is defined by Organization for Economic Co-operation and Development (OECD) as 'the efficiency with which ecological resources are used to meet human needs'(as cited in Mickwitz et al., 2006).

The goal of sustainable design is to develop sustainable solutions which meet the needs of the present generations without endangering the right and ability of future generations to meet their own needs and minimize the negative impact on economy, environment and society (Brundtland et al., 1987). To achieve this goal, companies should develop new products by considering the environmental impacts occurred throughout the entire product lifecycle including extraction, processing and supply of energy and materials, production, distribution, use, re-use or recycling and finally disposal (Crul, 2004). As these stages can have varying degree of environmental impact depending on the product type, different approaches can be more effective in reducing a product's impact. For instance, while this impact, of a steel cutlery, is mostly associated with the extraction of materials, production and distribution, it is mostly associated with the use phase for an electric kettle. For the steel cutlery, designers can prefer using recycled materials, improving resource efficiency during

production and distribution; whereas for the electric kettle, they can more focus on energy efficiency besides using the strategies preferred for the former.

Research showed that such product focused strategies seem to be problematic for sustainability; they may not always suffice to reduce a product's environmental impact, especially for the ones with a significant use impact like the electric kettle. This is because the way people use a product is as much influential as product related features on this impact (Mccalley & Midden, 2002; Wood & Newborough, 2003). In other words, unintended user behavior can suppress environmental benefits gained by designing an energy efficient product. Boiling too much water than needed or leaving the lights on when a room is not occupied because an energy efficient light bulb consuming less energy compared to others, known as 'the rebound effect' (Khazzoom, 1980), are examples of unintended user behavior.

Another underlying reason for this importance and relevance is the suitability of design activity for changing user behavior, its persuasive nature enabling designers to convey their intentions to users in the form of persuasive arguments (Buchanan, 1985; Redstorm, 2006). According to Buchanan (2001), designing is a persuasive act that can be used to tackle social problems, and designed objects are arguments about how we should live our lives. When thinking of a new product, designers make decisions about various product dimensions like form, function, material, interaction, technology and so on. By manipulating these dimensions, they convey messages to the users about how the product is (or should be) used, how it functions and how users interact with it. This ability to influence user behavior makes designers powerful agents for reducing the environmental impact associated with unintended user behavior.

Another reason is that designers' role in addressing a sustainable society is changing from creating sustainable products towards envisioning products, processes, and services that encourage widespread sustainable behavior (Stegall, 2006). Promoting sustainable behaviors through design is a good candidate to facilitate this transition. However, despite its popularity and importance for the design community and despite the emergence of new products and methods for promoting sustainable behaviors, there is still much work to be done within design research and practice. The research on this approach is still growing and it is not as advanced as research on other sustainability approaches like eco-efficiency. Perhaps because of this, today,

few designers really know how to do this. While almost every industrial design program teaches students to design for manufacture, few programs instill an equal level of competence when it comes to designing for behavior change for sustainability, which makes further research essential to mature this growing field.

One of the actions that the design research community can take to mature the field is providing more guidance for design researchers and practitioners so that they can make informed decisions when conducting research on behavior change and sustainability as well as designing behavior changing products to promote sustainable behaviors.

1.2.Significance of the study

Aimed at developing such a guidance, this thesis advances the field of behavior change and sustainability by 1) offering a method (user orientation maps) for exploring and communicating the diversity in users' orientations towards sustainable behaviors, a significant but overlooked topic in this field, 2) offering a design tool integrating user orientation maps with a set of behavior change strategies to help designers better explore potential solutions for promoting sustainable behaviors and 3) assessing this tool's impact on generation of design ideas to motivate sustainable behaviors through an idea generation study. The remainder of this section explains these contributions by relating them to the previous work on user diversity and idea generation for promoting sustainable behaviors.

1.2.1. A method for exploring and communicating user diversity for promoting sustainable behaviors

Designing products motivating sustainable behaviors involves series of activities. Selvefors, Pedersen and Rahe (2011) suggested a design process model[1] summarizing these activities and relating them to a generic design process consisted of exploration, generation and evaluation. Among these activities, target user selection is very fundamental to the success of a behavior change project. This is because user characteristics like knowledge, skills, norms, intentions, attitudes,

[1] Section 2.4.4 (page 32) elaborates on this process.

habits and so on, influence the amount of environmental benefits gained by targeting a particular user group and their agreement with a behavior change strategy. To illustrate this, let's assume a scenario in which a design team is trying to reduce household electricity consumption of two different user groups, and let's assume that the first group includes people having low negative impact on the environment, high environmental concern and positive attitude towards energy conservation, while the second group includes people having high negative impact on the environment, no environmental concern, no interest in sustainability and no motivation to conserve energy.

When they are introduced with a behavior changing product, e.g. a smart energy monitor, the users in the first group will be more likely to adopt sustainable behaviors than the second group (greater agreement). However, the amount of savings that can be gained by changing their behavior may be lower than doing this for the second group, as they may already have a sustainable lifestyle with low environmental impact (less environmental benefits). As for the behavior change strategies, although providing feedback on electricity consumption may promote energy conservation for the first group, it may not be effective for the second group. Other strategies, such as giving financial rewards may be more effective for them, as rewards can create an external motivation to change their behavior. In this scenario, the design team can select one of these users depending on the design goal, and develop solutions by considering the characteristics of the selected user group.

However, unlike this example scenario, designers do not always have the option to choose their target users. They are usually asked to design for predetermined target populations which can be more diverse. For instance, besides the user groups described above, their target population may include different users with various perceived barriers for behavior change, such as lack of knowledge, lack of skills, lack of control, lack of social support and so on. Thus, without an understanding of the individual differences between users, i.e. user diversity, it would be challenging for designers to design products that can promote sustainable behaviors of different user groups in such a target population.

There are only few design research studies exploring means of addressing user diversity for sustainable behavior and behavioral change (Cor and Zwolinski, 2014; Coskun and Erbug, 2014a; Lilley, Bailey & Charnley, 2013; Lockton, Harrison &

Stanton, 2012). One of these studies, Coskun and Erbug (2014a) identified four hypothetical personas to be taken into account when designing for sustainable behavior by using the constructs of Theory of Planned Behavior (Azjen, 1991) as a classification framework. Specifically, they created these personas based on environmental concern, intention, attitude, subjective norm, perceived behavioral control and personality traits. They suggested suitable behavior change strategies for these personas based on Geller's (2002) Geller's (2002) categorization of behavioral intervention approaches which identifies three approaches as instructional, motivational and supportive (Table 1).

Table 1. Hypothetical personas proposed by Coskun and Erbug (2014a)

Hypothetical persona	Suggested technique and approach
Enthusiastic users tend to be sensitive of environmental issues and usually engaged in sustainable behaviours.	Remind and reward sustainable behaviour so that the behaviour becomes habitual, a supportive approach.
Worried users are assumed to be reluctant to engage in sustainable behaviours due to a lack of motivation and lack of control over behaviour, despite their intention and high concern for the environment.	Make the behaviour easier through affordances and constraints, and promising rewards for the performance of sustainable behaviours, a motivational approach.
Undecided users are reluctant to act on environmental issues due to a lack of knowledge and a lack of social support, despite their concern for the environment.	Inform these users about ways of dealing with environmental issues and motivating them with offers of social support, an instructional and motivational approach.
Irresponsible users are assumed to have neither the intention to engage in sustainable behaviours nor a high environmental concern.	Use a combination of instructional, supportive and motivational approaches to increase their awareness of environmental problems and sustainable behaviours, while also making these behaviours desirable for them.

In another study, Lockton et al. (2012) proposed three different user models based on users' involvement level in the decision-making process when using a product, naming them *pinball users*, *shortcut users* and *thoughtful users*. They created these user models by analyzing designers' statements about how designers model users, and they suggested some ways to influence these different models (Table 2).

Table 2. User models proposed by Lockton et al. (2013)

User model	Suggested technique and approach
Pinball users are assumed to perform the same actions repeatedly without thinking about any decisions at all beyond basic reflex responses.	Control user behaviour through affordances and constraints, behaviour steering.
Shortcut users are assumed to be interested in performing certain actions in the easiest way possible through the use of behavioural heuristics, and make choices in favour of the options that require the least energy and cognitive costs.	Use defaults and shortcuts to influence their behaviours.
Thoughtful users are assumed to be people who think carefully about their actions and the consequences of them.	Inform and give feedback in order to influence their behaviour.

Another way of addressing user diversity is creating user groups based on user research. In their study on product repair of household appliances, Lilley et al. (2013) proposed three different mending typologies as *fixers*, *sometimers* and *non-fixers*. According to their analysis, *fixers* are the people who always attempted repair; *sometimers* are those that attempted repairs, but not for all products; and *non-fixers* are those that did not attempt repair in the past. In this study, they engaged in design workshops with students to generate product concepts encouraging product repair for these three typologies. Following the workshops, they carried out user studies to explore the user preferences of different product concepts. They found that *fixers* preferred product concepts that focused on informational strategies, such as feedback; *non-fixers* preferred product concepts that focused on intelligent products that automated user behavior; and *sometimers* preferred either informational strategies or intelligent products, depending on their intention to repair.

Similarly, in a study on coffee machine use, Cor and Zwolinski (2014) identified two different user groups as *eco-sensitive* and *non eco-sensitive* based on questionnaires measuring the environmental knowledge, habits and environmental concern of the participants. The first group consisted of people who scored high in environmental knowledge, habits and environmental concern, whereas the second group consisted

of people who had low score in these measures. The authors stated that the acceptance level of a behavior change strategy changed across these groups. For instance, the acceptance of feedback tended to be high among eco-sensitive users, while it was low for non-eco-sensitive users, and while the reverse was the case for their acceptance of intelligent products.

As the design work on user diversity for promoting sustainable behavior is very few, studies outside design research might also provide a different perspective to the discussion on user diversity. An example for a study is the green segments identified by Natural Marketing Institute based on consumers' belief and value systems and purchasing decisions influenced by these systems (as cited in Ottman ,2011, p.24), These include five psychographic segments varying in terms of their involvement and interest in environmental sustainability.

1. *LOHAS* (Lifestyles of Health and Sustainability) consumers are early adapters of sustainable behaviors and have a strong influence on others, with stronger attitudes towards personal and planetary health.
2. *Naturalites* tend to be more concerned about their personal health than overall sustainability, which serves as the basis for their environmentally responsible actions, such as consuming healthy and natural food.
3. *Drifters* have no deep commitment to sustainability, and any sustainable behavior they adopt is due to their tendency to follow the latest trends like purchasing sustainable products. Although lacking any particular environmental concerns.
4. *Conventionals* engage in sustainable behaviors for practical reasons, such as purchasing energy-efficient appliances and recycling.
5. *Unconcerneds* are the people with little concern about environmental sustainability or healthy living.

Another way of addressing user diversity is constructing user profiles for adaptive persuasive technologies (Kirman, Linehan, Lawson & Doughty, 2010). These technologies use a combination of behavior change strategies to influence users with different needs, motivations and behaviors. They adapt themselves to different user types by collecting user data on whether a user changes his or her behavior after a

particular strategy is used. To make this task easier, Kaptein and Eckles (2010) suggested persuasion profiles which they defined as the collection of the anticipated effects of different behavior change strategies for a specific individual, how he or she would respond to a behavior change attempt. These profiles are constructed through synthesizing demographic, personality and behavioral data.

It would seem that there are several issues related to these examples. First of all, the green market segments (Ottman, 2011) and persuasion profiles (Kaptein and Eckles, 2010) were not put forward specifically for the use of designers. The former has a marketing focus, helping to target appropriate market segments in order to increase the success of green marketing attempts. The latter serves as a method for adaptive persuasive technologies, allowing for the selection of a suitable behavior change strategy based on individual's susceptibility to these strategies. Furthermore, previous studies on persuasion profiles have tended to fall outside the sustainability domain, e.g. health (Kaptein, Lacroix, & Saini, 2010) and e-commerce (Kaptein, 2011).

Second, although they follow a more design focused approach, Lockton et al.'s (2012) user models and hypothetical personas proposed by Coskun and Erbug (2014a) are not based on actual user data, but rather rely on assumptions and predictions about users. Unlike these user models and personas, the mending typologies proposed by Lilley et al. (2013) and user groups proposed by Cor and Zwolinski (2014) are based on quantitative data and such variables as socio-demographics, motivations, barriers, environmental concern and habits, and as a result, they provide a more systematic way of creating user groups that can be used in behavioral change projects for sustainability.

This brief review showed that there is still a need for systematic ways for addressing user diversity when designing for sustainable behaviors. Aimed to fulfill this need, this thesis offers a new method for exploring and communicating the diversity in users' orientations towards sustainable behaviors. This method differs from previous work on user diversity in terms of three aspects. First, it provides a systematic way of exploring user diversity; it uses a well-known theory of human behavior, Theory of Planned Behavior (TPB), as a theoretical framework to determine the dimensions of user diversity, and it relies on collecting quantitative data from large samples and analyzing this data through cluster analysis. Second, along with proposing a method

for exploration, it also offers a method for representing user diversity in an inspirational way and communicating this diversity to designers during idea generation. Third, it investigates user diversity in terms of a behavioral domain has not been explored before, eco-friendly driving.

1.2.2. A design tool for promoting sustainable behaviors and its evaluation

Previous design research provided valuable guidance on behavior change and sustainability through methods for exploring opportunities for behavior change, strategies and guidelines for generating product concepts that motivates sustainable behaviors based on these explorations, and methods for evaluating behavior changing products and strategies through field studies. The literature review conducted in the scope of this thesis (see Chapter 2) showed that this research gave less attention to the generation of solutions for behavior change compared to the exploration of opportunities and the evaluation of solutions.

For the guidance on generation, several review studies proposed different strategies for promoting sustainable behaviors by reviewing environmental psychology, sociology and sustainability literature (Froehlich, Findlater & Landay, 2010; Lilley, Lofthouse & Bhamra, 2005; Yun, Scupelli, Aziz & Loftness, 2013):

1. *Information*: informing about environmental problems
2. *Advice*: offering advice on how to deal with them
3. *Choice*: providing a choice to act on these problems;
4. *Feedback*: providing feedback on behavioral impact;
5. *Goal setting*: setting goals for being more sustainable;
6. *Commitment*: ensuring commitment to be sustainable;
7. *Emotional engagement*: engaging in sustainable behaviors by appealing emotions;
8. *Behavior steering*: steering behavior through affordances and constraints:
9. *Reward*: rewarding sustainable behaviors:
10. *Comparison*: comparing one’s performance with others;
11. *Control*: making sustainable behaviors easier to do;

12. *Technical intervention*: constraining unsustainable behaviors through technical intervention
13. *Intelligent products*: the products that automate sustainable behaviors.

Other studies offered frameworks characterizing different behavior change strategies in order to help designers understand the differences between strategies and explore different solution spaces. For instance, Lilley (2009) proposed three strategies classified based on the division of power in decision making between user and the product; feedback (user has the power), behavior steering (the power is divided between product and the user) and intelligent products (product has the power) (Figure 2).

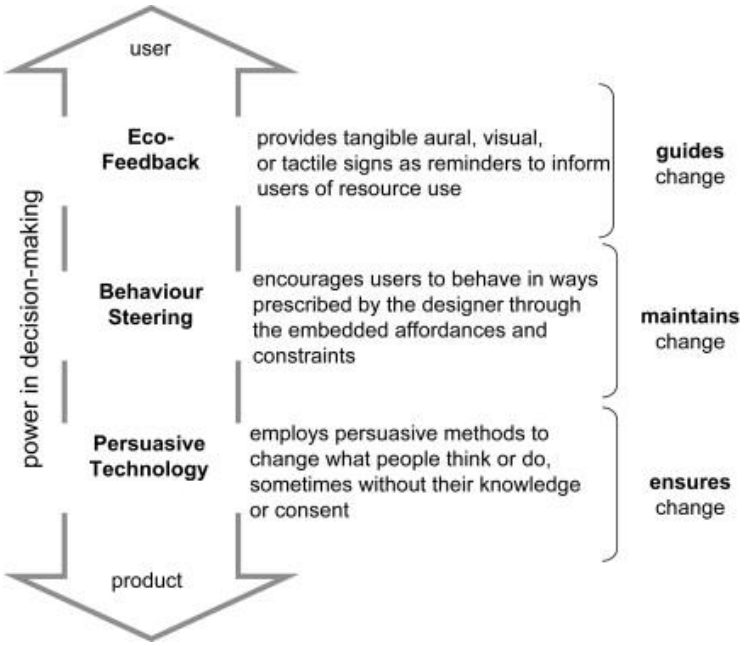


Figure 2. Design for sustainable behavior strategies (Lilley, 2009)

Later, Lilley and her colleagues linked this framework to idea generation through two studies. First, Lilley, Bhamra and Lofthouse (2006) conducted a two weeks design study with master of industrial design students at Loughborough University, in which they asked students to identify a social issue resulting from the use of mobile phones in public space and respond to this issue by using one of the strategies in the framework. They found that the students understood the strategies easily expect behavior steering, they had difficulty in defining the boundary between

intelligent products and behavior steering. The students preferred using a combination of strategies even though they were not asked to do so. Furthermore, they reported that students had concerns about the effectiveness of feedback, whether it suffices to change the behavior, and intelligent products' high control over user behavior as they might make users feel controlled by the product.

Second, Lilley et al. (2013) combined these strategies with design personas in a project on product repair (as described in page 7). They conducted design workshops with students in which they developed concepts encouraging repair of household appliances for three different repair personas (fixers, sometimers and non-fixers) by using the strategies. Later, they used these concepts to learn about users' preferences of different strategies, and found that different user types preferred different strategies.

Another framework is Design Behavior Intervention Model (Tang and Bhamra, 2012). This model advances the one proposed by Lilley (2009) by extending the strategies from three to seven and categorizing them into three different intervention levels as guiding the change, maintaining change and ensuring the change based on the stages of habit formation and three types of behavioral factors influencing user behavior (Figure 3).

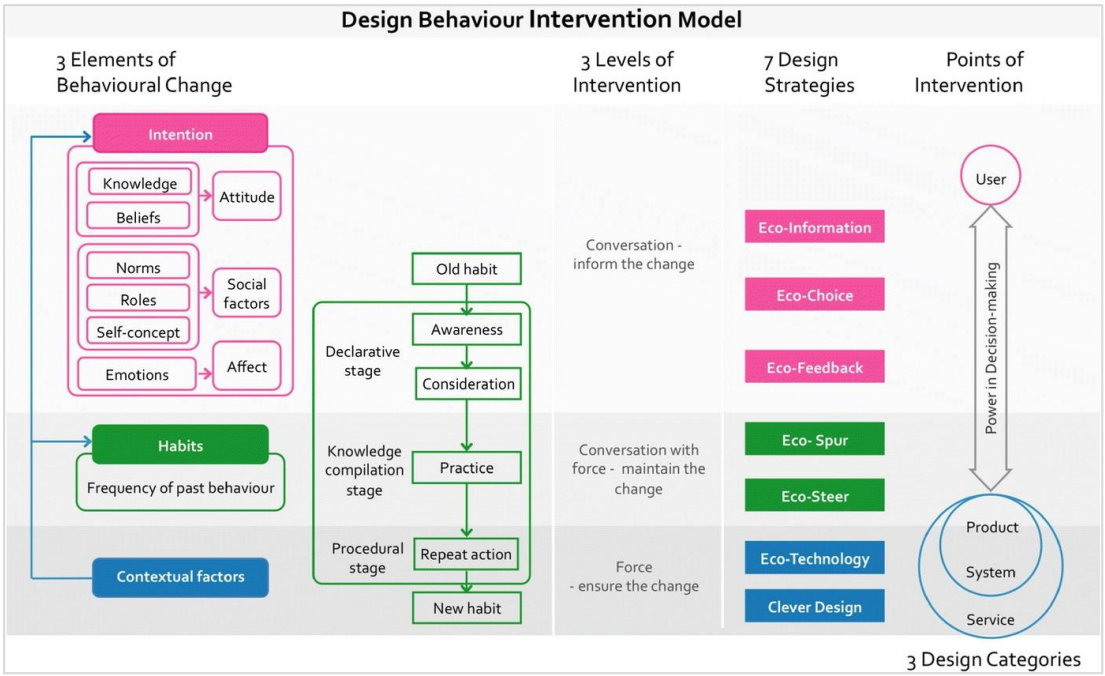


Figure 3. Design Behavior Intervention Model (Tang & Bhamra, 2012)

Intentional factors include intention, attitude, norm and belief. Habitual factors include the frequency of past behavior. Contextual factors include the ones enabling or constraining user's ability to perform a behavior like technological constrains and capabilities, availability of resources, costs and so on.

This model matches the strategies with three stages of habit formation: declarative stage, knowledge compilation stage and procedural stage as defined by Anderson (1982). According to the model, when people are in declarative stage, i.e. when they are trying to adapt a new behavior, *information*, *choice*, and *feedback* is used to create an awareness by targeting intentional factors. When they are in knowledge compilation stage, i.e. when the knowledge turned into procedural operation, *reward (spur)* and *steering* is used to maintain a behavior by targeting habitual factors. Finally, when they are in procedural stage, i.e. when the behavior is fully automatic, *technical intervention* and *intelligent products (clever design)* is used to ensure behavior change by modifying contextual factors. Although this model has a lot of potential for guiding designers during ideation, no study so far have linked this model to idea generation

Others integrated behavior change strategies into special toolkits for helping designers in generating product concepts motivating behavior change (Figure 4).

Figure 4. Design with intent toolkit (Lockton et al., 2013)

Lockton, Harrison and Stanton (2013) proposed a toolkit including design strategies achieved through reviewing the literature on decision making, psychology, usability

engineering and architecture. They prepared these strategies in the form of design patterns grouped into eight theoretical lenses (architectural, error proofing, interaction, ludic, perceptual, cognitive, Machiavellian and security) suggesting potential solutions for different situations. They iteratively developed this toolkit through series of design workshops with design students and designers. In one of these workshops, they compared traditional brainstorming methods with the toolkit. They asked 16 design students from Brunel University to redesign four household products to influence more sustainable behaviors; electric kettle, curtain, printer and water tap. They found that the toolkit helped students generate more ideas in comparison to traditional brainstorming.

More recently, Daae and Boks (2014) proposed another toolkit, called Dimensions of Behavior Change, to guide designers' decisions by showing the dimensions they need to consider when designing for behavior change (Figure 5).

Figure 5. Obtrusiveness dimension from Dimensions of Behavior Change Toolkit (Daea, 2014)

They used a construction method similar to Lockton et al. (2013). They first identified several dimensions through a literature review on behavior change, and

then, through interviews and design workshops, they asked designers to articulate the dimensions that they found relevant for behavior change. Based on these studies, they developed a version which includes nine dimensions (control, obtrusiveness, encouragement, meaning, direction, empathy, importance, timing and exposure) prepared as cards including examples for behavior changing products placed along each dimension, e.g. obtrusive versus unobtrusive for obtrusiveness dimension.

They tested this tool through design workshops with 46 industrial design and aerospace engineering students from Delft University of Technology. In these workshops, they asked students to generate behavior changing solutions for three design tasks: making people unplug their phone charges when it is not being used, making people only boil the amount of water they need in a kettle and avoiding heating being turned on and a window being at the same time. They found that the students' overall experience with the tool was positive, and it helped them generate more ideas with greater variation in strategies compared to traditional brainstorming methods.

Reviewing this work on idea generation for promoting sustainable behaviors shows that there is a value in providing students with behavior change strategies, the strategies helped generate more ideas with increased variety. It also shows that very little research connected specific behavior change strategies to ideation, and a few studies explored the idea generation process in the scope of a behavior change project. This thesis advances on this problem through proposing a design tool and evaluating its impact on idea generation through a study on promoting eco-friendly driving. The tool and its evaluation differ from previous studies in terms of four aspects. First, the proposed tool provides a different classification for behavior change strategies used to influence user behavior. Second, in addition to these strategies it also represents the users' diversity in their orientations towards sustainable behaviors, an important consideration when designing for behavior change. Third, the idea generation study explores a different behavioral domain, eco-friendly driving, which has not been explored by other studies. Fourth, it explores the idea generation activities of two different participant groups from USA and Turkey. It should be noted that the purpose of selecting these groups was not to explore the cultural differences between Turkish and American design students, rather it was to identify tool's contribution to ideation better through minimizing the influence of

participant characteristics such as cultural background, lifestyle, education, skills, capabilities and so on.

1.3. The goal of the thesis and research questions

Discussing its significance for the design research on sustainability and behavior change, this thesis aims to provide guidance on the exploration, representation and consideration of the diversity in users' orientation towards sustainable behaviors when designing for behavior change, a significant but overlooked topic in the field of design for behavior change. To achieve this goal, it offers a method for exploring user diversity (identifying different user groups in a target population based on behavioral factors), a method for communicating this diversity to designers and integrating it into idea generation process (user orientation maps), and a design tool combining user orientation maps with a set of strategies designers can use when designing for this diversity. The research questions it tries to answer are:

1. How can we explore user diversity for promoting sustainable behaviors through design?
2. How can we communicate this diversity to designers?
3. How would the proposed tool support designers' ideation for promoting sustainable behaviors?

1.4. Study methodology

This thesis consists of three stages: a systematic literature review, a user study on eco-friendly driving and a study with design students on the applicability of the proposed tool to the idea generation (Figure 6).

The first stage includes the exploration of the current state of design research on behavior change and sustainability with a review of journal articles and conference proceedings published between 2000 and 2014. This review identifies how previous research informs the design of products encouraging sustainable behaviors, research gaps and potential directions for further research, as well as helping to develop a new classification of behavior change strategies, which was intended to be used as a part of the proposed design tool.

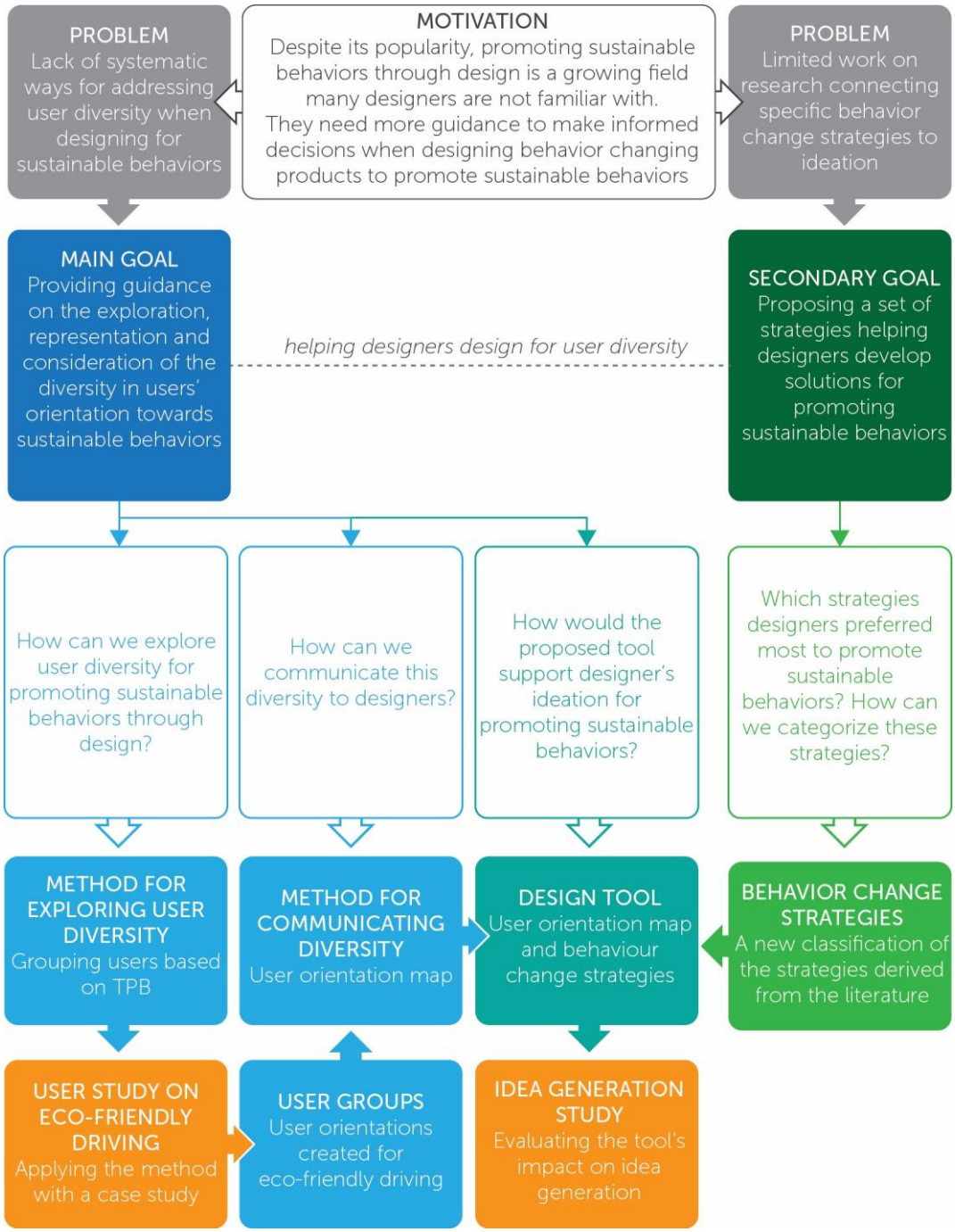


Figure 6. Study methodology

The second stage is developing the method for exploring user diversity. This stage includes determining the dimensions of user diversity by using TPB (Azjen, 1991) as a theoretical framework and implementing it into a case study on eco-friendly driving, in which nine different user groups were identified based on the dimensions of user diversity. It also includes developing a method for representing and communicating user diversity based on the groups identified in the case study.

The last stage is assessing the tool's potential impact on idea generation through a study with students from Carnegie Mellon University (CMU) and Middle East Technical University (METU) in which they were asked to develop ideas for promoting eco-friendly driving by using the proposed design tool along with a design brief.

1.5. The structure of the thesis

This thesis has five chapters. Chapter 1 introduces the problem, the significance and the rationale for the study, the goal of the study, research questions and the proposed methodology to answer these questions.

Chapter 2 summarizes the results of a literature review on design for behavior change and sustainability. It explains how current research informs the design of behavior changing products promoting sustainable behaviors and it identifies research gaps to be addressed to mature the field further.

Chapter 3 discusses the important dimensions of user diversity, introduces the method for exploring user diversity and illustrates this method with a case study on eco-friendly driving. It also presents the method for communicating user diversity and compares it with other user representation methods.

Chapter 4 introduces the proposed tool for promoting sustainable behaviors which combines behavior change strategies with user orientations. Based on the results of four idea generation workshops conducted with design students, it elaborates on how the tool supported students' idea generation in terms of the generation of ideas (how it contributed to exploration of different strategies and user orientations), the execution of the design process (how students used it during the process) and students' evaluation of the tool (to what extent they found the tool satisfactory).

Chapter 5 summarizes the findings, discusses the proposed method for exploring and communicating user diversity and the proposed too for promoting sustainable behaviors in terms of design research and practice.

CHAPTER 2

PROMOTING SUSTAINABLE BEHAVIORS THROUGH DESIGN

Promoting sustainable behaviors through design is an important and growing area for design research. Substantial work now exists to make a systematic review possible and beneficial for design researchers and practitioners. This chapter presents a literature review of previous work on behavior change and sustainability with a design research perspective. It begins with a brief introduction on research approaches, behavior change strategies, behavior change theories and models for promoting sustainable behaviors. Then, it discusses the results of a systematic review characterizing the current state, as well as identifying research gaps and opportunities for further research.

2.1. Research approaches for promoting sustainable behaviors

Design researchers working on behavior change and sustainability have been using different research approaches for promoting sustainable behaviors. These are design for sustainable behavior, critical design, practice oriented design and persuasive technology.

2.1.1. Design for sustainable behavior

While critical design, practice oriented design and persuasive technology are broad research approaches applied to the field of sustainable design, design for sustainable behavior is an approach particularly focusing on environmental sustainability with a behavioral change perspective. It deals with influencing user behavior to decrease products' environmental and social impact occurred during the use phase (Bhamra,

Lilley & Tang, 2011). This approach was introduced to the community by design researchers from Loughborough Design School (Bhamra, et al., 2011; Lilley et al., 2005; Lilley, 2009; Lilley et al., 2013; Tang and Bhamra, 2008; 2012,). Since then it has been used as an umbrella term for referring designs that meant to change user behavior for the purpose of sustainability. So far, design researchers illustrated this approach through reducing the social impact of mobile phone use (Lilley et al., 2009), reducing the environmental impact of household refrigerators and freezers (Tang and Bhamra, 2012), and motivating repair of small electrical household appliances (Lilley et al., 2013).

2.1.2. Critical design

Previous work using critical design in promoting sustainable behaviors investigated energy consumption awareness of with the intention of challenging the current sustainable design practice and to create a discussion on its concepts, strategies and ideologies (Maze & Redstom, 2008). Within the scope of two projects, design researchers from Swedish Interactive Institute worked on this approach by developing propositional objects to investigate how design can increase energy awareness in everyday life by making it more visible as a material (Backlund et al., 2006; Broms, Bång & Hjelm, 2008; Ernevi, Palm & Redström, 2007; Gustafsson & Gyllensward, 2005; Maze & Redstorm, 2008). These studies primarily focused on everyday practices, lifestyles, material, technical and social systems, and explored ways of creating energy awareness beyond technical solutions like energy monitors that give numeric feedback to users. For instance, Erratic Radio (Figure 7) starts acting unnaturally in order to direct users' attention to their consumption by distorting the frequency of a radio station or decreasing the volume as household energy consumption increases (Ernevi et al., 2007).

Figure 7. Erratic radio (Ernevi et al., 2007)

2.1.3. Practice oriented design

Practice oriented design was introduced to the field to the field of behavior change and sustainability as an insight generation method for solutions encouraging sustainable behaviors (Juijer and Jong, 2009; 2012; Petterson, 2009; Scott and Quist, 2011). Influenced by theories of social practice, this approach requires a shift from products to practices and from individuals to interactions occurred within large socio-technical systems, which is common to many design research studies on promoting sustainable behaviors. Researchers exploring this approach argues that this shift is important because understanding the persistence and change in practices can inform more sustainable ways of living and doing (Ingram, Shove & Watson, 2007; Shove, 2008; as cited in Scott & Quist, 2011), and it can open up larger sustainability improvements (Petterson, 2009). So far, researchers illustrated this approach by exploring different everyday practices such as bathing (Scott & Quist, 2011), heating and thermal comfort (Kuijer & Jong, 2012) and laundering (Petterson, 2009).

2.1.4. Persuasive technology

Persuasive technology refers to using computers to change people's attitudes and behaviors towards a desired direction (Fogg, 2003), and it differs from other three approaches mentioned above in terms of the medium used to change user behavior. While other approaches mostly focus on physical objects (e.g. freezer) to promote sustainable behaviors, persuasive technology puts a special emphasis on digital objects (e.g. software). Perhaps because of this, the approach has gained considerable interest from researchers working in human computer interaction (HCI), information

and communication technologies (ICT) and software engineering. Although previous research in this field has mainly focused on health related behaviors, such as eating healthy food, exercising, quitting smoking and so on, there are many examples illustrating how persuasive technologies can reduce environmental impact associated with different behaviors including personal transportation (Froehlich et al., 2009), water consumption (Arroyo, 2005) and electricity consumption (Kjeldkov, Skov, Paay & Pathmanathan, 2012).

2.2. Behavior change theories and models for promoting sustainable behaviors

Behavior change is a new area of interest for the design community. To familiarize the community with this topic and to discuss it in the context of design and sustainability, design researchers adapted several existing theories and models from disciplines like psychology, sociology and behavioral economics as theoretical frameworks. These are Theory of Planned Behavior (Ajzen, 1991), Theory of Interpersonal Behavior (Triandis, 1977), Trans-theoretical Model of Change (Prochaska & Velicer, 1997) and Comprehensive Action Determination Model (Klökckner & Blöbaum, 2010).

2.2.1. Theory of Planned Behavior

Coskun and Erbug (2014b) used the TPB as a theoretical framework for their user study on mobile phone applications as persuaders of sustainable behaviors. This theory postulates that behavior is directly determined by a person's intention and his or her actual control over behavior (Ajzen, 1991). The intention to perform a behavior is influenced by attitude towards behavior, subjective norms and perceived behavioral control. These factors are further influenced by behavioral beliefs, normative beliefs and control beliefs. In other words, beliefs indirectly affect a person's intention by shaping attitudes, subjective norms and perceived behavioral control. Finally, background factors including knowledge, global dispositions, personality traits, demographics and experience indirectly influence the intention by acting upon these beliefs (Figure 8).

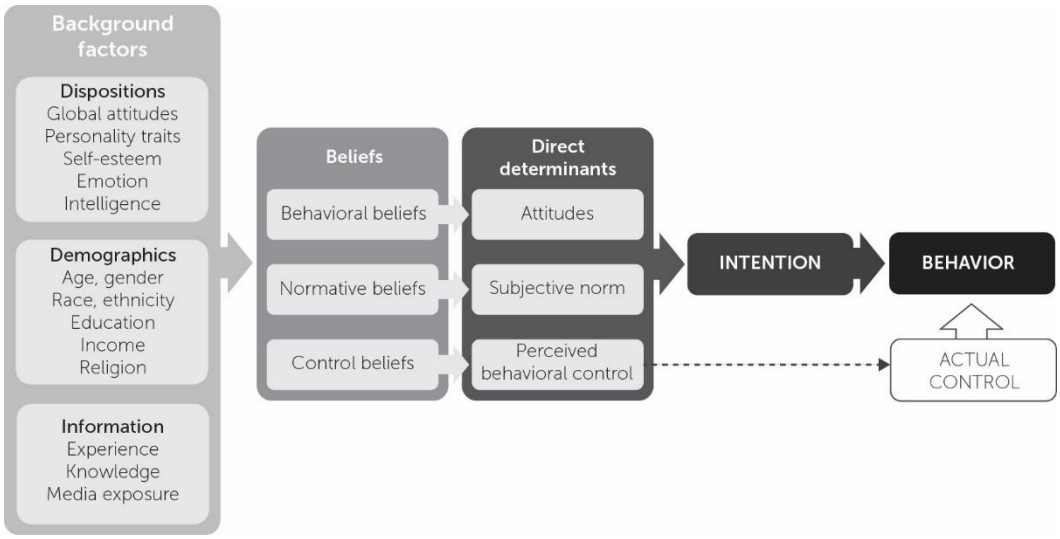


Figure 8. Theory of Planned Behavior (adapted from Ajzen, 1991)

2.2.2. Theory of Interpersonal Behavior

Developing Design Behavior Intervention Model (see Chapter 1, p.12), Tang and Bhamra (2012) benefited from the Theory of Interpersonal Behavior (TIB) in order to explain the factors influencing behavior and to map these factors to behavior change strategies. According to this theory, similar to TPB, intention is the immediate antecedent of behavior, but it differs from TPB by stating that behavior is also mediated by person's habits and external conditions facilitating or constraining the behavior (Triandis, 1977). Intention is further moderated by attitudes (beliefs about behavioral outcomes and evaluation of these outcomes), social factors (norms, roles and self-concept) and affect (emotions) (Figure 9).

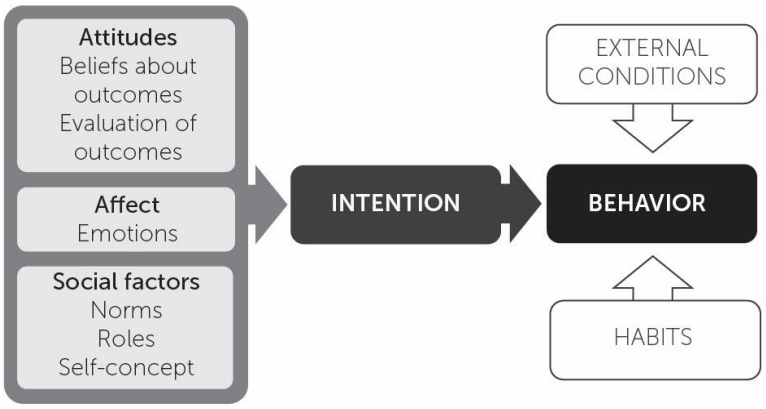


Figure 9.Theory of Interpersonal Behavior (adapted from Triandis, 1977)

2.2.3. Trans-theoretical Model of Change

Criticizing that previous research on promoting sustainable behaviors usually offers one size fit all solutions, He, Greenberg and Huang (2010) used Trans-theoretical Model of Behavior Change (TTM) as a theoretical framework in order to discuss how people with different stages of readiness, willingness and ability to change can be persuaded by different feedback technologies. Apart from other theories mentioned before, TTM introduces the temporal dimension of behavior change by postulating that people follow six different stages when changing their behaviors (Prochaska & Velicer, 1997). According to this theory, in the pre-contemplation stage people are unware of the desired behavior and unwilling to change their current behavior. In contemplation stage people are aware of the need to change their behavior, and they have intention to do so. In preparation stage, they are ready to take immediate action. In action stage, they are performing the desired behavior. In maintenance stage they try to sustain the behavior change. In termination stage their behavior becomes habitual and they gained 100 % confidence to maintain it (Figure 10).

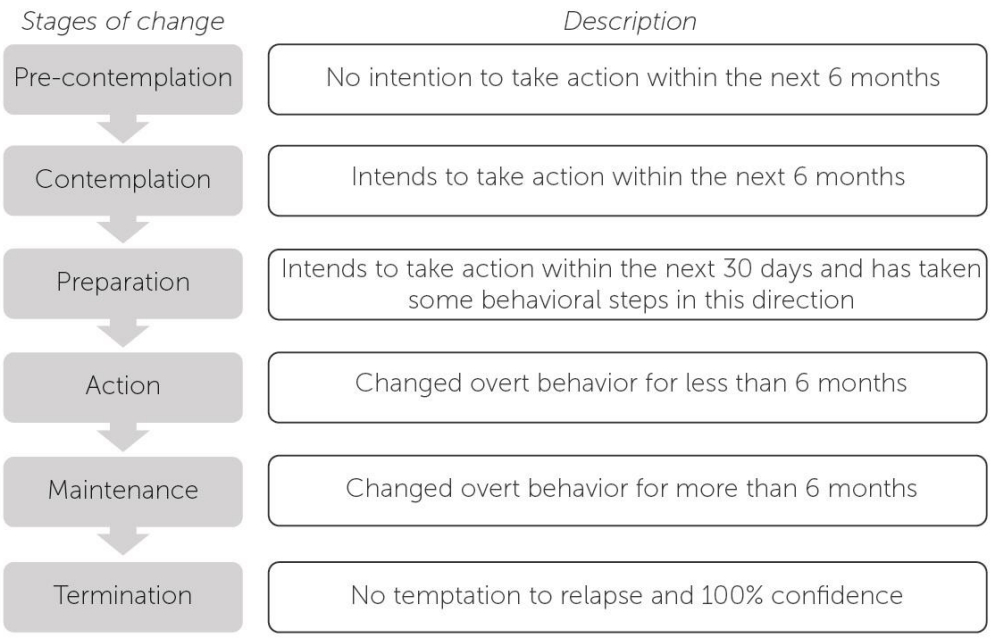


Figure 10. Trans-theoretical Model of Change (adapted from Prochaska & Velicer, 1997)

2.2.4. Comprehensive Action Determination Model

Zachrisson and Boks (2010; 2012) introduced Comprehensive Action Determination Model (CADM) as a theoretical framework to provide guidance on the challenge of selecting behavior change strategies appropriate for different behavior change contexts. Unlike other theories mentioned previously, this model specifically focuses on determinants of sustainable behavior. According to CADM, sustainable behavior is influenced by four distinct factors: intentional, habitual, situational and normative (Klökckner & Blöbaum, 2010) (Figure 11).

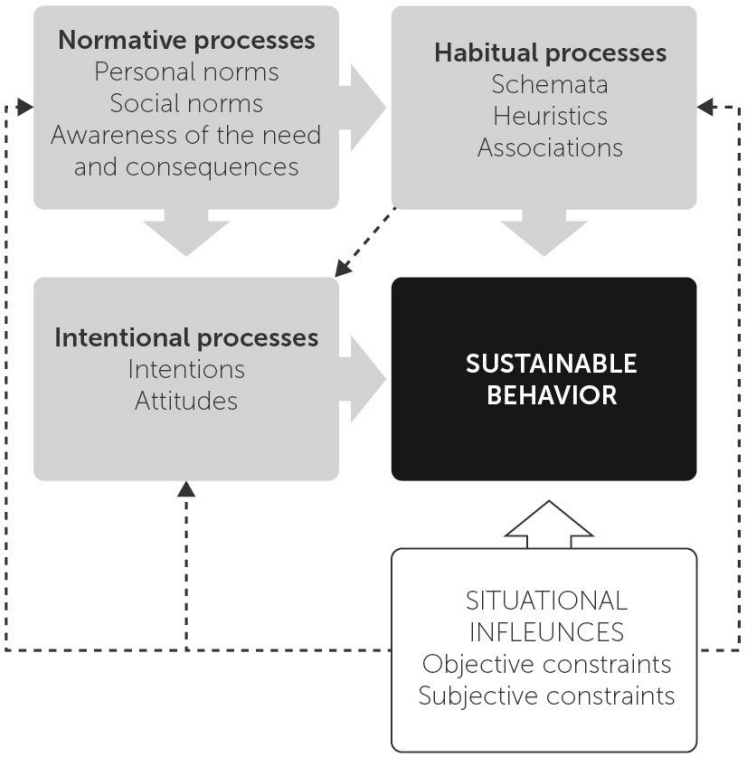


Figure 11. Comprehensive Action Determination Model (adapted from Klökckner & Blöbaum, 2010)

First three factors influence the behavior directly, whereas normative factors influence the behavior indirectly by mediating habitual and intentional factors. Intentional factors are mostly related to individual, and consist of intentions, attitudes and beliefs. These factors are moderated by habitual and situational factors. Habitual factors include schemata (blueprint of a behavior in certain situations), heuristics (decision rules) and associations (neural connections activated together in the brain)

(Klöckner & Matthies, 2011; as cited in Zachrisson & Boks, 2012). Situational factors consist of constraints that limit the performance of a behavior. Constraints can be objective, those influence the behavior directly, and subjective, those perceived by the individual. Finally normative factors consist of subjective norms, personal norms, awareness of the need and awareness of consequences, and they are moderated by situational factors.

2.3. Strategies for promoting sustainable behaviors

So far, design researchers have suggested various strategies that can be used to promote sustainable behaviors (Table 3). One of the initial work on this topic is Lilley et al.'s (2005) review of behavior change strategies from various areas including sociology, behavioral psychology and sustainability. They identified several strategies of interest to design researchers with a focus on education, manufacture, and product behavior.

Education included *informing*: increasing awareness on environmental issues; *rewarding*: rewarding sustainable behaviors and punishing unsustainable ones; and *guilt*: activating guilty feelings so people worry about the wellbeing of future generations. Manufacture focused on the creation of energy efficient products. Product behavior included *feedback*: facilitating environmentally responsible decisions through providing feedback; *steering*: directing user behavior through behavioral scripts (Jelsma & Knot, 2002); and *intelligent products*: products that control user behavior to minimize consumption.

Wever, Van Kuijk and Boks (2008) added a fourth group to these product focused strategies as *functionality matching*: preventing the mismatch between delivered and desired functionalities. Tang and Bhamra (2008) incorporated these interventions into seven design strategies. They added two strategies building on the five strategies identified by Lilley et al. (2005) as information, feedback, rewards, steering and intelligent products. These included *choice*: providing options so that people can reflect on their behavior and take responsibility; and *technical intervention*: controlling user behavior by limiting habits with advanced technology.

Table 3. Behavior change strategies for promoting sustainable behaviors

Strategy	**Definition**
Information	increasing awareness on environmental issues
Choice	providing options so that people can reflect on their behavior and take responsibility
Advice	giving suggestions on how to behave sustainably
Feedback	facilitating environmentally responsible decisions through providing real-time feedback
Communication	facilitating sustainable behaviors through social networks
Comparison	demonstrating to others performing a behavior and comparing their performance
Guilt	activating guilty feelings so people worry about the wellbeing of future generations
Steering	directing user behavior through behavioral scripts
Control	making target behaviors easier to do
Functionality matching	preventing the mismatch between delivered and desired functionalities
Technical intervention	controlling user behavior by limiting habits with advanced technology
Intelligent products	products that control user behavior to minimize consumption
Commitment	asking people to make a commitment to perform a behavior
Goal setting	asking people to aim for a predetermined goal
Rewards	rewarding sustainable behaviors and punishing unsustainable ones
Engagement	promoting sustainable behaviors through appealing people's emotions and curiosity

More recent work by Froehlich et al. (2010) reviewed feedback studies from environmental psychology literature and compared this to research activities within HCI. They identified six strategies. These included three strategies (information, feedback and rewards) previously reported by Lilley et al. (2005), and three new strategies including *goal setting:* asking people to aim for a predetermined goal; *commitment*: asking people to make a commitment to perform a behavior; and *comparison*: demonstrating others performing a behavior and comparing their

performance. Yun et al. (2013) identified nine strategies from environmental psychology, social psychology and behavioral science. They discussed their potential to encourage energy conservation in the workplace. Besides the strategies previously identified by others (information, goal setting, comparison, reward, feedback), they suggested four others including *advice*: giving suggestions on how to behave sustainably; *communication*: facilitating sustainable behaviors through social networks; *engagement*: promoting sustainable behaviors through appealing people's emotions and curiosity; and *control*: making sustainable behaviors easier to do.

2.4. The review of design research on promoting sustainable behavior

Having mentioned research approaches, theories and strategies for promoting sustainable behaviors, this section presents the findings from a review on 70 peer reviewed design research articles on behavior change and sustainability. This review advances the work on this field first by characterizing the current state of design research as conceptual studies and empirical studies. Second it exposes critical gaps in the literature, and third it makes two recommendations for further research based on these gaps.

2.4.1. Review methodology

For this review, several search approaches were undertaken to assure good coverage of design research on sustainability and behavior change. To be included in this review, an article needed to be published in a design journal or a conference. The search started with peer reviewed design journals and design conferences, looking at the work published between January 1, 2000 and June 30, 2014. All journals and conferences had a focus on design and some had a focus on sustainable design and persuasive technology. During this process, *design for behavior change, design for sustainable behavior, environmentally responsible behavior, intentional design, persuasive design* and *persuasive technology* were used as search terms, and 59 design research papers were found. Then, this initial set was expanded by using articles derived from the reference sections of the found papers, looking at other design research papers from journals and conferences outside design. For these papers, the inclusion criteria was being published in other areas when they were

written by design researchers who regularly publish in design research venues. As a result of this search, 70 papers were found published between 2002 and 2014 (Figure 12).

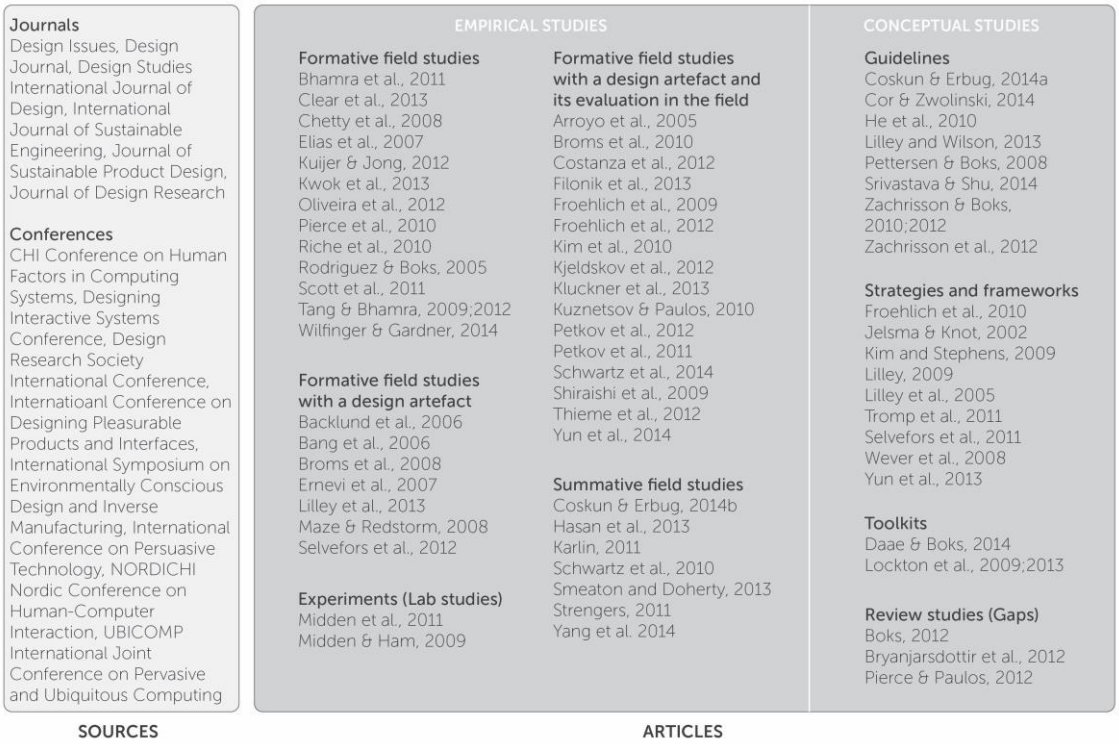


Figure 12. Sources and articles

For the analysis, the papers were sorted according to the methodological approach they adopt as conceptual studies and empirical studies. The conceptual studies were further categorized based on their outcome. These are frameworks, guidelines, toolkits and research gaps. The empirical studies were further categorized based on their outcome and the method. These are formative field studies exploring opportunities for behavior change and proposing a designed artifact, formative field studies proposing a design artifact based on identified opportunities and evaluating this artifact in the field, summative field studies evaluating commercial behavior changing products, and finally experiments evaluating the effectiveness of behavior change strategies in lab settings. The purpose of this categorization to make higher-level observation by characterizing the current state.

To better identify how current research informs the design of products promoting sustainable behaviors, the papers were analyzed by using a design process as a framework, i.e. which stages of the design process it informs and which stages need further attention by design researchers (See Figure 14). The design process proposed by Selvefors et al. (2011) was used for the analysis because it employs a generic product development process consisting of exploration, generation and evaluation, and it maps this three stage process to design for sustainable behaviors.

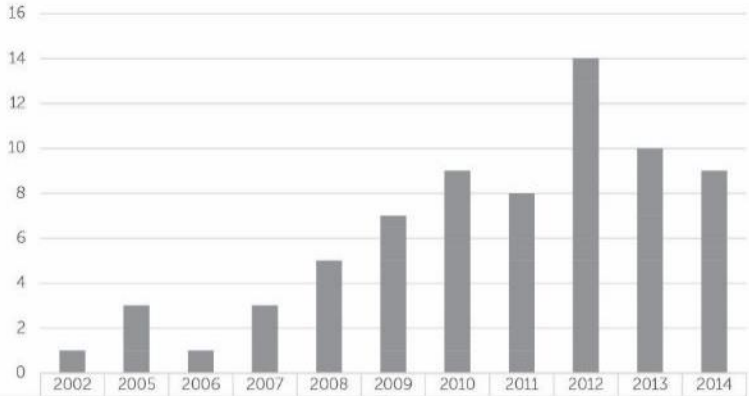
2.4.2. Other review studies

Among the entire database, six papers were review articles. Three of them investigated behavior change strategies from the disciplines outside of design (Froehlich et al., 2010; Lilley et al., 2005; Yun et al., 2013). Section 2.3 'Strategies for promoting sustainable behaviors' elaborates on these strategies.

The other three focused on identifying the research gaps in the literature. Based on their review of projects that attempt to reduce electricity consumption through feedback, Pierce and Paulos (2012) discussed how previous research used a particular type of technology (displaying consumption data), investigated mostly domestic environments, encouraged mainly one type of behavior (conservation behavior), and used attitude and behavior change theories from social psychology while ignoring other consumption theories from sociology and anthropology. Brynjarsdottir et al. (2012) critically reviewed persuasive technology and sustainability in HCI. They claimed that current research defines sustainability too narrowly by explicitly focusing on individuals and specific behaviors. They further argued that attempts to increase awareness by assuming that people are rational actors controlled by information does not fully account for the socio-cultural particularities and complexities of everyday life. They critiqued the short-term evaluations common in this research as inadequate for dealing with the dynamics of change over time. Finally, Boks (2012), in a review of design research on sustainable behavior, discussed the lack of common terminology facilitating research progress despite the abundance of design strategies. He noted a lack of systematic and structured case studies providing relevant user research data for the design of behavior changing products.

2.4.3. Characterizing the design research on promoting sustainable behaviors

Ordering the articles by year revealed a growing interest in behavior change and sustainability, 82% of the papers appeared with the last five years (Figure 13). Note that the decreasing number of articles in 2014 does not indicate a declining interest, as the collection of the articles for this year only covers the first six months.



		2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Conceptual studies	Frameworks	1	1			1	2	1	2		1	
	Guidelines					1		2	1	1	1	3
	Toolkits						1				1	1
	Research gaps									3		
Empirical studies	Formative field		1		1	1	1	2	1	4	2	1
	Formative field/artifact			1	2	2				1	1	
	Formative field/artifact/evaluation		1				2	3	1	5	2	2
	Summative field							1	2		2	2
	Experiments						1		1			

Figure 13. Article distribution according to year and categories identified during sorting

Sorting the articles, two main categories were identified according to their methodology as empirical studies (46) and conceptual studies (24). 14 empirical studies focused on exploring and identifying opportunities for behavior change (formative field studies), seven proposed an artifact or a product concept developed based on opportunities identified for behavior change (formative field studies with a design artifact), 16 identified opportunities, proposed an artifact and evaluated its impact on behavior change through field studies (formative field studies with a design artifact and its evaluation), seven evaluated a commercial product meant to promote sustainable behaviors either by giving it to the users and observing their interactions or by observing people who already own such a product (summative field studies), and two evaluated the effectiveness of different feedback types in promoting sustainable behaviors through lab experiments.

Nine of the conceptual studies proposed various behavior change strategies designers can use to promote sustainable behaviors, and offered frameworks categorizing these strategies along different dimensions. Nine proposed guidelines for selecting suitable strategies for different situations. Three proposed toolkits to be used in generating ideas for promoting sustainable behaviors. Finally, three identified research gaps in the current state and opportunities for further research.

Looking at how previous research unfolded over time, it seems that conceptual studies initially focused on developing strategy frameworks through adapting strategies from other disciplines like psychology and sociology. Later, researchers provided guidelines on selecting these strategies and toolkits with the intention of integrating these strategies into idea generation. Empirical studies initially focused on formative explorations of opportunities for behavior change and developing design concepts based on these opportunities, later work more focused on evaluating these artifacts and commercial behavior changing products.

2.4.4. How previous research informs the design of behavior changing products

As stated before, a design process was used as a framework for analyzing how previous research informs the design of products promoting sustainable behaviors. This process consisted of exploration, generation, and evaluation (Selvefors et al., 2011).

Exploration includes selecting the target for behavior change, and it begins when design teams choose the behavior they wish to change (e.g. household electricity consumption), a problematic product (e.g. electrical kettle), or a target set of users (e.g. university students). This is followed by observing users acting in their environment to identify design opportunities, discovering undesired behaviors and perceived barriers preventing users from changing these behaviors. Generation includes choosing design strategies suitable for the selected target behaviors, products or users and generating ideas based on these strategies. Evaluation involves prototyping selected product concepts and refining them based on their evaluations in field studies. This also helps determine the most promising behavior change strategies having an impact, which provides directions for the design of future behavior changing products.

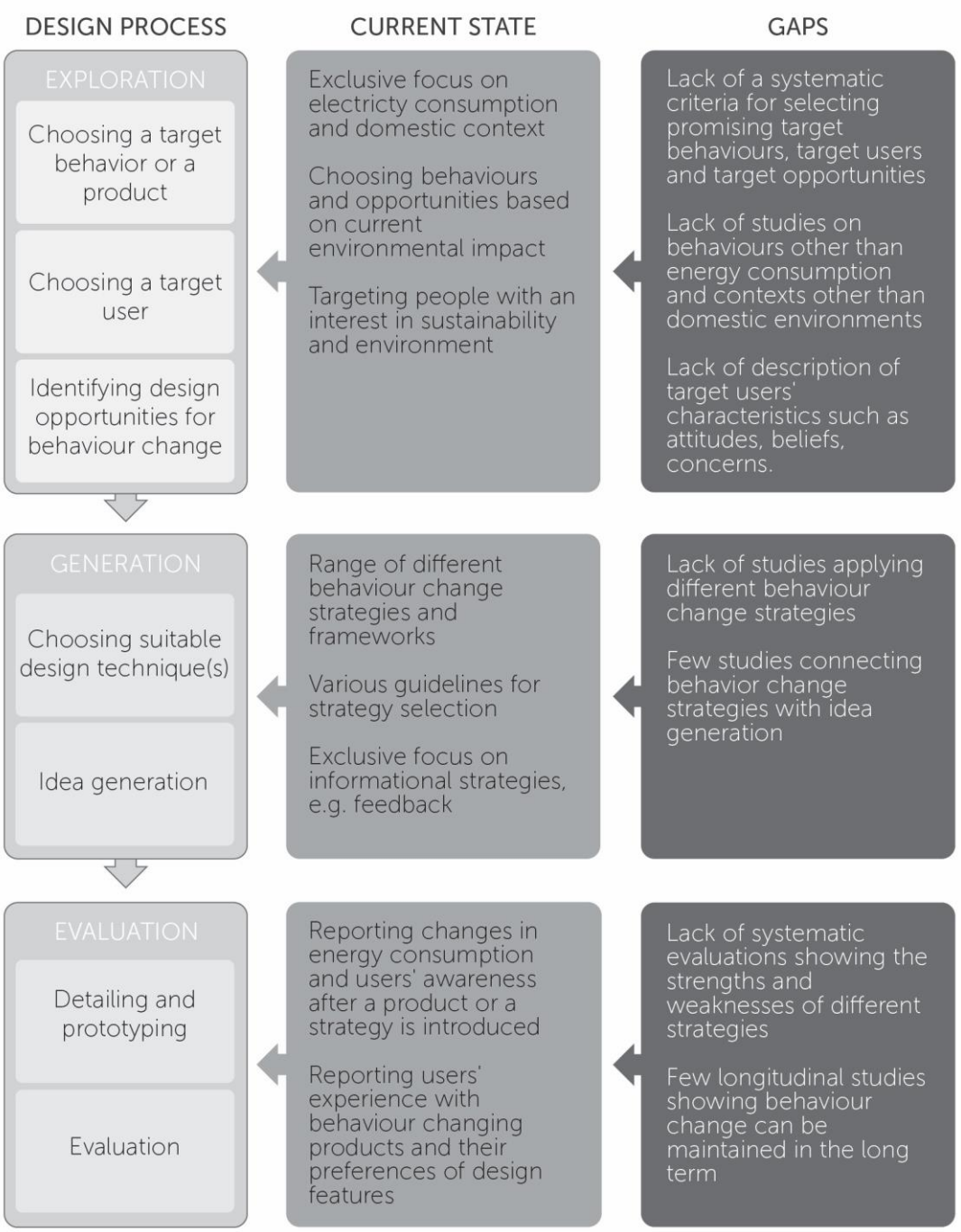


Figure 14. Current state of the work and research gaps mapped to design process

Looking at how previous research informs these three stages, it seems that conceptual studies mainly inform the generation phase by providing various behavior change strategies and guidelines for their selection (Figure 14). Empirical studies inform all three stages. Formative field studies inform the exploration stage through identifying opportunities for behavior change, formative field studies with design artifacts inform generation, formative field studies with an artifact and its evaluation,

summative evaluations and experiments inform the evaluation phase. The remainder of this section elaborates on each phase and how previous research informs these phases.

2.4.4.1. Exploration

As stated earlier, exploration phase involves choosing a target behavior (or a product) and a target user, and identifying design opportunities for behavior change. Across the empirical studies, electricity consumption proved to be the most popular target behavior (34), followed by water consumption (5). Other target behaviors included fuel consumption (3), paper consumption (1), making repairs to already owned artifacts (1), purchasing more sustainable clothing (1), mobile phone use in social context (1), and various environmental behaviors (2). Almost all of the studies explored domestic environments (42). A few looked at work environments (3) and one looked at public spaces.

Looking across these studies, there was no systematic process employed by researchers to select a target behavior. Most papers never discussed the rationale for selecting a behavior. The few that did report that they chose behaviors or products with a significant environmental impact by referring to previous studies assessing environmental performance.

When selecting target users, the empirical studies investigated either individuals (28) or households and families (14). Nine studies specifically targeted students, while others recruited participants based on their fit to a specific age range. The number of participants in each study differed depending on the data collection method. Studies rarely specified a rationale for selecting a target group. They commonly provided demographic information for the participants. Interestingly, only about half of the empirical studies (24) examined the target users' attitudes towards sustainable behaviors and their concern for the environment, which can influence performance of sustainable behaviors and response to a behavior changing product. The articles mentioning user attitudes mainly focused on users with a positive attitude towards sustainability and high environmental concern (14). Researchers considered this as a limitation by arguing that targeting such users may not have the most impact, as these users might be already engaged in sustainable behaviors (Costanza, Ramchurn,

& Jennings, 2012; Strengers, 2011; Thieme et al., 2012). Only four studies included people with wide variety of attitudes towards sustainable behaviors and the environment, e.g. people with high and low environmental concern.

The majority of the formative field studies investigating user behavior (8 out of 11) focused on electricity consumption in the home. Two studies investigated water consumption, and one investigated fuel consumption. The studies focusing on electricity revealed several barriers preventing users from energy conservation. The most common barriers cited were the invisibility of energy, lack of awareness on the consequences of an action, and the perceived difficulty of changing habits that lead to unnecessary energy consumption (e.g. Tang & Bhamra, 2009). The perception of 'clean' (Scott & Quist, 2011) and the invisibility of water as a resource (Chetty, Tran & Grinter, 2008) were cited as barriers for water conservation The barriers identified for fuel consumption were unpredictable trip times (a trip can be either 10 minutes or an hour depending on the traffic), stress due to driving in such situations, and people's tendency to postpone change until they are faced with the negative consequences (Wilfinger, Gärtner, Meschtscherjakov & Tscheligi, 2014).

The lack of a systematic method for selecting target behaviors also relates to the challenge of identifying high impact opportunities. While formative field studies identified barriers and opportunities, a few provided a systematic way for selecting the best target opportunities. There were only two studies that used a more systematic approach to make this selection. To decide on the most promising opportunity, Clear et al. (2013) suggested observing user behavior and calculating the average energy consumption associated to an activity (e.g. cooking) and selecting the one with the biggest consumption (e.g. grilling). To select a high impact product, Elias, Dekoninck and Culley (2007) suggested focusing on products consuming more energy, even though their efficiency is very close to theoretical minimum, defined as the minimum amount of energy required to fulfill a task e.g. boiling 1 liter of water.

2.4.4.2. Generation

As stated before, generation includes choosing suitable behavior change strategies and generating ideas based on them. It appears that conceptual studies provided valuable guidance for this phase. First of all, inspired by literature from psychology

and sociology, researchers proposed numerous strategies designers can use to influence user behavior (Froehlich et al., 2010; Lilley et al., 2005; Yun et al., 2013). Some notable strategies include informing about environmental problems, offering advice on environmental problems, providing a choice to act on these problems, providing feedback on behavioral impact, setting goals for being more sustainable, ensuring commitment to be sustainable, engaging in sustainable behaviors by appealing emotions, steering behavior through affordances and constraints, rewarding sustainable behaviors, comparing one's performance with others, making sustainable behaviors easier to do, constraining unsustainable behaviors through technical intervention and intelligent products that automates sustainable behaviors.

Despite the range of strategies available to designers and researchers, few studies appeared to consider more than a few strategies. All of studies either exploring a behavior change strategy or evaluating its effectiveness (33) used feedback to increase user awareness. 33 used feedback on past and current behavior, 13 used feedback on others performing a behavior, and 3 used feedback on the consequences of future behavior. The second popular strategy was rewards (7), followed by informing about environmental problems and offering suggestions on how to deal with these problems (4). Other strategies included communication through social networks (4), behavior steering (3), intelligent products (2), and goal setting (1).

Several conceptual studies offered strategy frameworks categorizing the strategies according to different criteria. These categorized the strategies according to the extent a strategy controls user behavior, i.e. the distribution of power in decision making between the user and product (Lilley et al., 2005; Lilley, 2009; Tang & Bhamra, 2008; Wever et al., 2008), the salience and force of a strategy as it is experienced by the user (Tromp, Hekkert & Verbeek, 2011), how it evokes user motivation and when it influences user behavior in relation to different consumption activities (Selvefors et al., 2011), and different dimensions of interventions that designers can pursue when designing for behavior change (Kim & Stephens, 2009).

Others proposed guidelines on how to decide on suitable strategies in different situations. These guidelines are based on the division of control between the product and the user (Zachrisson & Boks, 2010; 2011; 2012), different stages of change people are in when changing their behavior (He et al., 2010), the characteristics of target users (Cor & Zwalonvski, 2014; Coskun & Erbug, 2014a), ethical

considerations (Lilley & Wilson, 2013; Petterson & Boks, 2008), and the type of the behavior change problem (Srivastava & Shu, 2014).

Despite the frameworks offering and characterizing behavior change strategies and guidelines for selecting a suitable strategy, very little research connected specific strategies to ideation; the generation of many different possible solutions. A few studies explored the idea generation process in a behavior change project with design students. Lilley (2009) reported that when they asked design students to identify a social issue resulting from the use of mobile phones in public space and respond to this issue by using the three strategies (feedback, behavior steering and intelligent products), students generally understood the strategies. They struggled when working with behavior steering because they had difficulty in defining the boundary between intelligent products and behavior steering. They preferred using a combination of strategies, even though they were not instructed to do so.

Other design researchers offered a collection of strategies incorporated into idea generation toolkits. Lockton et al. (2009; 2013) compared traditional brainstorming methods with the toolkit they proposed, i.e. design with intent. They asked design students redesign four household products to influence more sustainable behaviors; electric kettle, curtain, printer and water tap. They found that the toolkit helped students generate more ideas in comparison to traditional brainstorming. Daae and Boks (2014) tested their tool, i.e. dimensions of behavior change, through design workshops with industrial design and aerospace engineering students. They asked students to generate solutions for three design tasks: making people unplug their phone charges when not in use, making people only boil the amount of water they need, and avoiding opening a window when central heating is on. They reported that the students' overall experience with the tool was positive. It helped them generate more ideas with greater variation in strategies compared to traditional brainstorming methods.

2.4.4.3. Evaluation

The evaluation phase includes assessing the impact of a product or a prototype on promoting a target behavior, and refining it based on this assessment. 16 empirical studies proposed a design artifact meant to promote sustainable behaviors and

evaluated this artifact in the field to gain insights on how they influenced user behavior (e.g. energy consumption) and how users experienced the new design (e.g. ease of use). Some notable findings are users had difficulty in understanding consumption data and relating it to everyday actions (Broms et al., 2010; Kjeldskov et al., 2012); they preferred personal, comparative, comprehensive, visually appealing, specific and entertaining feedback to keep using behavior changing products and to adapt new behaviors (Froehlich et al., 2012; Kim, Hong & Magerko, 2010; Petkov Goswami, Köbler & Krcmar, 2012); and feedback using numerical representations of consumption data is less effective in resource conservation than ambient and iconic representations (Kuznetsov & Paulos, 2010).

Seven empirical studies evaluated commercial behavior changing products in the field by observing the behavior of the users who either were provided with such products or already own them. Some notable findings from these studies are users were engaged with the products initially due to their novelty, while their engagement wore off in time (Coskun & Erbug, 2014b; Strengers, 2011; Yang, Newman & Forlizzi, 2014), and individual feedback techniques are not sufficient to sustain energy savings in the long term, variety of techniques should be used to maintain behavior change and user interest (Smeaton & Doherty, 2013).

Seven empirical studies also measured changes in consumption by comparing the values before and after a behavior change attempt. They showed that feedback contributed to resource conservation by increasing users' awareness of their consumption and potential actions to reduce it. Although, these evaluations provide an account for understanding the effectiveness of strategies, there was no common set of criteria for evaluating the success of a strategy, i.e. what makes them effective in changing behavior. Furthermore, since all of these evaluative studies were conducted in short term, most of them is less than a month, currently there is no evidence to support that these changes will remain in the long term.

There were only two studies investigated if behavior change persisted over time. Both observed users' energy consumption behavior for seven months in the field. Their findings do not agree upon whether a product or a strategy produced a sustaining behavior change. While one of them showed that providing feedback to users on their behavior stimulated energy savings (Kluckner, Weiss, Schrammel & Tscheligi, 2013), the other study showed no effect for feedback systems when

monitored over a longer period of time (Hasan, Medland, Foth & Curry, 2013). Furthermore, there are other studies reported that changes in behavior were short lived when products could not continuously engage users (Coskun & Erbug, 2014b; Shiraishi et al., 2009; Yang et al., 2014).

2.5. Summary and discussion

This review showed that there has been a growing interest in exploring the potential of design in promoting sustainable behaviors. The work on this topic illustrated that this idea is very important for the design research community in terms of having an impact on environmental problems that we face today. Today the field has reached a level of maturity thanks to the substantial amount of work. Researchers has produced different design strategies to change behavior, frameworks and guidelines that help designers and researchers make informed decisions when changing behavior, and many field studies that observed how these strategies work in the real life. The design research community has reached a point where it is ready to go the next phase, i.e. to learn how to do this better. This review aimed to facilitate the transition towards the next phase by summarizing the current state and identifying research gaps and opportunities for further research. Based on the gaps identified, it reveals two recommendations as prioritizing the problem areas and identifying the most promising ways or strategies for promoting sustainable behaviors to have a greater impact.

2.5.1. Prioritization of the problem areas: which behaviors, users and contexts should be targeted?

This review showed that previous work extensively focused on electricity consumption, domestic contexts, and mostly users with interest in sustainability. There is a need for work that investigates other types of consumption, other contexts, and other user groups. As design researchers broaden this exploration, they should begin employing more systematic approaches to selecting consumptive practices, contexts, and target users. In all cases, they should rationalize their selection choices based on the level of impact they might have on the larger challenge of sustainability. Deciding on problems relevant to and promising for design would enhance the

research's connection to relevance and makes a more powerful design contribution, as design maps to relevance (how the world should be) and science on rigor (what it is), the tension between rigor and relevance (Schön, 1983). It would also create opportunities for design researchers to build on and advance the previous research of other design researchers instead of only working on new things, a crucial aspect of a maturing field.

In the scope of this review, two criteria were suggested that can be used to identify promising problem areas systematically. The first is the level of negative impact a behavior has on the environment, as also cited in Boks (2012), and reported in other field studies reviewed here. However, it should be noted that selecting a behavior with high environmental impact does not always guarantee greater environmental benefits. For instance, adding an LCD display to a product in order to provide energy consumption feedback could encourage energy conservation during use, but it might increase the overall impact of the product due to the production of additional parts. Thus, besides evaluating current environmental impact of a product or a behavior, researchers should also carefully consider and predict the potential impacts that can be caused by behavior change attempts.

This criterion should be applied to not only target behaviors but also target users and target opportunities, as they can increase or decrease the potential environmental benefits gained from targeting a certain behavior. For example, if target users are already conserving energy, a technique may not lead to any significant changes in overall consumption. Or when target users learn that they are consuming less energy compared to others, their consumption may increase as a result of this discovery. In a similar vein, when identifying user actions creating environmental impact and perceived barriers for behavior change, i.e. target opportunities, researchers should focus on the ones have the biggest influence on the target behavior. For instance, if a family's energy consumption is mainly dominated by their cooking habits, or if they consider changing their routine behavior as cumbersome and perceived as a barrier, targeting their cooking habits and this perceived barrier could be a great opportunity for design.

The second criterion is the predicted acceptance of the proposed behavioral change attempt. User compliance with behavior change strategies can differ according to individual and contextual factors. For instance, users may refuse coercive strategies

as they think that such strategies jeopardize their autonomy (Lilley et al., 2009). Or even though they comply with a strategy initially, their compliance may decrease over time due to the disappearance of the novelty effect (Yang et al., 2014). Furthermore, these two criteria (the level of environmental impact and predicted acceptance) should be evaluated together, as the latter can change according to the type of behavior. For instance, changing behaviors with high environmental impact like use of air conditioning may have low predicted acceptance than changing behaviors with lower environmental impact, like turning off the lights when a room is unoccupied.

2.5.2. Identification of the strategies with profound and lasting impact

Design research community need to better identify the most effective ways of influencing user behavior through design. Besides making a contribution to behavioral changes with greater impact, this would also facilitate the field's transition towards education and practice, an area in which currently very few studies exist (Lilley & Lofthouse, 2009; Lilley & Lofthouse, 2010; Selvefors et al., 2011), as this transition requires a thorough understanding of what is working and not working in terms of behavior change strategies.

One way to achieve this is exploring the range of different behavior change strategies in order to compare their effectiveness. This review showed that although there are different strategies, most work focused on feedback, and there is little evidence that feedback can produce a sustaining behavioral change. The challenge with using informational strategies is that they often fail to engage users over a long period of time. It is true that strategies such as feedback might be an initial attractor, getting people's attention to reflect on their current behavior; however, it has a novelty effect that can quickly wear off. Since informational strategies such as this essentially rely on users' attention and continuous engagement to change behavior, this becomes more problematic when designs fail to create lasting engagement.

Researchers have attempted to combine feedback with different strategies to overcome this issue. However, almost no studies have reported the effectiveness of this approach. This might be a possible solution to compensate the weaknesses of informational strategies; strategies like rewards, commitment and goal setting create

and maintain engagement when they are used with feedback. Nevertheless, the real potential of using a combination of strategies becomes evident when they are used separately depending on the changes in user experience. For instance, at the early stages, when users are learning a desired behavior, informational strategies can be preferred to attract users' attention. Once they perform the behavior, strategies like affordances and intelligent products can be preferred to transform the new behavior from a self-directed stage to a habitual stage. This transition to habitual behavior is very important for design, since when they incorporated a behavior into their daily routines, people can repeatedly take the action without giving to much attention, which in turn leads to a sustained behavior change. To facilitate this transition, designers and design researchers need to focus on developing 'unremarkable' products (Tolmie et al., 2002), which are successfully immersed into people's daily routines in such a way that they are perceived as invisible in everyday life yet functional and visible when people need them.

To have a better understanding of what is working and not working, there is a need for more longitudinal field studies. This review revealed that there is a lack of longitudinal studies assessing the effectiveness of behavior change strategies. These are essential for identifying the most promising ways of promoting sustainable behaviors. Thus, besides exploring different strategies, future research should focus on systematically evaluating them through field studies. This would not only help clarify the impact they have on changing behavior and maintaining this change for different behaviors, contexts and users, but also discover how user experience evolves over time and how this influences behavior change in the long term.

More work is also needed on improving previous frameworks that characterized behavior change strategies and proposed guidelines for strategy selection. The increasing number of field studies along with the introduction of the new frameworks and strategies appears to be a healthy sign of maturing area of research, an evidence for research programs not just for individual projects (Koskinen et al., 2011). However, this indication of matureness lessens when we specifically look into frameworks. Even though several authors provided different strategy frameworks and guidelines for strategy selection, there were few studies that applied them in order to generate ideas for promoting sustainable behaviors. This is because design researchers tend to prefer creating their own frameworks and models, which are not

usually utilized by others in different behavior change projects. To see whether these frameworks can be operationalized effectively, whether they contribute to better designs and to build knowledge and theory in design for behavior change field, design researchers should add to and challenge other design researchers' work (Zimmerman, Stolterman & Forlizzi, 2010).

CHAPTER 3

USER DIVERSITY FOR PROMOTING SUSTAINABLE BEHAVIORS

This chapter presents the proposed method for exploring user diversity for promoting sustainable behaviors, and communicating this diversity to designers during idea generation. It introduces the method with an explanation of dimensions for exploring user diversity, scales for measuring these dimensions, along with the data collection and analysis methods. It then illustrates this method with a case study on eco-friendly driving, and presents the user groups identified as a result of this study. After discussing other user representation methods in design, it introduces the proposed method for communicating user diversity by using the identified user groups in the exploration study.

3.1.Exploring user diversity for promoting sustainable behaviors

As stated in Chapter 1, user diversity is an important aspect of promoting sustainable behaviors through design and currently the field lacks approaches for its exploration. Aiming to fill this gap, this thesis offers a new method for exploring user diversity for promoting sustainable behaviors, and identifying different user groups based on user research data. According to this method, exploration process begins with either selecting a target behavior or a target user. After this selection, a survey is designed to measure user diversity in terms of the dimensions (or variables) derived from TPB (Ajzen, 1991). Then, a pilot test is conducted to test the reliability of these measures prior to the data collection. Next, data is analyzed by using cluster analysis to find the significant user clusters. Lastly, these clusters are turned into user groups by using the dimensions derived from the theory (Figure 15).

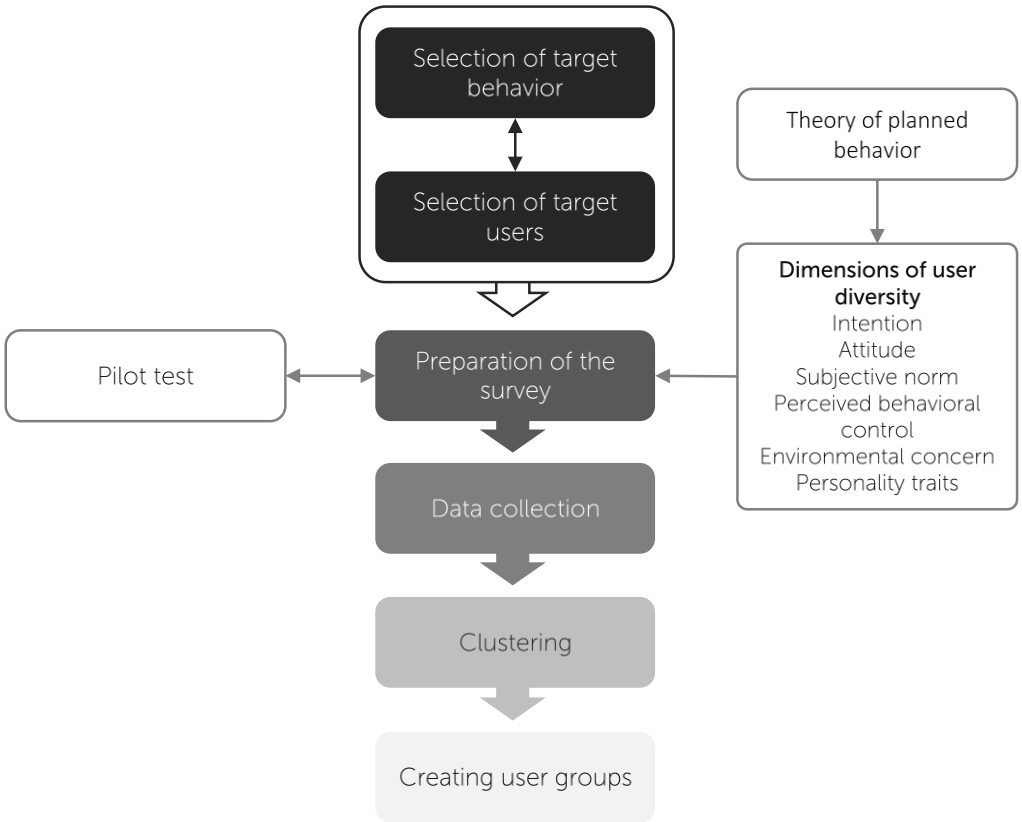


Figure 15. The method for exploring user diversity for promoting sustainable behaviors

3.1.1. Dimensions of user diversity

There are numerous models and theories explaining the determinants of human behavior, i.e. what shapes and influences behavior, and how it can be changed towards a desired direction. Jackson's (2005) review of socio-psychological theories of behavior and behavior change provides a good collection for design researchers interested in promoting sustainable behaviors. In this review, he made a distinction between two kinds of theories. The first includes the theories exploring the behavior as a concept influenced by factors internal to individuals, such as intentions, attitudes, values, and personal norms. The second includes the ones exploring the behavior as influenced by factors external to individuals, such as institutional and situational factors. This distinction is important for user diversity as it can help selecting the theoretical framework for determining its dimensions. As user diversity represents the variance of individual factors influencing a behavior across different users, theories focusing on internal factors may have a greater value for its exploration than the ones focusing on external factors. In the scope of this thesis,

referring to the theories reviewed by Jackson (2005), Ajzen's (1991) TPB was selected as a theoretical framework for determining the dimensions of user diversity.

The decision to select this theory was based on its value as a well-known theory of human behavior that has been applied across diverse behavioral domains, including those related to sustainability, health, addiction, purchasing, and so forth. It remains as a valid theory for understanding human behavior (Ajzen, 2014) despite recent criticism (Sniehotta, Presseau & Araújo-Soares, 2014). Furthermore, it allows for the prediction of intentions by measuring attitudes, subjective norms and perceived behavioral control with considerable predictive validity (Ajzen, 2011), and provides a guideline for the development of scales to measure these determinants.

TPB postulates that the behavior is directly determined by a person's intention and actual control over behavior. The intention to engage in a behavior is further influenced by attitude towards behavior, subjective norms and perceived behavioral control. These factors are further influenced by behavioral beliefs, normative beliefs and control beliefs. In other words, beliefs affect a person's intention indirectly by shaping attitudes, subjective norms and perceived behavioral control. Finally, background factors, such as knowledge, global dispositions (e.g. environmental concern), personality traits, demographics and experience indirectly influence the intention by acting upon these beliefs (Figure 16).

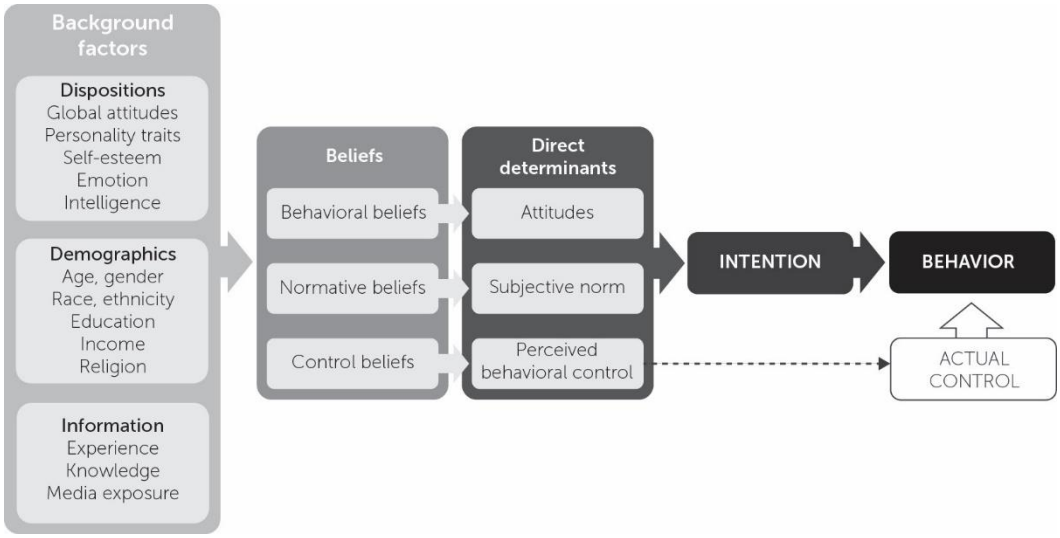


Figure 16. Theory of Planned Behavior

By using TPB as a framework, ten variables were selected as dimensions of user diversity for this study, since it would be complex to handle all of the variables mentioned in the theory in a single study. The rationale behind the variable selection was based on their potential to contribute to the prediction of behavior. The first variables included in this selection were direct determinants of behavior (intention, attitude, subjective norm and perceived behavioral control), as evidence showed that 53 percent of the variation in behavior can be explained by only intention, and up to 66 percent variation in intention can be explained by attitudes, subjective norms and perceived behavioral control (Ajzen, 2011). Later, environmental concern was added to this selection, since it is one of the most studied variables in environmental psychology literature in the context of sustainable behaviors and environmental problems, although its influence on behavior is not direct (e.g. Fransson and Gärling, 1999). Lastly, personality traits (extraversion, conscientiousness, agreeableness, neuroticism and openness to change) was added to this selection in order to better understand the individual differences between the participants at the personality level and their relationship with other variables (Table 4).

3.1.2. Scales for measuring the dimensions of user diversity

To measure these dimensions, the proposed method suggests using three different scales adapted from the literature. The first one is the attitude-intention scale[2] measuring intention, attitude, subjective norm and perceived behavioral control. Since TPB considers these variables as factors specific to a behavior, which makes it hard to design a scale applicable to different behaviors, a new questionnaire should be designed according to the selected target behavior. Fishbein and Ajzen (2010) provided several guidelines for preparing such a questionnaire. The second scale is New Environmental Paradigm (Dunlap, Van Liere, Mertig & Jones, 2008) which measures people's environmental concern (with high internal consistency, α=.81), and the third one is Big Five Personality Traits Inventory (John, Naumann & Soto, 2008), which measures extraversion, conscientiousness, agreeableness, neuroticism and openness to change (with high internal consistency α=.84).

[2] As it is advised to design a new scale for a target behavior, internal consistency was not reported here.

Table 4. Variables for exploring user diversity

Variable (Dimension)		Definition
Direct determinants of behavior	*Intention*	Readiness to perform a behavior (Fishbein & Ajzen, 2010)
	Attitude	Positive or negative evaluation of the behavior to be performed (Fishbein & Ajzen, 2010)
	Subjective norm	Perceived social pressure to perform or not to perform a behavior (Fishbein & Ajzen, 2010)
	Perceived behavioral control	The perception of ability to perform a behavior (Fishbein & Ajzen, 2010)
	Environmental concern[3]	General dispositions and beliefs related to environmental problems and sustainable behaviors (Kaiser, Wölfing & Fuhrer, 1999)
Personality traits	*Extraversion*	Being socially active, full of energy, outgoing and enjoying interacting with others (McCrae & John, 1992)
	Conscientiousness	Being self-disciplined and organized, and acting dutifully (McCrae & John, 1992)
	Agreeableness	Being considerate, kind, generous, helpful and trustworthy (McCrae & John, 1992)
	Neuroticism	The tendency to feel negative emotions, such as anxiety, stress and anger (McCrae & John, 1992)
	Openness to change	Being open to new experiences, ideas and appreciating art, emotion and creative ideas (McCrae & John, 1992)

3.1.3. Data collection and analysis technique

As it is important to access large samples to achieve desired amount of user diversity, it is suggested to use questionnaire as the data collection method. The scales mentioned above can be easily integrated into a questionnaire delivered to many participants within a short time. Suggested technique for data analysis is cluster analysis, as it allows identifying statistically significant user groups in a target population. For this process, either partitioning methods, such as *k-means* or hierarchical methods, such as *agglomerative hierarchical clustering* can be used to identify groups in the data (Kaufman & Rousseeuw, 2005). But, in the scope of this thesis, the latter was preferred, as it does not require the number of clusters to be

[3] Although it influences sustainable behavior indirectly, here environmental concern is presented as a direct determinant for the sake of simplicity.

determined prior to analysis by the researcher; rather it represents the clusters within a hierarchical structure, which is more informative than the former.

3.2.Applying the method to the case of eco-friendly driving

A case study on eco-friendly driving was conducted in order to visualize how the proposed method can help exploring user diversity for promoting sustainable behaviors. As stated before, the procedure to explore user diversity begins with either selecting a target behavior or a target user.

3.2.1. Selecting target behavior

Sustainable behavior[4] can be defined as the behavior that a person performs consciously in order to minimize his or her negative impact on the environment (Kolmuss & Agyemen, 2002). Stern (2000) describes four different types of sustainable behaviors. *Environmental activism* refers to people's active involvement in environmental organizations and demonstrations. *Non-activist behaviors in public sphere* includes behaviors supporting or accepting public policies, such as willingness to pay high taxes for environmental protection. *Private sphere environmentalism* refers to making informed decisions when purchasing (efficiency behaviors), using (curtailment behaviors) and disposing (green consumerism) personal and household products which have significant environmental impact. The last type is other sustainable behaviors that include individual's decisions influencing the actions of organizations, such as designers and engineers effort to design a product in a more environmentally friendly way or managers' willingness to comply with environmental legislations.

So far design researchers working on behavior change have mostly focused on behaviors in private sphere environmentalism, and especially curtailment behaviors, such as reducing resource consumption (See Chapter 2). Garner and Stern (2008) provided a useful list for sustainable behaviors in this domain including 11 actions individuals can take to reduce their negative impact on environment. These actions

[4] Researchers used different phrases to refer such behaviors like environmentally significant behavior (Stern, 2000), sustainable behavior (Lilley, 2009) and pro-environmental behavior. Throughout this thesis, sustainable behaviors will be used to refer these type of behaviors.

vary in terms of their cost and the potential environmental gains they provide, i.e. energy savings and reduction in carbon emissions (Table 5).

Table 5. A short list of effective actions to conserve energy and reduce carbon emissions (Garner & Stern, 2008)

Time & Cost	Domain	*Action*	Energy saved (%)
Immediate low-cost/no-cost actions	Transportation	*Carpool to work with one other person*	Up to 4.2
		Get frequent tune-ups, including air filter changes	3.9
		Alter driving (avoid sudden acceleration and stops)	Up to 3.2
		Combine errand trips to one-half current mileage	Up to 2.7
		Cut highway speed from 70 to 60 mph	Up to 2.4
		Maintain correct tire pressure	1.2
Immediate low-cost/no-cost actions	Inside the home	*Lighting: Replace 85 percent of all incandescent bulbs with compact fluorescent bulbs*	4.0
		Space conditioning: Heat: Turn down thermostat from 72° F to 68° F during the day and to 65° F at night A/C: Turn up thermostat from 73° F to 78° F	3.4
		Clothes washing: Use only warm (or cold) wash, cold rinse setting	1.2
Longer-term, higher cost actions	Transportation	*Buy low-rolling resistance tires*	1.5
		Buy a more fuel-efficient automobile (30.7 vs. 20 mpg EPA average-adjusted composite)	13.5

Referring to this list, eco-friendly driving was selected as a target behavior due to two reasons. First, as also literature review presented in Chapter 2 indicates, previous research on behavior change and sustainability mostly focused on electricity consumption, there were very few studies focusing on transportation. Second, adapting eco-friendly driving habits could bring significant environmental benefits (see Table 5). Research showed that providing feedback to drivers on their fuel

consumption resulted in fuel savings between 3%-25% (Barkenbus, 2010; Harvey, Thorpe & Fairchild, 2013; Tulusan & Felisch, 2012).

In the scope of this thesis, eco-friendly driving is defined as driving efficiently with the intention of decreasing ones' fuel consumption and carbon emissions. To adapt an eco-friendly driving style, drivers should properly change gears, remain a safe following distance, carry out routine maintenance of their vehicles and minimize the amount of time they spend for parking. They should avoid rapid acceleration, instant break, long idling times, excessive use of air-conditioning, and excessive load (EPA, 2014).

3.2.2. Selecting target users

The second step of the proposed exploration method is selecting the target users. As the diversity is one of the primary concerns for applying this method, a broad and diverse sample was selected by using quota sampling strategy (Battaglia, 2008) based on age, sex and educational level. These sampling variables were identified from a previous work on the relationship between socio-demographics and green segmentation (Diamantopoulos, Schlegelmilch, Sinkovics & Bohlen, 2013). Participants were also required to be active drivers and have a valid driver license. A research company was hired to reach participants with diverse backgrounds. By using their participant pool, 200 private car drivers living in Ankara, Turkey that represent groups with different demographics and socio-economic status were selected for the main study. Table 6 shows the participant distribution according to the sampling variables.

Table 6. Participants' distribution according to age, gender and educational level

	Female					*Male*					
	18-24	*25-34*	*35-44*	*45-54*	*55+*	*18-24*	*25-34*	*35-44*	*45-54*	*55+*	
Primary school	3	3	6	6	0	2	4	5	3	4	36
Middle school	2	4	3	3	2	7	4	4	5	4	38
High school	6	6	4	4	4	5	5	4	4	5	47
Undergraduate	4	6	4	5	4	4	3	5	4	4	43
Graduate	2	4	5	4	6	2	5	3	5	0	36
	17	23	22	22	16	20	21	21	21	17	

3.2.3. Data collection

A questionnaire was designed to measure the dimensions of user diversity based on Attitude-Intention Scale (Fishbein & Ajzen, 2010), New Environmental Paradigm (Dunlap et al., 2000) and Big Five Personality Traits Inventory (John et al., 2008).

The Attitude Intention Scale (AIS) included 12 statements measuring participants' intention, attitude, subjective norm and perceived behavioral control in relation to eco-friendly driving. Each statement was prepared as a seven point semantic differential scale. Since there was no study offering a scale translated into Turkish, the items were prepared by using the guidelines proposed by Fishbein and Ajzen (2010).

New Environmental Paradigm (NEP) included 15 items measuring environmental concern. These items were adapted from a study offering a Turkish version of the original scale having .53 as internal consistency co-efficient (Aytac & Ongen, 2012).

Big Five Personality Trait Inventory (BFI) included 44 items measuring extraversion, conscientiousness, agreeableness, openness to change and neuroticism. The items for these scales were prepared as five point Likert scale, and they were adapted from a study offering a Turkish version of the original scale with internal consistency coefficients ranging between .76 and .86 (Karaman et al., 2010).

The questionnaire also included demographic questions on age, sex and education level. (See Appendix A, B and C for the entire questionnaire and consent form for the study).

After the initial questionnaire design, a pilot test was conducted to check the understandability of the questionnaire items. An online version of the questionnaire was prepared, and it was delivered to 40 participants via e-mail for the pilot test. The participants were recruited from METU Department of Industrial Design mailing list. 21 females and 19 males were participated in the pilot study. Most of them were less than 40 years old (27 participants 18-30; 11 participants 31-40, 1 participant 41-50, one participant 50 +), and almost all of them had either Bachelor's or Master's Degree (n=39). The questionnaire was designed by using Google Docs and delivered to participants via e-mail.

Pilot tests showed that the participants did not have a problem with understanding the items. However, some of them found some items referring to very similar things, e.g. the slight difference between the items in AIS scale, 'I intend to perform' and 'I plan to perform'. Based on these observations, the questionnaire was revised. The sections including NEP and BFI remained unchanged except few minor changes in wording. As for AIS, several wording changes were made for some of the items, since they were perceived as referring to the same things by the participants. The revised questionnaires were distributed to participants between February and March 2014.

The reliability of the scales used in the revised questionnaire was evaluated by computing Cronbach's alpha. In general, the scales were reliable (alpha values were between .601 and .800). According to the rules of thumb provided by George and Mallery (2003), NEP had acceptable reliability. AIS items measuring attitude and subjective norm had excellent reliability, while items measuring perceived behavioral control and intention had good reliability. BFI items measuring extraversion, conscientiousness, openness and neuroticism had good reliability, whereas the ones measuring agreeableness had acceptable reliability (Table 7).

Table 7. Reliability levels of each scale used in the revised questionnaire

Scale	**Cronbach's alpha(α)**	**Reliability**
NEP	.620	Acceptable
AIS		
Attitude	.832	Excellent
Subjective norm	.839	Excellent
Perceived behavioral control	.711	Good
Intention	.725	Good
BFI		
Extraversion	.724	Good
Agreeableness	.601	Acceptable
Conscientiousness	.725	Good
Neuroticism	.727	Good
Openness	.750	Good

3.2.4. *Data analysis*

An agglomerative hierarchical cluster analysis[5] was used to identify significant clusters in the data. All of the variables were included in the clustering algorithm, aside from the demographics, since they were used to determine the quotas in the sample. As the scales in the questionnaires had different interval values, e.g. 1 to 5 and 1 to 7, they were transformed into standardized scores in order to minimize the distortion that might be caused by the difference in scale intervals. Additionally, the mean values were transformed from numerical to categorical. For instance, if a cluster had a mean value of higher than 3.5 for intention, it was coded it as high intention, and vice versa. A specific set of criteria was used to determine the significant clusters, according to which the maximum distance between two clusters should be 2, significant differences should exist between clusters (for at least one variable) but should remain at the categorical level, and finally the population of a cluster should be more than one user. This method led to the identification of twelve significant clusters (Figure 17). For the clustering dendrogram, and p values for significant differences in cluster see Appendix D.

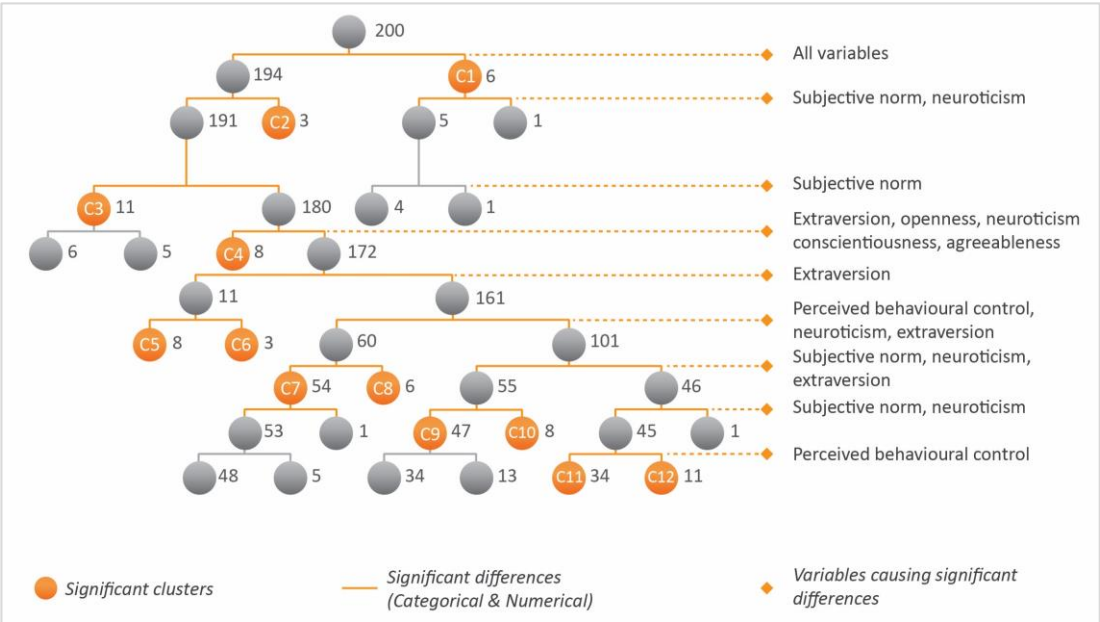


Figure 17. Hierarchical tree of significant clusters for eco-friendly driving

[5] During the analysis, average distance algorithm was used because it had the higher value of cophenetic correlation coefficient (c=0.79) than complete distance (c=0.68) and simple distance (0.56).

3.2.5. User groups for eco-friendly driving

After the analysis, the clusters with similar characteristics were grouped into higher level categories. Specifically, each cluster was assigned to a group based on direct determinants of behavior including environmental concern, intention, attitude, perceived social support and perceived behavioral control. The purpose was to identify different user orientations towards the adaptation of eco-friendly driving, e.g., ready to adapt eco-friendly driving, willing to adapt eco-friendly driving but lacks perceived social support. Then, a similar grouping was made by using five personality traits including extraversion, agreeableness, conscientiousness, openness to change and neuroticism to identify different user personalities, e.g., introvert, extravert, conscientious, neurotic. These categorization led to five user orientations and four user personalities represented along with their appearance within the entire sample (Table 8).

Table 8. Grouping clusters based on direct determinants of behavior and personality traits

	Cluster(s)	Variable	Percentage
USER ORIENTATIONS Direct determinants of behavior[6]	C1	Low environmental concern Low intention Negative attitude Low perceived social support Low perceived behavioral control	3
	C6	High environmental concern High intention Positive attitude High perceived social support Low perceived behavioral control	2
	C12	High environmental concern High intention Negative attitude High perceived social support Low perceived behavioral control	6
	C2, C3, C8, C10	High environmental concern High intention Positive attitude Low perceived social support High perceived behavioral control	14
	C4, C5, C7, C9, C11	High environmental concern High intention Positive attitude High perceived social support High perceived behavioral control	75
USER PERSONALITIES Personality traits	C1, C4	Introvert Disagreeable Unconscientious Emotionally stable[7] Not open to change	7
	C5, C8	Introvert Agreeable Conscientious Emotionally stable Open to change	7
	C2, C6 ,C7, C10	Extravert Agreeable Conscientious Neurotic Open to change	35
	C3, C9, C11, C12	Extravert Agreeable Conscientious Emotionally stable Open to change	51

As each cluster was assigned to both a user orientation and a user personality, this categorization also allowed seeing the relationship between different orientations and

[6] Even though environmental concern is not a direct construct, it is included here for the sake of simplicity
[7] Here, emotional stability was used to refer to neuroticism.

personalities, that is, what type of user personalities a user orientation includes and vice versa. For instance, the user orientation including people who do not care adapting eco-friendly driving consists of unconscientious users, and the user orientation including people ready to adapt eco-friendly driving consists of users with multiple personalities, such as extravert, agreeable, introvert, neurotic and unconscientious users. This relationship will be illustrated in the next section through the proposed method for communicating user diversity.

3.3.Communicating user diversity to designers

Communicating user diversity to designers in a usable, understandable and inspiring way is essential for their consideration of this diversity when developing products meant to promote sustainable behaviors. This thesis offers a method, user orientation map, aimed at communicating this diversity to designers in such a way. It illustrates this method with user groups previously identified in this study. Before explaining the method, other user representation methods used in design were reviewed with the intention of comparing them with the proposed method.

3.3.1. Persona

So far, design researchers and practitioners have offered different user representation methods. One of the most common method is personas, which are defined as fictional characters representing real users in terms of their goals, behaviors and thoughts (Cooper, Reimann, & Cronin, 2007). They are considered as powerful design tools widely used in user centered design and goal oriented design projects, as they allow designers to imagine users and the context of use in detail during the design process. A persona provides a rich description of one single user derived from contextual interviews, observations or previous research findings. It usually includes an image of the fictional user, demographic information, such as age, sex, occupation etc. and detailed information about specific goals and behaviors (Figure 18),

Figure 18. A persona example (Pruitt & Adlin, 2006)

3.3.2. Mental model

Another user representation method used in design is mental models defined as affinity diagrams of user behaviors and goals (Young, 2008). Similar to personas, they provide designers with rich information about users based on ethnographic data. However, they differ from personas in a sense that instead of focusing on one specific type of user group, they try to cover different type of users; the method involves grouping the users based on their behavior (task based audience segments) and then generating a mental model for each group (Figure 19).

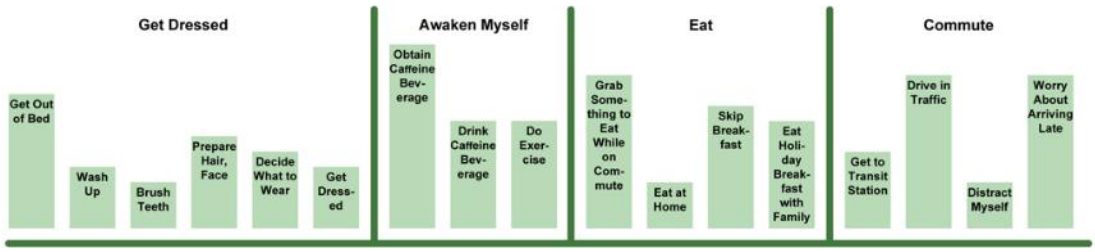


Figure 19. Mental model of a typical for people who commute to work or school (Young, 2008)

3.3.3. User profile

Another method is user profiles, which usually consist of user information based on skills, preferences, needs, interests, abilities, characteristics and behaviors (Dijk et al., 2005). Similar to personas they are at the very center of user centered design that help designers emphasize with their users. They are commonly built for ICT systems which are used by different type of users to tailor the right information to the right users at the right time in the right way; for instance, an application in a hospital used by patients, patient families and doctors. They can be built in many forms, such as list-based, personal form and narrative user profiles (Hackos & Redish, 1998), which implies that the level of the detail can vary from short sentences to paragraphs according to the purpose and the context (Figure 20).

User 1, Large animal veterinarian

- Rural Wyoming, county population about 3,500
- Al told us there are more cows than people around
- Age 45
- Doctor of veterinary medicine, specializing in large animals
- More time spent at client site (farms and ranches) than in office.
- Prefers outdoor to indoor work in general
- Office work done mostly by assistants (local teenagers, elderly mother) but all by hand, lots of forms.
- Frequent computer users, only user in the office (doesn't want anyone else to touch the computers)
- Computer used for business accounting only
- No web access or CD-ROM available
- Has difficulty in the rural in the rural area getting additional phone lines for computers
- Told us that everyone is on party lines, which makes using modems or fax machines next to impossible

Continues...

User 4, Harry

He is known by our team as Harry, is a 73-year-old large animal veterinarian. Harry practices in a rural community in southern Illinois, about 100 miles from the Southern Illinois University campus where he attended veterinary school. Harry has a computer in his office, but he made a special point of telling us that he doesn't use it very much. He said he really doesn't know much about this Windows stuff. His computer still has DOS.

Harry knows enough about brucellosis disease, studied in the school, of course, but they don't see much of it in his area. In fact, he hasn't seen a cause in 35 years, not since an outbreak that scared everyone enough to make them very careful. He really doesn't know if he'd be really interested in hooking up his computer to a modem so that he could communicate with USDA. Doesn't sound all that useful.

Harry's office is handled by his two stuff members, a 32 year old woman who is the office manager and an 18 year old man who is interested in becoming a veterinarian...

Continues...

Figure 20. Example user profiles (Adapted from Hackos & Redish, 1998)

3.3.4. *User role model*

User role models refer to the list of different users who interact with a system, where each role is defined and distinguished by user requirements, expectations, behaviors and responsibilities (Constantine & Lockwood, 1999). They usually describe what different groups of users can do with a system or an application. For instance, for a university ticket transaction service various user roles can exist each of which have distinctive characteristics and needs, such as ticket buyer, ticket seller, event manager, office manager and so on (Figure 21).

- **ticket buyer,** with further sub-roles as described later, who interacts with the ticket seller to learn about event information and buy event ticket
- **ticket seller,** who serves ticket buyers and uses the system to find and buy tickets on behalf of ticket buyers
- **event manager**, who negotiates with event promoters about event information and tickets to be sold by the MUTTS ticket office
- **advertising manager,** who negotiates advertising to be featured via MUTTS
- **maintenance technician,** who maintains the MUTTS ticket office computers, Website, ticket printers, and network connections
- **database administrator,** who tends the reliability and data integrity of the database
- **financial administrator,** who is responsible for financial and accounting-related affairs
- **administrative supervisor,** who oversees the entire MU services department
- **office manager,** who is in charge of the daily MUTTS operation
- **assistant office manager,** who assists the office manager

Figure 21. An example user role model, user work roles for Middleburg University Ticket Transaction Service (adapted from Hartson & Pyla, 2012)

3.3.5. *Market segments*

Market segments, traditionally used in marketing studies, divide a market into homogenous segments in response to users' product preferences (Smith, 1956; Wedel & Kamakura, 2000). Different segmentation bases are used to allocate consumers to different segments (Wedel & Kamakura, 2000), such as geographic, demographic, psychographic characteristics. When compared to other representation methods, the amount of detailed information that a market segment contains is low, they usually consist of keywords or short sentences (Figure 22).

A - Upper middle class (head of the household successful business or professional person, senior civil servant, or with considerable private means)
B - Middle class (head of the household senior, well off, respectable rather than rich or luxurious)
C1 - Lower middle class (small trades people and white collar workers with administrative, supervisory and clerical jobs)
C2 - Skilled working class (head of the household mostly has served an apprenticeship)
D - Semiskilled and unskilled working class (entirely manual workers)
E - Persons at the lowest level of subsistence (old age pensioners, widows, casual workers, those dependent on social security schemes)

Figure 22. Market segments based on demographic measures (McDonald & Dunbar, 1995)

3.3.6. User orientation map: the proposed method for representing and communicating user diversity

A user orientation map is a method for representing the user diversity in a target population based on users' different orientations towards a desired behavior and their personality traits, and it is intended to be used by designers interested in promoting behavioral change. It aims at providing three different information types corresponding to designers' expected outcomes from user research. According to Töre Yargın's (2013) model of effective communication of user research findings, designers want inspirational information that facilitates creative idea generation and that helps them empathize with their users. They also need guidance in the form of suggestions and possible directions that a design team can follow during the process (or to initiate the design process), especially when the design brief is not sufficient to describe the design task. Furthermore, they would like to have information that helps them justify their decisions, when they are communicating them to other stakeholders or when they are making judgements internally during the process.

Considering these expected outcomes, a user orientation map describes each user orientation and user personality with a quotation, such as 'I am ready to drive environmentally friendly' or 'I am willing to drive environmentally friendly, but my friends would make fun of me', so that designers can have an empathy with their users and gain inspiration for idea generation. Furthermore, it shows their distribution in the entire population and their relationship to each other, e.g. users who are ready to adopt environmentally friendly driving form the most populated user orientation which also includes extravert, agreeable, introvert, neurotic and unconscientious users. As this information relies on actual user data, it can be used as

a justification of design decisions, for instance, for selecting the most common user orientation. Lastly, it includes some design recommendations[8] tailored to each user orientation and personality to provide more guidance on selecting the appropriate behavior change strategy.

We can compare a user orientation map with other user representation methods in terms of different dimensions. The first dimension would be the purpose. Other representation methods reviewed here usually aim at helping designers design products and services usable and desirable for their target users, whereas a user orientation map aims at helping them make these products and services persuasive for their target users, e.g. how they encourage eco-friendly driving for different users.

The second dimension would be the representation style. The representation methods discussed here are descriptive in nature, they describe target users based on various user characteristics such as preferences, goals, behaviors, demographics etc. Similarly, a user orientation map is descriptive; as it presents user groups clustered according to direct determinants of behavior and personality traits, it describes different user orientations and user personalities based on these variables. But a user orientation map is also relational; besides describing these personalities and orientations, it also shows the relation between them, i.e. what type of user personalities are present in a user orientation and vice versa. Furthermore, a user orientation map is directive; it provides design recommendations tailored to different user groups with the intention of providing directions for designers.

The third dimension would be the number of users depicted in a single representation. A persona is a representation of a single user. Although mental models, user profiles, user roles and market segments are used to represent different type of user groups unlike personas, each representation also includes one single user group at a time. A user orientation map, however, differs from them as it puts a special emphasis on diversity, it shows the range of user groups with different sets of behavioral factors in relation to a desired behavior in a single representation.

[8] These recommendations were achieved by using a decision tree (see Appendix E) constructed based on behavior change strategies from the literature and constructs of TPB including intention, attitude towards behavior, subjective norm (perceived social support) and perceived behavioral control.

The fourth dimension would be the level of detailed information given to designers. The methods reviewed here describe users with varying degree of detail. For instance, personas, mental models and user profiles provide thick descriptions of users, whereas user roles and market segments give very little information about them. As it emphasizes the breadth over depth, a user orientation map is in place between these two poles; it gives brief information about different user groups having a varying degrees of appearance in a target population (Table 9).

Table 9. Comparing user orientation map with other user representation methods

Method	Purpose	Representation style	Number of users represented	Level of detail
User orientation map	Descriptive Relational Directive	Make it persuasive	Multiple	Medium
Persona	Descriptive	Make it usable and desirable	Single	High
Mental model	Descriptive	Make it usable and desirable	Single	High
User profile	Descriptive	Make it usable	Single	Various
User role	Descriptive	Make it usable	Single	Low
Market segment	Descriptive	Make it desirable	Single	Low

3.3.7. User orientations and user personalities for eco-friendly driving

After comparing the proposed method with others, Figure 23 illustrates a user orientation map for eco-friendly driving which shows the five different user orientations and the four user personalities identified in the case study along with recommendations for strategy selection.

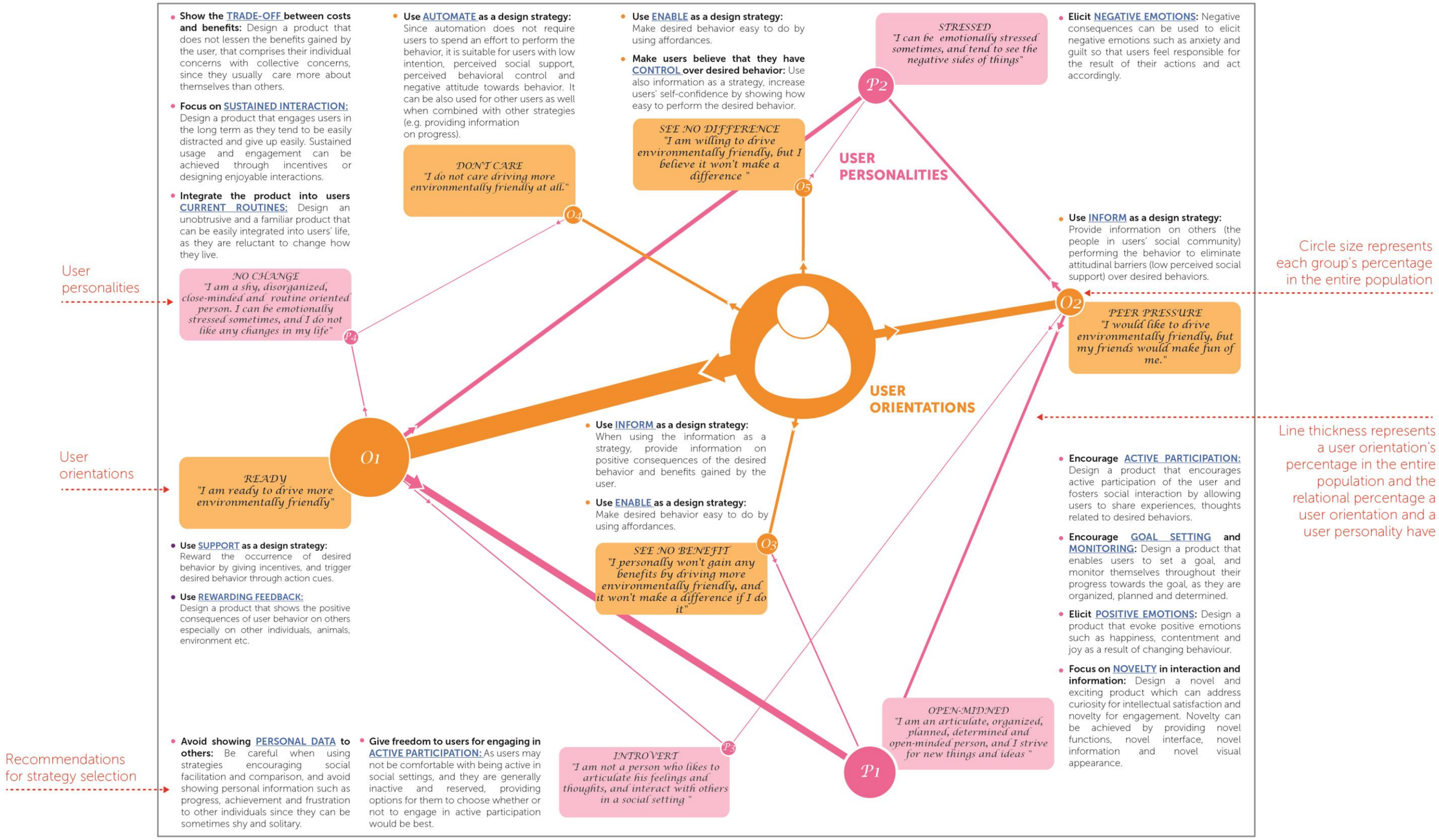


Figure 23. User orientation map for eco-friendly driving

According to this map, the first orientation (*ready*) included users with high levels of environmental concern, intention, perceived behavioral control and social support, and positive attitude. Given their willingness to drive in a more environmentally friendly manner, it is recommended to use behavioral change strategies that reminded them to perform the behavior through triggers (e.g. warning of excessive fuel consumption with a light on the dashboard) or supporting their continued use of the strategies through incentives (e.g. showing them the amount of money and fuel saved in a week after adopting eco-friendly driving strategies).

The second orientation (*peer pressure*) included users with high levels of environmental concern, intention, perceived behavioral control and positive attitudes, but low levels of perceived social support. They are willing to drive in a more environmentally friendly manner, but they believe that others do not approve of this. It is advised to use a strategy in which they are informed about others engaging in the desired behavior (e.g. an application comparing one's fuel consumption with his or her friends).

The third orientation (*see no benefit*) included users with high levels of environmental concern, intention and perceived social support, but a negative attitude and a low level of perceived behavioral control. They do not believe that their adaptation of eco-friendly driving would make a big difference, and think that there is little to gain in doing so. It is recommended to use strategies informing them about the positive consequences of a change in their behavior for them and also for the environment (e.g. a dashboard display showing the potential fuel savings and reduction in carbon emissions to be made by driving in an environmentally friendly manner), and combining them with strategies to increase their perceived control over behavior by making it easier to do (e.g. an eco-button that regulates acceleration, braking and following distance to save energy when pressed by the user).

The fourth orientation (*see no difference*) included users with high levels of environmental concern, intention and perceived social support and positive attitudes, but low levels of perceived behavioral control. As they want to drive in an environmentally friendly manner, but lack the confidence to do so, it is advised to use strategies increasing their self-confidence (e.g. an application simulating the savings achieved by one's driving environmental friendly and its contribution to the

overall sustainability attempts, saying that the driver can make a big difference by changing his or her behavior).

The fifth orientation (*don't care*) included users with low levels of environmental concern, intention, perceived behavioral control and perceived social support, and negative attitude. As they care little about driving in an environmentally friendly manner, it is advised to use strategies that automate behavior change (e.g. a device to turn off the engine after a certain amount of stationary time, or a mechanism to control the amount of pressure that can be applied to the accelerator).

As these orientations were further grouped into four user personalities, additional recommendations were made by considering the characteristics associated to five personality traits; extraversion, conscientiousness, agreeableness, neuroticism and openness to change.

The first user personality (*open-minded*) included users who are extravert, agreeable, conscientious, emotionally stable and open to change. As they are articulate, organized, planned, determined, open-minded people that strive for new things and ideas, it is advised to use strategies that allow them to set their own goals and monitor themselves throughout the process towards achieving their goal. It is also recommended to design a product to encourage social participation (e.g. an application allowing drivers set a goal for fuel conservation, giving feedback on their progress, enabling them to become a member of a social community of eco-friendly drivers with whom they can share their savings, experiences and thoughts).

The second personality (*stressed*) type included users who are extravert, agreeable, conscientious, open to change and neurotic. As they can be emotionally stressed sometimes and may see the negative sides of things, it is advised to use strategies that show them the negative consequences of their actions so as to elicit such negative emotions as guilt, stress and anxiety, which will make them feel responsible and act accordingly (e.g. a display providing feedback on the disappearance of polar bears as a result of excessive fuel consumption and carbon emissions).

The third personality (*introvert*) included users who are introvert, agreeable, conscientious, open to change and emotionally stable. As they do not like to articulate their thoughts or feelings, or interact with others in a social settings, it is advised to avoid strategies that require their active participation or the sharing of

their personal information,, such as their driving performance (e.g. an application that sends personal feedback on fuel consumption directly to the users' mobile phones instead of showing it on the dashboard or sharing this information with others).

The fourth personality (*no change*) included users who are introvert, disagreeable, unconscientious and neurotic, and those who are not open to change. As they are shy, disorganized, not determined, close-minded and routine-oriented people who may sometimes be emotionally stressed and do not take well to changes in their life, it is advised to design a product that can be integrated into their life without changing their routine (e.g. a regenerative braking system that conserves energy during braking, without changing driver behavior). Alternatively, it is also advised to use strategies that engage them in the long term through incentives or playful interactions (e.g. awarding a virtual badge after a user achieves a desired amount of fuel savings).

3.4.Summary

This chapter aimed at providing a systematic method for exploring user diversity for promoting sustainable behaviors and communicating it to designers. It illustrated this method with a case study on eco-friendly driving. It explained the process of creating user groups based on the data collected from 200 car drivers, and it presented five user orientations and four user personalities derived from the case study. The discussion on the proposed method can be found in Chapter 5. The next chapter focuses on evaluating the impact and the value of a design tool including user orientations and behavior change strategies on behavior change through an idea generation study.

CHAPTER 4

PROMOTING ECO-FRIENDLY DRIVING THROUGH DESIGN: AN IDEA GENERATION STUDY

As mentioned in the introductory chapter, a design tool was proposed in the scope of this thesis with the intention of guiding designers through the exploration of different design solutions that motivate sustainable behaviors. This tool consists of user orientations identified in the user study (Chapter 3) and a set of behavior change strategies achieved through synthesizing strategies from the design literature in this area.

This chapter presents the results of an idea generation study assessing the potential impact of this tool on designing for sustainable behaviors. To assess the tool's impact on idea generation, four workshops were conducted with design students from CMU and METU. In these workshops, the students were expected to work in teams to develop ideas related to eco-friendly driving, solutions helping people to drive in more sustainable ways. During each workshop, the students were divided into three teams (three groups of two and three groups of three from each university) to better understand the impact of user orientations and strategies on students' idea generation both individually and collectively. One team had only a design brief, one team had a design brief and the strategies, and one team had the brief, strategies, and user orientations.

This study investigates the tool's impact on idea generation by looking at the ideas students generated during the workshops, the design process they followed to produce these ideas and their satisfaction with the tool. For the generation of ideas, it explores how the tool influenced the range of strategies considered during ideation, and how it impacted the range of user groups selected as the focus for new concepts.

For the execution of the design process, it explores how the students utilized the tool during the design process. For the satisfaction with the tool, it explores to what extent students found the tool useful, easy to use and inspirational (Figure 24).

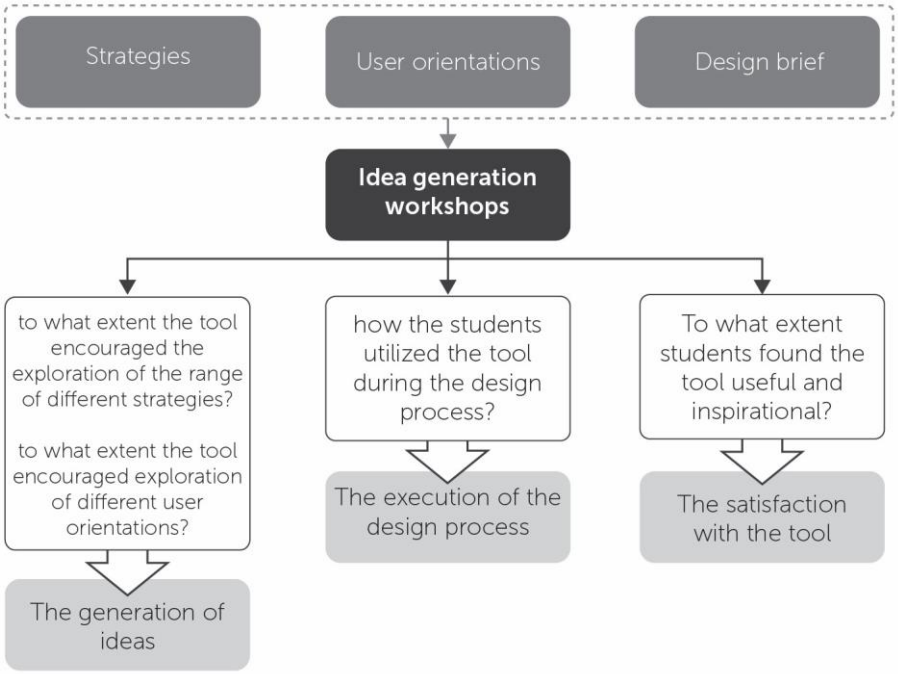


Figure 24. The structure of the idea generation study

Collectively, the workshops showed that the tool helped students explore a range of strategies during idea generation as well as it increased the number of ideas generated. The teams having the strategies generated more ideas with increased variety. The tool served as an inspirational source to initiate ideation, as well as a categorization scheme to cluster generated ideas and find overlooked clusters, which leaded to exploration of different strategies.

It also helped students consider different user orientations and encouraged them to generate ideas for these orientations. It motivated them to consider different users at the early phases of idea generation. The teams did not receive orientations tried to find a suitable target user after generating an idea, whereas the teams having the orientations selected a suitable orientation and tried to generate an idea for it. Another impact that user orientations had is that they served as a criterion for evaluating ideas, assessing the suitability of an idea for a specific user orientation.

Both strategies and user orientations contributed to a shared understanding between team members which facilitates communication and discussion. Students found the tool inspirational, easy to use, and useful but they indicated their concerns about the difficulty in integrating user orientations into their design process.

4.1. The proposed design tool for promoting sustainable behaviors

4.1.1. Behavior change strategies and strategy cards

The design tool proposed in this thesis includes a new classification of behavior change strategies for promoting sustainable behaviors inspired from the strategies in the literature. Its purpose is to encourage designers explore different possibilities for behavior change by showing them the range of strategies they can use to influence user behavior. The review in Chapter 2 showed that most common strategies used in previous work in this field are providing feedback on user behavior (feedback on current behavior, feedback on others' behavior, and feedback on future behavior), rewards, informing about environmental problems, facilitating sustainable behaviors through social networks, behavior steering and intelligent products.

Being inspired from these strategies, four distinctive strategy types were identified and a new terminology was proposed. Providing feedback on user behavior, informing about environmental problems and facilitating sustainable behaviors through social networks were identified as techniques than can be grouped under a broader strategy category called as *inform*. Behavior steering was rephrased as *enable/disable*, and two techniques were identified in this strategy category as making a desired behavior easier through affordances and making a desired behavior harder through constraints. Reward was identified as a technique that can be grouped under a broader strategy called *support*. Another technique was proposed for this category as reminding the occurrence of a behavior through visual, textual or audial behavioral cues. Intelligent products was identified as a technique that can be grouped under a broader strategy called *automate*. Another technique was proposed for this category as making a default setting the most environmentally friendly.

To characterize these strategies in terms of how they influence user behavior, earlier work on this topic was investigated. Steg and Vlek (2009) and Tang and Bhamra (2012) categorized behavior change strategies according to the factors they target.

Steg and Vlek (2009) divided behavior change strategies into two broad categories as *informational strategies* and *structural strategies*. Informational strategies usually target attitudinal factors (e.g. knowledge, perceptions, beliefs and norms) without changing the external context, while situational strategies target contextual factors (e.g. availability and costs and benefits of behavioral alternatives). Tang and Bhamra (2012) grouped the strategies into three categories. The first group *informs* behavior change by targeting attitudinal factors, the second one *maintains* the change by targeting habitual factors, and the third one *ensures* behavior change by targeting contextual factors.

Aside from using targeted factors, Geller (2002) identified three different approaches for changing behavior varying in terms of their purpose. *Instructional approach* is typically used to start a new desired behavior or move an undesired behavior from habitual stage to self-directed stage through providing information. *Supportive approach* is used to make a desired behavior habitual with incentives and rewards. *Motivational approach* is used to make a behavior desirable through external motivation or pressure for the people who are consciously incompetent about performing it. Inspiring from this previous work, the strategies were classified according to their purpose, objective, actions taken to fulfill their purpose and factors they target when influencing user behavior (Figure 25).

According to this classification, *inform*, *enable/disable* and *support* aim to reduce environmental impact by changing user behaviors, whereas *automate* aims to reduce this impact with advance product design without changing user behavior. *Inform* and *enable/disable* are used to break a bad habit or start a new behavior, *support* is used to make a desired behavior habitual, and finally *automate* is used to eliminate a behavior. A product using *inform* as a strategy increases users' awareness, a product using *enable/disable* directs users towards a desired behavior by showing action possibilities, a product using *support* reminds and rewards the performance of a desired behavior, and a product using *automate* acts and decides on behalf of users to reach a desired state. As for the factors these strategies target, *inform* targets attitudinal factors like attitudes, beliefs, norms, *automate* targets contextual factors like physical difficulty of actions and technological capabilities and constraints, *enable/disable* and *support* target both attitudinal and contextual factors.

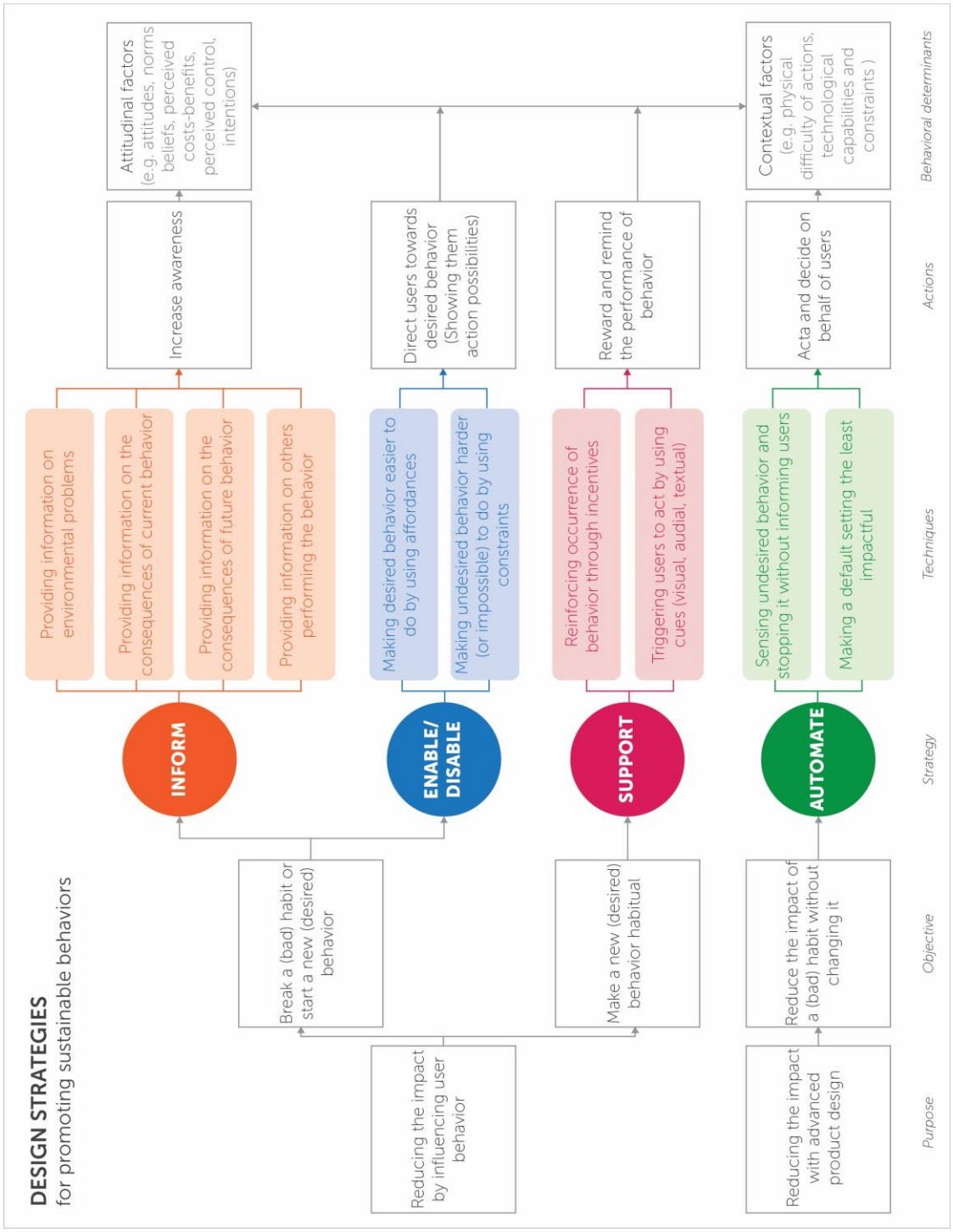


Figure 25. The proposed classification of strategies for promoting sustainable behaviors

This classification provides an abstract summary of different behavior change strategies, explaining how they can influence user behavior. Providing examples for each technique will probably make them more concrete and clear for designers. Thus, strategy cards showing an exemplar product for each technique were prepared as an addition to this classification (Figure 26-27).

Figure 26. Strategy cards for promoting sustainable behaviors

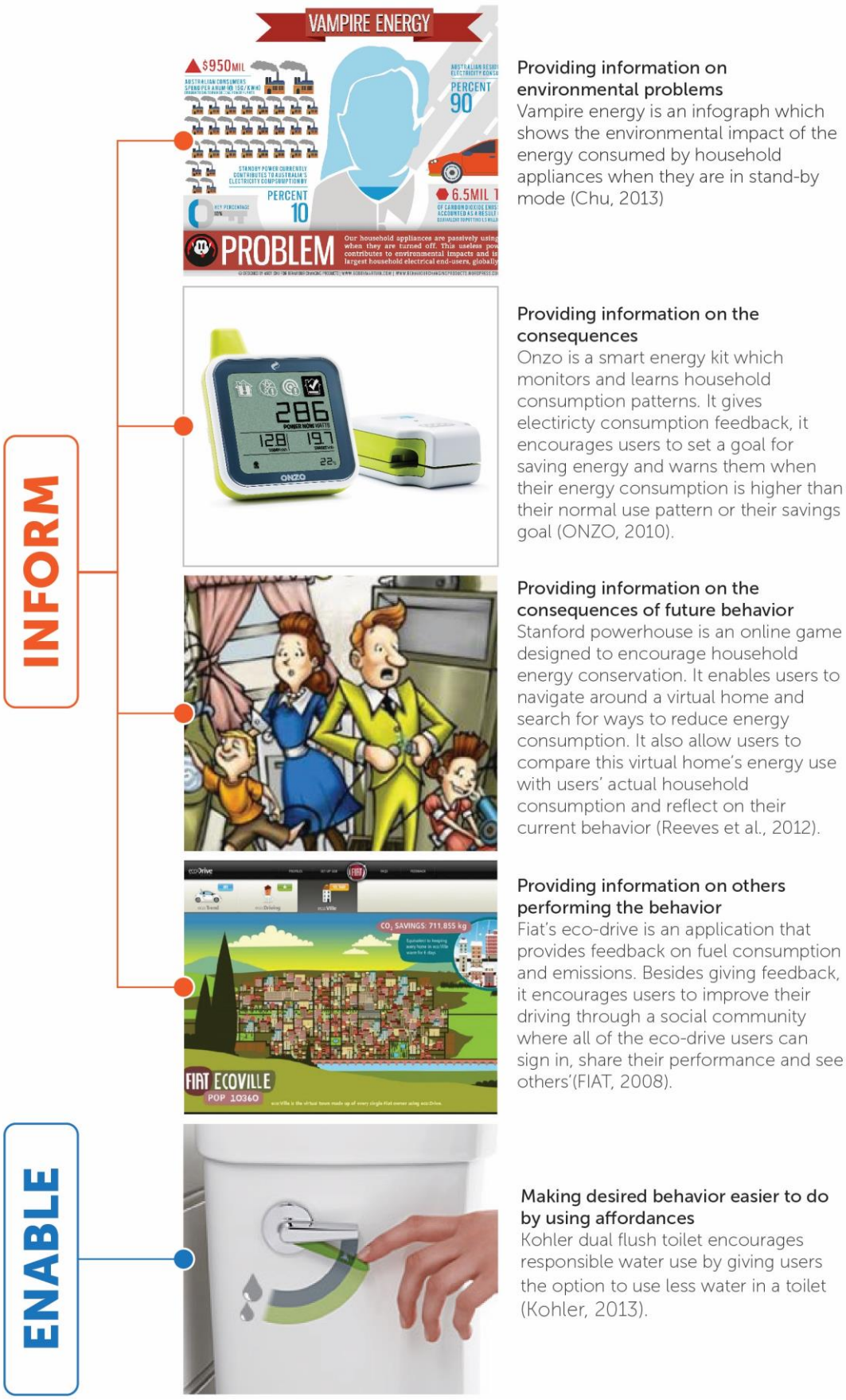
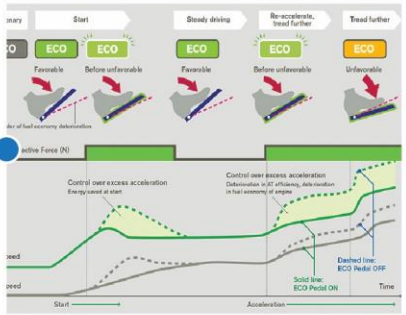


Figure 27. Product examples for strategies

DISABLE



Making undesired behavior harder to do by using constraints
Nissan eco-pedal is an assistive technology that helps drivers improve their fuel efficiency. Each time drivers put excessive pressure on acceleration pedal, it counteracts this pressure with a push-back control mechanism. Thus, it encourages eco-friendly driving by constraining drivers' ability to accelerate rapidly (NISSAN, 2009).

SUPPORT

Reinforcing occurrence of behavior through incentives
Energy plant is an ambient display showing household energy consumption with a growing plant. While modest energy consumption contributes to a fast growing plant, excessive consumption causes the plant fade. It reinforces energy conservation by providing rewarding feedback, i.e. a healthy plant (Broms & Gustafsson, 2007).

Triggering users to act by using cues (visual, audial, textual)
Aware puzzle switch is an on/off light switch encouraging energy conservation by reminding people to turn off the lights with the help of a visual cue, i.e. humans natural desire for order. The switch is painted in two colors that creates a visual symmetry disturbed when it is on position. Users need to turn the switch off to achieve the symmetry again (Broms & Ehrnberger, 2007).

AUTOMATE

Sensing undesired behavior and stopping it without informing users
Nest is a smart thermostat that adapts itself to user's cooling and heating habits by using temperature changes previously made by users. Furthermore, it minimizes the energy consumption when users are not at home with the help of a motion sensor (NEST, 2011).

Making a default setting the least impactful
Axor organic water faucet has a low default flow rate (0.9 GPM) that helps users reduce their water consumption (HANSGROHE, 2013)

Figure 27. Product examples for strategies (continued)

4.1.2. User orientations

The second part of the tool includes the user orientations identified in the user study (Chapter 3). Their purpose is to inform designers about the diversity in users' orientations towards sustainable behaviors and to encourage them consider this diversity when generating solutions for promoting sustainable behaviors. They represent this diversity through different orientations grouped according to various behavioral factors including environmental concern, intention, attitude, subjective norm and perceived behavioral control in relation to sustainable behaviors, and personality traits.

The proposed method for representing user diversity is a map showing different user orientations and user personalities in a single illustration along with several recommendations for selecting appropriate behavior change strategies. Although the intent was using this map at the beginning of the study, the representation format was changed based on the result of a pilot idea generation workshop. This pilot study revealed that students found the map complex and hard to understand. One student said that "it was very difficult to understand what it is, when you have a time pressure'. Thus, the design recommendations and user personalities were removed from the representation, as the essential part was users' different orientations towards eco-friendly driving. Then, remaining five orientations were changed to user orientation cards to make it simpler and more usable for design students. Each card included a quotation and a name describing an orientation along with a histogram showing its ratio in the entire population compared to other orientations (Figure 28).

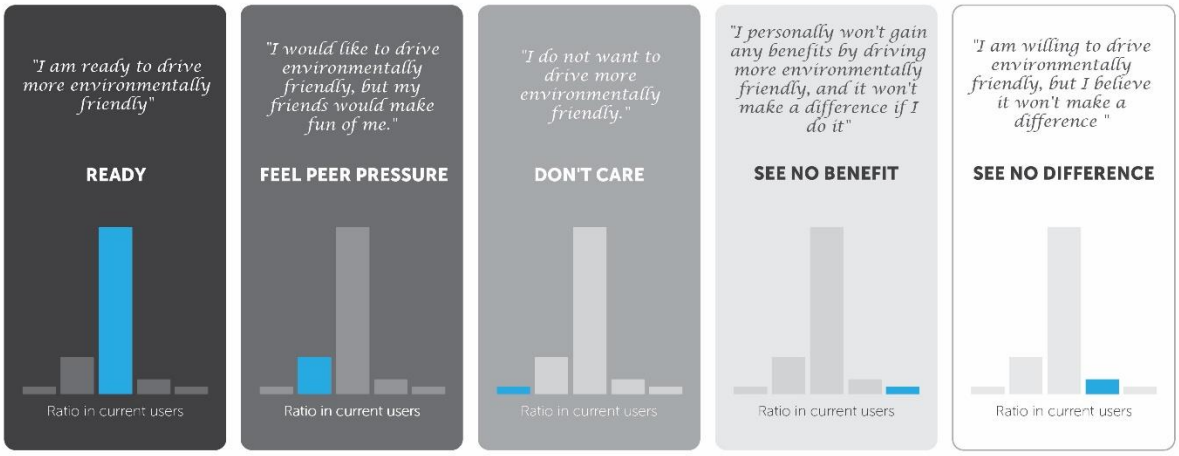


Figure 28. User orientation cards

The first user orientation represents people who are ready to drive more environmentally friendly; the biggest group. The second orientation represents the ones who would like to drive environmentally friendly but lacks social support from their peers; the second biggest group. The third orientation represents the ones who are willing to drive environmentally friendly but thinks that doing so will not make a big difference. The fourth orientation represents the ones do not see a personal benefit by driving more environmentally friendly. The last orientation represents the ones who do not care driving environmentally friendly and do not want to change their behavior.

4.2. Idea generation study: investigating the tool's impact

To evaluate how the proposed tool guide designers through the idea generation for behavior change, four design workshops were conducted. The first two were run at CMU on March 14th and 28th in 2015, the other two were run at METU on April 24th and 25th in 2015. Each session was moderated by the researcher. He was present at CMU workshops, however he moderated the workshops in METU through Skype with the help of two research assistant from METU Department of Industrial Design. In the workshops, students were provided with a design brief, a product example sheet including several product examples designed to change user behavior and the proposed design tool to facilitate ideation consisted of the new classification of behavior change strategies, strategy cards and user orientations. They were asked to generate behavior change ideas for promoting eco-friendly driving.

4.2.1. Participants

15 CMU students and 15 METU students participated in the workshops. The students participated in the study were either undergraduate or graduate level. Participants from METU were industrial design students enrolled at Department of Industrial Design. The sample drawn from CMU was more diverse, it consisted of design students from the Design School and HCI students from HCI Institute who took design related courses previously. Students were chosen as a sample due to practical reasons, it was more practical to reach them than professional car designers.

Although the participants were not professional designers and the workshops created were only a simulation of a real design task, the results would be good enough to understand the potential impact of the tool on idea generation.

4.2.2. Workshop setting

The workshops were conducted in a studio class, a familiar work environment for the students. The students were randomly divided into three groups depending on the number of attendees. Six students (three groups of two) participated in the first workshop session in each school, nine students (three groups of three) participated in the second workshops. The groups were distributed in the class in order to minimize the interaction between them. They were provided with post-it notes, markers, white boards and sketch papers to facilitate their ideation and discussion. The sessions were videotaped to understand how students interact with the materials provided (Figure 29).

Figure 29. A snapshot from a workshop session

4.2.3. Workshop materials

During the workshops, each group was provided with different materials. The purpose was to understand the impact of strategies and user orientations on idea

generation both individually and collectively. Table below summarized the materials given to each group.

Table 10. Workshop materials allocated to each group

	Group 1 (Control)	Group 2 (Strategy)	Group 3 (Orientation)
Design brief	X	X	X
Product example sheet	X	X	X
Classification of strategies and strategy cards		X	X
User orientations			X

A design brief summarizing the design problem, design task, target behaviors, target users, deliverables and workshop procedure were given to all three groups in a workshop session (See Appendix F for the design brief). The design task was ‘redesigning a car’s behavior and its interaction with the user with the intention of promoting eco-friendly driving’. Two separate briefs with minor changes were prepared for two schools. CMU students were asked to redesign the Ford Escape (one of the most common cars in USA), whereas METU students were asked to redesign the Fiat Linea (one of the most common cars in Turkey). As these two car models are very common, target user group included variety of users who can be individuals and families belonging to different socio-economic groups (middle, low middle), different age groups (young, middle aged and elderly), and different genders (male and female). Target behaviors need to be discouraged were long idling times, instant break, excessive use of AC, excessive load in the car, spending time to find a parking spot, and target behaviors need to be encouraged were gentle acceleration, regular maintenance and maintaining safe following distance to avoid instant break (EPA, 2014).

The students also received a product example sheet including several product examples designed to encourage sustainable behaviors. The purpose was to inspire students and also to familiarize them with the concept of behavior change (See Appendix G). Two groups were provided with the classification of behavior change strategies and strategy cards. One group was provided with five user orientations.

4.2.4. Workshop procedure

Each workshop session consisted of four phases (Figure 30). First, a short introduction was made by the researcher at the beginning of each session explaining the design brief, the workshop procedures and the concept of design for behavior change for sustainability. Second, students started generating ideas as a response to the brief by using post-it notes and sketches. This phase took 45 minutes. Third, they chose three promising ideas based on their discussion on previously generated ideas and refined them. In this phase, they were provided with a power point presentation template (See Appendix H) and asked to explain each solution in terms of their target user(s), target behavior(s) and the ways to influence these behavior(s). This phase also took 45 minutes. Fourth, each group presented their three ideas to other participants. This phase took 30 minutes. At the end of each session, a questionnaire was given to students in order to gain their insights on to what extent they found the tools useful and inspirational (See Appendix I for the questionnaire and J for the consent form for the idea generation study).

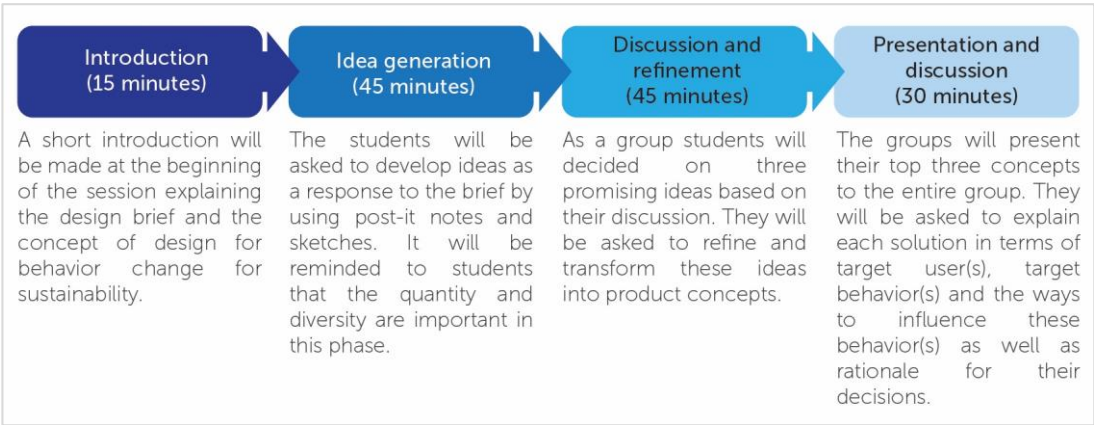


Figure 30. Workshop procedure

4.2.5. Data analysis

To understand the tool's impact on the generation of ideas, the ideas were analyzed according to target behaviors, strategies and user orientations. The purpose was to see how different groups explored the range of behaviors, strategies and user orientations during the process. For categorizing them according to behaviors, the target behaviors in the design brief were used. Two additional behaviors were found

outside the brief, i.e. modes of transportation and purchase of the car. For categorizing the ideas according to strategies, the strategies in the classification (inform, enable/disable, support and automate) were used. A fifth group of strategies (i.e. product performance) were created for the ideas focusing on improving the car's or its components' efficiency to reduce environmental impact because such ideas focus on modifying the product rather than changing user behavior. For categorizing the ideas according to user orientations, five orientations given to the groups were used. As only four groups received these orientations, this analysis included the ideas generated by these groups.

To understand the tool's impact on the execution of the design process, the video footage was transcribed into text for coding. The units of analysis were sentences representing students' discussions and their activities. As there was no pre-determined coding scheme used for the analysis, the coding was done iteratively. Each line of text was analyzed, and all student activities were listed. Later, these activities were refined and grouped into bigger categories, i.e. different phases of the design process including familiarization, generation, clustering, evaluation, refinement and visualization. Then, these activities were coded based on how students' perform them, i.e. whether they used one of the tools provided to them or they used a different technique. After finalizing the coding scheme, the entire data set was coded one more time. Table 11-12 give an example for coding and show the scheme used to code students' activities.

Table 11. An example for coding

Transcript	Activity	Part of the design process	Use of the tool or a different strategy
When you get in the car it is like a switch that you can select either long distance or short distance mode. It is likely the toilet (referring back to the examples in the strategy cards) like the big flush and small flush. Short distance less gas.	Sharing an idea	Idea generation	Strategy cards

Table 12. Coding scheme for students' activities

Phases of design process	Activities
Familiarization *The part students familiarize with the design task and the materials provided to them.*	**Reading the materials:** Reading through the materials to understand the problem, the design task, the strategies and user orientations **Problem framing**: Determining the approach to solve the problem (promoting sustainable behaviors)
Generation *The part students generate, share and comment on ideas in response to the design brief.*	**Looking for an inspiration:** Trying to find a starting point and inspiration for idea generation (e.g. design brief, behavior change strategies and user orientations) **Writing down an idea:** Writing down an idea, generating ideas individually **Sharing an idea:** Presenting a new idea to others, generating ideas as a group
Clustering *The part students categorized generated ideas based on a categorization scheme*	**Finding overlooked clusters:** Trying to find overlooked clusters so that students can explore more options **Putting an idea to a cluster:** After generating an idea, clustering it based on a categorization scheme (e.g. target behaviors or behavior change strategies) **Changing the cluster of an idea:** Changing the cluster of an idea based on a group discussion
Evaluation *The part students evaluate and eliminate ideas to select top three ideas*	**Commenting on an idea (agreement):** Agreeing on the potential of an idea for solving the problem **Commenting on idea (criticism):** Criticizing an idea shared by another student based on its feasibility and suitability **Deciding on promising ideas:** Based on evaluations deciding on the three ideas to refine
Refinement *The part students try to improve and detail a selected idea*	**Commenting on an idea (detailing):** Improving an idea by further thinking about the functions, users, usage scenario and technological feasibility **Commenting on an idea (modification):** Modifying an idea based on criticism done in previous stage
Visualization *The part students visualize the selected ideas and prepare the final presentation*	**Referring to the materials:** Referring to the brief, behavior change strategies and user orientations when preparing the final presentation
Miscellaneous	**Direction the process:** Planning the next step needs to be taken and directing other team members towards it

Lastly, the questionnaire data was analyzed by calculating mean values for each item and creating a bar chart to better compare the students' insights on and their satisfaction with the brief, strategies and user orientations.

4.3. The tool's impact on generated ideas

During the workshops, students generated 165 ideas[9], and refined 36 of them to product concepts (For the complete list of ideas and refined concepts see Appendix K). Comparing the number of ideas across groups revealed that the control group generated the lowest number of ideas. For the CMU students, strategy group generated more ideas than orientation group, while for the METU students the reverse was observed (Figure 31).

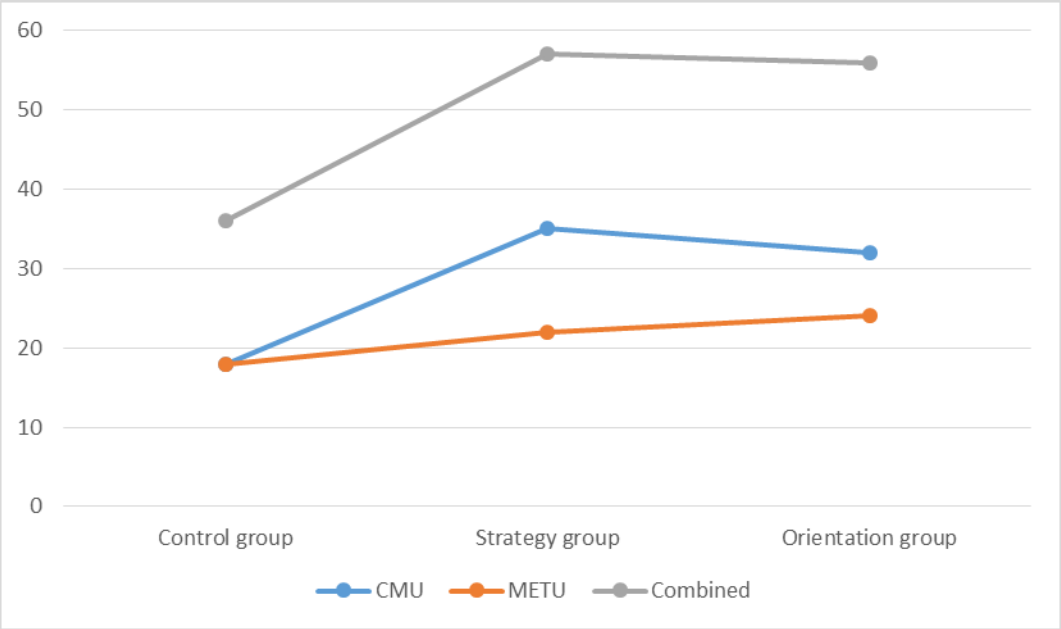


Figure 31. The number of ideas generated across groups

Although this figure shows that the tool increased the number of ideas generated, it is also important to investigate the variety of the ideas to better understand how the tool impacted the exploration of different solutions. In this respect, the remainder of this section discusses the ideas in terms of target behaviors, behavior change strategies and user orientations.

[9] Note that not all of the ideas are different from each other, some groups came up with similar ideas. When analyzing target behaviors, strategies and orientations, even though different teams came up with the same ideas, they were considered as separate ideas.

4.3.1. Target behaviors

149 ideas targeted the behaviors in the brief and 16 targeted behaviors outside the brief. The most popular target behavior was eco-friendly driving in general. Instead of targeting each behavior individually, students commonly thought of solutions combining different behaviors such as avoiding fast acceleration, instant break, and short following distance. The second most preferred behavior was excessive use of air-conditioning, it is followed by fast acceleration, idling and spending too much time to find a parking spot. Regular maintenance, safe following distance, instant break and excessive load were the least preferred ones. In addition to the behaviors given in the brief, students targeted the choice of transportation medium (e.g. encouraging carpool, public transportation, biking etc.) and purchase of the car (e.g. making environmentally friendly cards prestigious). Looking at the refined concepts students delivered, a similar order was observed except excessive use of air-conditioning; only one team targeted this behavior (Figure 32).

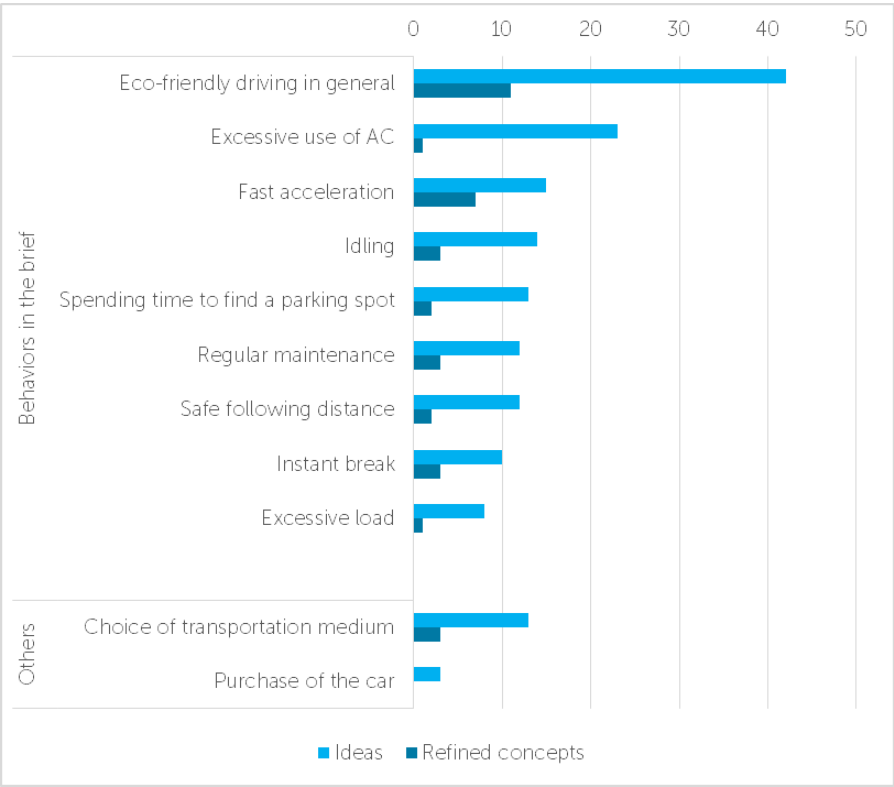


Figure 32. The distribution of target behaviors

Analyzing the target behaviors across the groups, it was observed that the strategy group explored a wider range of target behaviors compared to others. Control group were the ones that covers the least amount of variety in terms of target behaviors (Table 13).

Table 13. The distribution of target behaviors across the groups

	Control group (C)				Strategy group (S)				Orientation group (O)				**Combined**		
	CMU		METU		CMU		METU		CMU		METU		**C**	**S**	**O**
Eco-friendly driving in general	2	0	3	1	7	7	2	2	5	7	6	0	6	18	18
Excessive use of AC	2	3	0	4	1	2	1	2	3	2	1	2	9	6	8
Fast acceleration	2	0	0	1	2	2	0	1	4	1	1	1	3	5	7
Idling	0	1	0	2	2	3	0	1	1	0	2	2	3	6	5
Spending time to find a parking spot	0	2	0	1	2	1	2	1	1	2	0	1	3	6	4
Regular maintenance	2	0	0	1	1	1	2	1	0	0	0	4	3	5	4
safe following distance	0	3	0	1	1	2	0	2	1	0	0	2	4	5	3
Instant break	0	1	0	1	0	0	2	0	2	2	0	2	2	2	6
Excessive load	0	0	0	3	1	0	1	2	0	1	0	0	3	4	1
Number of behaviors targeted	**4**	**5**	**1**	**9**	**8**	**7**	**6**	**8**	**7**	**6**	**4**	**7**	**9**	**9**	**9**

4.3.2. Behavior change strategies

As for the strategies, it appears that most of the ideas included inform as a strategy, followed by enable/disable, support and automate. This indicates a similar results found in the literature review, design researchers commonly used informational strategies. Students also used a strategy outside the strategy framework, i.e. product performance, which is related with improving the efficiency and performance of the car or its components to reduce its environmental impact. A similar pattern was observed for product concepts with one exception; while students used the strategies individually during idea generation, they combined different strategies along with using them individually when they are asked to choose three promising ideas and

refined them. Preferred combinations were inform and support and inform and enable/disable. (Figure 33).

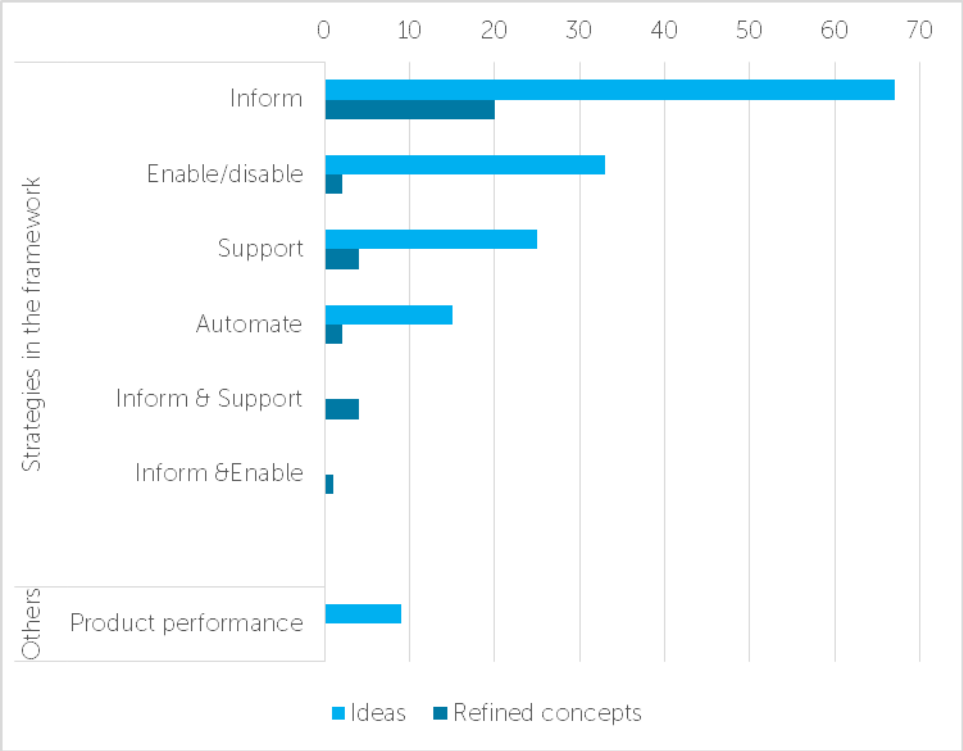


Figure 33. The distribution of behavior change strategies[10]

Analyzing the strategies across the groups revealed that inform was still the biggest category for each group, followed by enable/disable, support, automate and product performance. However, product performance was the least preferred strategy for the strategy group and orientation group, control group preferred product performance as often as support and automate. The classification of behavior change strategies seemed to be increasing the variety of strategies used during idea generation. The strategy group had the widest coverage of different strategies, whereas the control group has the narrowest coverage. Interestingly, when students were introduced with user orientations, they more focused on the strategies in the classification, not generating solutions focusing on product performance. By looking at these distribution, it can be said that the classification encouraged students to explore

[10] Note that, the ideas do not include the ones targeting behaviors outside the brief, i.e. modes of transportation and purchase of the car.

strategies other than inform (enable/disable, support and automate) without preventing them from trying different strategies outside the classification as well (Table 14).

Table 14. The distribution of behavior change strategies across the groups[11]

	Control group(C)				Strategy group(S)				Orientation group(O)				Combined		
	CMU		METU		CMU		METU		CMU		METU		C	S	O
Inform	0.13	0.40	1.00	0.53	0.47	0.50	0.40	0.42	0.47	0.33	0.40	0.57	0.44	0.46	0.45
Enable	0.25	0.30	0.00	0.20	0.18	0.17	0.30	0.25	0.29	0.27	0.20	0.14	0.22	0.21	0.23
Support	0.25	0.00	0.00	0.13	0.24	0.17	0.20	0.08	0.12	0.20	0.40	0.14	0.11	0.18	0.20
Automate	0.00	0.20	0.00	0.13	0.12	0.06	0.00	0.17	0.12	0.13	0.00	0.14	0.11	0.09	0.11
Product performance	0.38	0.10	0.00	0.00	0.00	0.11	0.10	0.08	0.00	0.07	0.00	0.00	0.11	0.07	0.02
Number of different strategies	4	4	1	4	4	5	4	5	4	5	3	4	5	5	5

4.3.3. Behavior change strategies and target behaviors

Analyzing the ideas based on target behaviors and strategies together showed that students preferred different strategies for targeting different behaviors. When they targeted ecofriendly driving in general, they mostly preferred inform and support strategies; for instance informing users about driving patterns (e.g. fuel consumption, energy consumption, fuel savings, car's 'health' condition based on current driving patterns etc.) and rewarding drivers who improved their performance through virtual rewards (a growing tree and eco-score) and financial rewards (a free song from iTunes and donations to environmental charities).

For fast acceleration, idling, instant break and safe following distance, students mostly preferred enable/disable and inform. For instance, increased pedal resistance to discourage fast acceleration, disabling acceleration when the safe following distance is violated and when the car is approaching to a traffic light, exaggerating the engine sound when drivers boost the acceleration pedal, informing about safe

[11] As each team produced different amount of ideas, the number of ideas that a team generated for a strategy was turned into a percentage by dividing this value with the total number of ideas the team generated.

following distance (safe zone indicator), the desired speed based on traffic conditions, and a car's health based on breaking patterns.

For excessive use of air conditioning, they mostly preferred automate, product performance and enable/disable. For instance, a smart air-conditioning system which collects user data on their cooling and warming habits, improving the energy efficiency of air-conditioning and limiting the use of boost mode (warming and cooling gradually). For decreasing the time spent to find a parking spot, the students mostly preferred inform, for instance a GPS integrated parking system showing available parking lots nearby.

For regular maintenance, students preferred support strategies, for instance, integrating the maintenance shop with shopping mall, giving a theater ticket or a coupon for each visit. For excessive load, they preferred enable, support and inform. For instance, preventing engine from starting when it is heavily loaded, reminding the excessive load remained in the car luggage for a long time, and informing about the excessive load and consumption associated to this load (Table 15).

Table 15. Distribution of target behaviors across behavior change strategies[12]

	inform	enable	support	automate	Product performance
combination of different behaviors	4.90	0.05	2.52	0.28	0.00
Excessive use of AC	0.28	0.62	0.00	1.29	0.74
Fast acceleration	0.44	1.25	0.02	0.00	0.04
Idling	0.44	0.50	0.03	0.13	0.04
Spending time to find a parking spot	1.01	0.18	0.03	0.00	0.04
Regular maintenance	0.12	0.00	1.32	0.00	0.17
safe following distance	0.46	0.53	0.00	0.04	0.00
Instant break	0.33	0.20	0.00	0.04	0.05
Excessive load	0.12	0.21	0.12	0.00	0.00

4.3.4. User orientations

The control and strategy groups did not receive user orientations and they generated ideas with a single user group in mind, i.e. describing his or her behaviors, reasons of

[12] Because different number of ideas generated were generated for each behavior and strategy, the number of ideas generated for a strategy was turned into a percentage by dividing this value with the total number of ideas generated for that strategy. Same rule was applied for the target behaviors. Then, these two values were multiplied to create a normalized percentage.

these behaviors and ways to encourage them. Unlike them, orientation group considered different user orientations during idea generation and they tried to generate ideas for them. This difference makes comparing the variety in target users difficult for each group. Thus, this variety was only analyzed for the orientation group.

All of the teams in orientation group (4) picked ‘ready’ users as a primary user orientation for generating ideas. As they did this selection at the early stages of their ideation, the ideas they generated mostly targeted the ‘ready’ user orientation. Seven of the 12 refined concepts these teams submitted at the end of the workshops were specifically developed for ‘ready’ users. For other ideas, teams defined their target users based on their age (e.g. young drivers) and traveling habits (e.g. people who travel a lot) rather than using their orientations towards eco-friendly driving (See Appendix K).

Besides targeting the ‘ready’ users, three teams also tried to generate ideas for different user orientations, however these were very few. Other orientations chosen were ‘see no difference’ ‘don’t care’ and ‘peer pressure’. For the ‘see no difference’ orientation, one team proposed giving feedback on how much fuel and money can be saved by shifting one’s behavior, as they think that these people are not aware of the potential benefits of adopting eco-friendly driving. For the ‘don’t care’ group, another team proposed limiting the use of air-conditioning boost mode for gradual warming and cooling by making it harder to press, as they think that these users might prefer performance over energy conservation. For peer pressure group, although the idea was outside the scope of the brief, one team proposed making the car more masculine as they think that these people do not want to use environmentally friendly cars because using such cars are not perceived as cool as using a sports car in their social community.

4.4. The tool’s impact on the execution of the design process

The tool together with the design brief guided students throughout the design process in different ways. First, design brief, behavior change strategies and user orientations helped them initiate ideation. Design brief and strategies helped them proceed in the design process, e.g. clustering generated ideas based on target behaviors or strategies

and identifying overlooked clusters to continue ideation with unexplored areas. Third, user orientations helped them empathize with target users as well as they served as a justification of students' decisions, eliminating or selecting an idea for refinement based on its suitability for a particular user orientation. Fourth, strategies and user orientations contributed to unity in team communication, a shared understanding between team members.

The students went through a six phase process during the workshops: familiarization, generation, clustering, evaluation, refinement and visualization. All of the materials (except product example sheet) were used in idea generation phase, the design brief and strategies were used in clustering, and user orientations were also used during evaluation. None of the tools were used during refinement (Table 16).

Table 16. Students' interaction with tools during different phased of the process[13]

				Generation	Clustering	Evaluation	Refinement	
Design brief	CG	CG-1	Familiarization with the materials and the problem					Visualization
		CG-2						
		CG-3						
		CG-4						
	SG	SG-1						
		SG-2						
		SG-3						
		SG-4						
	OG	OG-1						
		OG-2						
		OG-3						
		OG-4						
Strategy framework and strategy cards	SG	SG-1						
		SG-2						
		SG-3						
		SG-4						
	OG	OG-1						
		OG-2						
		OG-3						
		OG-4						
User orientations	OG	OG-1						
		OG-2						
		OG-3						
		OG-4						

[13] As students only used the product example sheet during familiarization stage, it was not included in this table.

4.4.1. Familiarization and generation

In the familiarization phase, the students read through all the materials in order to familiarize with them and the problem. In generation phase, they started generating ideas by inspiring from the target behaviors in the brief, strategies in the classification and user orientations. The following participant comments illustrate how they used these materials in initiating ideation. As the comments from METU students (marked with a star) were in Turkish, they were translated into English by the researcher. The original versions of these comments can be found in Appendix L.

> Design brief - So there is these target behaviors they want us to encourage and discourage. We can think of solutions for each of them. (P19)*
>
> Strategies- May be we can cluster our ideas based on these strategies (the strategies in the classification). Even though I like this one (support) we can generate ideas for all of them. I start with automate (P4)
>
> User orientations - I think we can do more about that (user orientation peer pressure). It is pretty big. Think about it if we can make it desirable for these people (user orientation see no benefit, peer pressure) the other group (user orientation ready) they are already there. (P2)

Besides using these materials, they were also inspired from other examples they are familiar with, e.g. adapting the Dance Dance Revolution (DDRgame, 2014) to eco-friendly driving. Another technique they used to initiate ideation was scenarios. When they are inspiring from target behaviors in the brief, they commonly imagined a scenario including the target behaviors and target users to identify the reasons of undesired behaviors, and to find opportunities for potential solutions. For instance, one participant stated that “so we have a car, we have a parking slot. There is this whole floor so he is circling around the floor to find a space. Someone just moves out and he has the spot. So how we can decrease this time that this guy spend” (P11).

During idea generation, students’ approach to target users were different across groups. Teams in control and strategy group commonly tried to find a suitable target user for an idea after generating it, rather than trying to generate an idea for a target user. Different from these groups, three teams in orientation group tried to find ideas for different user orientations. However, unlike behaviors and strategies, the diversity in ideas developed for different user orientations were low. Students mostly considered the ‘ready’ user orientation as their primary target user for idea generation because it was the highest among others, as they stated. In addition to ‘ready’ orientation, one team generated and idea for ‘peer pressure’ orientation

stating that it was the second biggest group in the population, one group generated an idea for ‘see no difference’ orientation and one group for ‘don’t care’ orientation stating that a product encouraging them is more likely to encourage other orientations.

4.4.2. Clustering

Once students had several ideas, they started clustering them by using target behaviors in the brief and the strategies in the classification. Four groups used both the strategies and target behaviors, and seven groups either used the former and the latter. None of the groups used user orientations for clustering. One group also created their own categorization scheme (physical solutions versus digital solutions).

Clustering ideas also helped students find the overlooked clusters and explore more solutions, trying to find an idea for a strategy or a target behavior not addressed previously. The following comments are examples of how the students clustered the ideas according to strategies and target behaviors, and how they used this clustering to discover overlooked areas.

> Clustering with strategies- Hmm, calibrating the temperature, and automatically adjust it based on outside temperature. This one is automate then. (P1)
>
> Finding overlooked clusters with strategies- So we cluster these ideas and see any part that we did not focus on (referring to the strategies in the classification) (P1). We did not think much about support (P5)
>
> Clustering with target behaviors- So it seems like we have very clear ideas on idling less, and we have ideas on driving efficiently or driving less. May be these are three ideas, or at least they are three problem areas we can work in. (P6)
>
> Finding overlooked clusters with target behaviors- Let’s see, we do not have any for ‘fast acceleration’. May be we can focus on this next. (P24).*

4.4.3. Evaluation

After generating and clustering ideas, they started evaluating them based on feasibility and suitability. For feasibility, students thought about the technical feasibility (whether an idea is applicable into real life), feasibility in relation to sustainability (whether it can actually reduce the fuel consumption or not) and feasibility in relation to safety (whether it can create safety problems). Especially, they thought that ideas using disable and automate strategies forcing the performance of a certain behavior were found dangerous for emergency scenarios, e.g. what

happens if a driver needs to do instant break if we are giving away this freedom by disabling it.

For suitability, they thought an idea's suitability for the target users (whether they want it, whether they believe that the solution will not make their life harder, and less comfortable, or whether they comply with the strategy and change their behavior). To discuss the suitability, the control and strategy groups used the term 'majority of the people' to refer to target users and they defined them with existing behavior patterns, experience in driving, socio-economic status, age, income, driving style. Except one team which took into account users' environmental awareness, they did not consider users' individual characteristics related to eco-friendly driving like environmental concern and intention to adapt eco-friendly driving, which is an essential aspect of user orientations. The orientation group, however, used the orientations to discuss the suitability and feasibility of an idea for a specific user orientation, whether the idea encourages them to drive environmentally friendly or whether the idea is desirable for them. The following discussions illustrate how they used the orientations for evaluating and idea.

> P1: There is this incentive idea that, you do this the better you drive you level up, it is like a game. You can have a reward like cash back, free gas, free maintenance, gift card. It is a great incentive, but there are some issues like how the car do knows that you are the driver. P2: I think, it is good for these users (the student is pointing the orientation card ready). As they are willing to do it, they will put more effort in this. (OG-2)

> P4: What if the car color changes so that it become humiliating when you drive badly. Everyone targets to be white. P5: We are not helping the person who feels peer pressure than. He would like to own a cool car. P4: No we are getting him more humiliation. (OG-1)

4.4.4. Refinement and visualization

Based on their evaluations, each group selected three promising ideas and refined them. During refinement, they did not use any of the materials. They refined the ideas based on the three questions given to them which includes the target behavior, target users and techniques for influencing user behavior. In this phase, three of the teams in the orientation group who generated an idea for a specific orientation (ready orientation) used the same orientation for target users. But other teams tried to think of a receptive target group for their solutions. When they were elaborating on how the product promotes eco-friendly driving, they used the same criteria they discussed when evaluating ideas, technical feasibility, safety issues, and suitability for the

users. In the last phase, they visualized three product concepts by using the template given to them. In visualization and refinement phases, students' interaction with the materials were minimum, they only referred to the materials when they were answering the questions in the template.

4.5. Students' evaluation of the tool

In addition to understanding the tool's impact on the generation of ideas and the execution of the design process, this study also aimed to know students' initial thoughts about the tool (Figure 34).

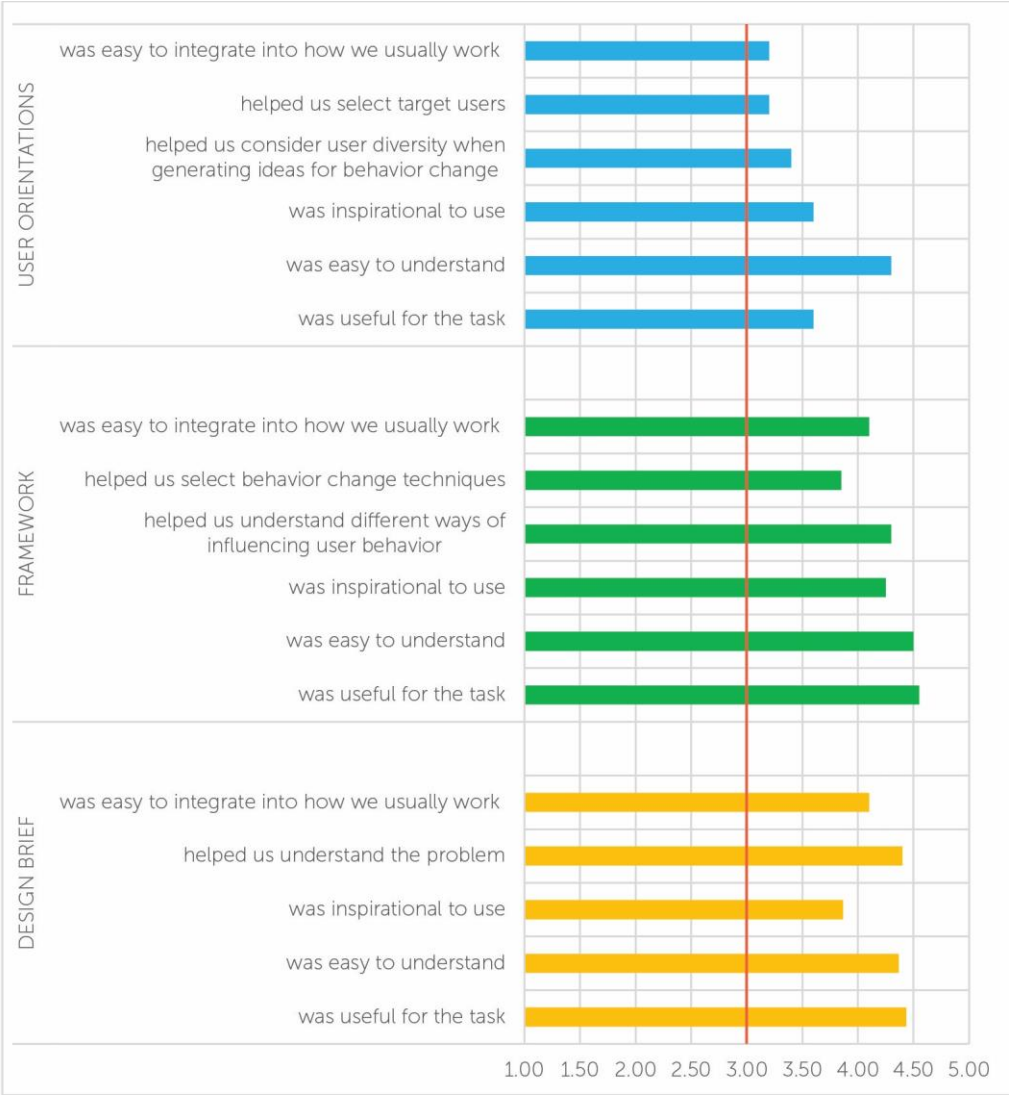


Figure 34. Students' evaluation of the tools

The questionnaire given to students for this purpose showed that students had very positive opinions about the classification of strategies and the design brief. They found these materials useful, inspirational, easy to understand and easy to integrate how they usually work. They also indicated that they contributed to a shared understanding between team members, facilitating their discussion. Several students indicated their enthusiasm about the classification and strategy cards, by saying that they want to use them in their future projects as well. However, some of them stated that the differences between some strategies were not clear to them, e.g. inform and support. During the workshop, they tried to solve this issue by discussing the exemplar products on the back side of the strategy cards. Furthermore, some students stated that they would like to see which specific behaviors consume more fuel in the brief. Compared with the classification and the design brief, students were less satisfied with user orientations. Even though they found them easy to understand, inspirational and useful, they had concerns about its integration into their idea generation.

4.6. Summary and discussion

This chapter presents the results of an idea generation workshop conducted to understand the impact of the design tool proposed in this thesis, consisting of the classification of behavior change strategies and user orientations. The results indicate that the tool has a great value to designers and design researchers interested in behavior change and sustainability. This value can be better understood by discussing the results of this study based on designers' expectations from a tool providing information to them during the design process. As described in the model of effective communication mentioned previously in Chapter 3 (Töre Yargın, 2013), these expectations are guidance, inspiration and justification (Figure 35).

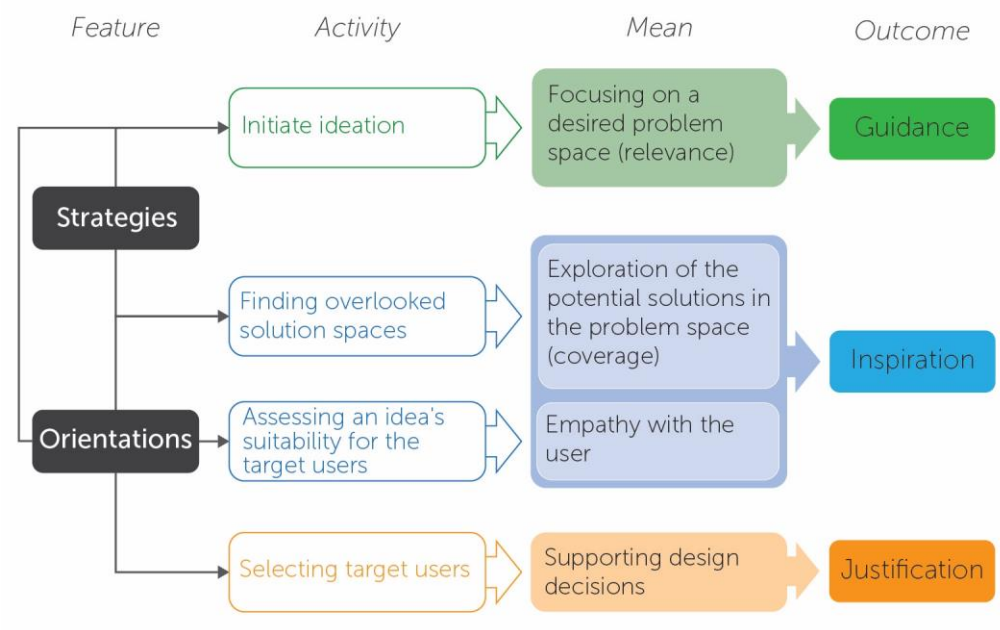


Figure 35. The tool's support to idea generation

The results showed that students found the tool useful in generating solutions that help people to drive environmentally friendly and that it guided them throughout this generation process. The tool provided this guidance by encouraging them to focus on a desired problem space. In order to address environmental sustainability, designers can explore three different problem areas; designing products with better environmental performance (e.g. fuel efficient cars, electric cars), motivating people to consume less (e.g. carpooling, public transportation) and changing people's behavior (e.g. informing about fuel consumption and its impact on environment). As design researchers have extensively explored the first two, changing behavior through design is a relevant problem space to further increase their impact on environmental sustainability. In this respect, the proposed tool guided students towards the exploration of solutions promoting sustainability through behavior change rather than focusing on other problem areas.

Specifically, the tool made them focus on this problem space by helping them initiate ideation. The use of classification of strategies in idea generation reduced the ratio of ideas outside behavior change like product performance and efficiency to the ideas focusing on behavior change. The use of user orientations in idea generation contributed to the ideas generated for a specific user group rather than for a broader group. Furthermore, the questionnaires showed that the tool also helped students

understand different ways of influencing user behavior and the diversity in users' orientations towards eco-friendly driving. These observations support the argument that the tool increased the awareness of behavior change strategies and the diversity in users' orientations as well as it helped focusing on a desired problem space, which might create an advantage in terms of minimizing the time spent to find a focus and explore potential solutions within that focus.

The results indicate that the students found the tool inspirational and that it provided inspiration through helping them explore various solutions for behavior change. Students used the tool to categorize their ideas, find overlooked solution areas need further attention and direct their attention to these areas. This motivated them to generate solutions by using the range of strategies and the range of user orientations. For the strategies, the teams having the classification more explored the strategies other than inform (enable/disable, support and automate) compared with the control group, which contributes to a wider coverage of different strategies. For the orientations, while the teams in orientation group tried to generate ideas for different user orientations, other teams commonly tried to find a suitable target user for an idea after generating it.

The tool also provided inspiration through helping students empathize with target users in terms of their orientations towards eco-friendly driving. A major difference between the teams having orientations and others was in their approach to think about their target users. The control and strategy groups used the term 'majority of the people' to refer to target users and defined them with socio-economic status, age, income, driving style and so on. Unlike these groups, teams having orientations defined their target users by referring to these orientations and by considering individual characteristics related to eco-friendly driving like environmental concern and intention to adapt eco-friendly driving.

The results showed that the tool helped students select their target users and served as a source for justification in supporting such decisions. The teams having orientations commonly selected the most promising target user group (ready orientation) by considering the percentage each orientation has. After making this selection, they started generating ideas for this orientation. This observation might indicate that the proposed tool can also be used to justify the decisions designers make during idea generation as well as directing the design process.

To sum up, this idea generation study showed that the proposed tool is promising for helping designers in developing solutions promoting sustainable behaviors, as it provides guidance, inspiration and a source for justification. Next chapter concludes the thesis by discussing the proposed method for exploring and communicating user diversity and the proposed tool for promoting sustainable behaviors in terms of design research and practice.

CHAPTER 5

CONCLUSION

This thesis investigates promoting sustainable behaviors through design, a popular yet growing area of research in the design community. Aimed at providing guidance to designers and design researchers working in this area, it advances the current state by making the following contributions.

1. A method for exploring and communicating the diversity in users' orientations towards sustainable behaviors, a significant but overlooked topic in this field
2. A design tool integrating user orientations with a set of behavior change strategies to help designers better explore potential solutions for promoting sustainable behaviors
3. Assessment of this tool's impact on generation of design ideas to motivate sustainable behaviors through an idea generation study

This chapter discusses these contributions by revisiting the research questions, as well as it reveals the study limitations and potential directions for future studies.

5.1. Q1: How can we explore user diversity for promoting sustainable behaviors through design?

This thesis illustrated that the user diversity for promoting sustainable behaviors can be explored systematically by the proposed method which includes determining the important dimensions of user diversity from TPB, developing questionnaires for measuring these dimensions and analyzing user research data through cluster analysis to identify significant user groups in a target population. Besides helping design researchers and practitioners responsible for conducting user research explore user diversity systematically, it also provides a flexible way of doing this.

As the full version of the theory provides numerous factors influencing the performance of a behavior varying in their effect size, design researchers and practitioners have the option to select different variables depending on the project type and the type of target behavior they focus on. For instance, in this thesis, environmental concern and personality traits were used as dimensions of user diversity in addition to direct determinants of behavior including intention, attitude, subjective norm and perceived behavioral control. Others can use other additional variables like previous knowledge, skills of the users, past behavior, previous experience, belief, values and so on. This flexibility makes this method adaptable to other target behaviors or other behavior change contexts, e.g. household electricity and water consumption, recycling, and even the behaviors outside the sustainability domain like adapting a healthier diet.

This way of exploring user diversity and creating user orientations based on this exploration, however, can be time intensive. For instance, data collection and data analysis for this thesis took approximately four months. When designers have time pressure during a project, using this method to address user diversity might be undesirable for them. In such situations, designers can create user orientations without conducting user research. As the core constructs of the TPB (intention, attitude, subjective norm and perceived behavioral control) have a high explanatory power over behavior, they can be used in this process. By using a two level categorization (low/high), they can create different combinations distributed along a scale as illustrated in Figure 36.

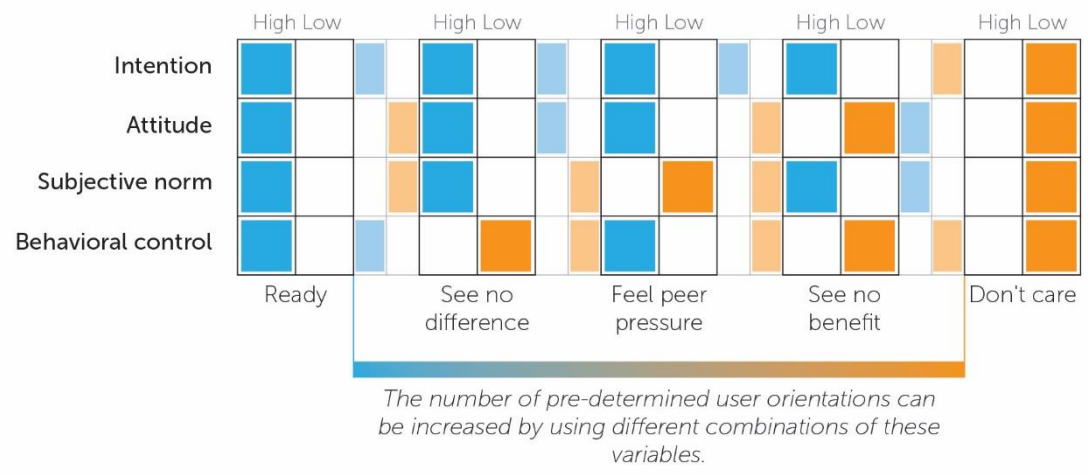


Figure 36. Creating user orientations based on core constructs of TPB without using user research data

According to this figure, the orientation at the left side of this scale includes users having intention to perform a behavior, positive attitude towards the behavior, high social support and high perceived behavioral control. These users are more likely to perform a desired behavior, and probably the easiest to persuade. The orientation at the right side of this scale includes users having the opposite characteristics. These users do not want to change their behavior, and probably the most difficult to persuade.

The orientations between these two sides include users having varying degree of intention, attitude, social support and behavioral control in relation to a desired behavior. For instance, users who do not see any benefit from changing their behavior, the ones who feel peer pressure on changing their behavior and the ones who do not believe that their behavior change makes a big difference. Note that these five orientations only represent the ones identified in this thesis. This is preferred for the sake of simplicity. If desired, the number of pre-determined orientations can be increased or decreased. Designers are free to choose any of these combinations depending on the project brief, for instance they may want to add another user orientation including people with no behavioral intent, negative attitude, low social support but high perceived behavioral control.

This thesis illustrated that the proposed method can serve other purposes besides offering a systematic and adaptable way of exploring user diversity for promoting sustainable behaviors. For instance, as it relies on quantitative data collection, the proposed method can be used to decide on a desired target user group in a target population. When this exploration was performed before preparing a design brief, one specific user orientation can be selected based on its appearance in the entire population so that designers can focus on generating ideas for this specific user orientation.

Alternatively, it can be used to identify a receptive audience who is more likely to respond positively to a behavior changing product, like design students participated in the idea generation study did. For instance, the ‘ready’ user orientation identified in this study represents the people who are eager to adapt environmentally friendly driving practices. After identifying the most receptive orientation, researchers can select several users from this group and conduct observations or interviews to

acquire in-depth knowledge about their needs, wants, expectations, desires and behaviors.

5.2. Q2: How can we communicate this diversity to designers?

This thesis proposes a new method for communicating user diversity, as none of the user representation methods discussed in chapter 3 is tailored to communicate user diversity for promoting sustainable behaviors. The proposed method, user orientation map, differs from previous ones in terms of its purpose, representation style, the number of users depicted in a single representation and finally the level of detailed information. In essence, a user orientation map represents the characteristics of different user groups as they relate both to a desired behavior and to each other, as well as their degree of appearance in a target population. It also provide recommendations for selecting suitable strategies for different orientations.

The thesis also provides design researchers and practitioners with a procedure to create a user orientation map. In order to construct a user orientation map, designers or design researchers should first categorize the identified user groups according to the dimensions of diversity they determined in the exploration phase. For example, core constructs of TPB and personality traits were used in this thesis. After this categorization, they should create a diagram showing the percentage of each group's appearance in the population. If the users were grouped according to more than one set of dimensions like in this thesis, this diagram should also show the relation between two different user groups, whether a group contains users also belonging to another group categorized according to a different dimension. Lastly, by using the decision tree depicted in the Appendix E, they should decide on the most suitable strategies for different orientations and make recommendations on strategy selection based on this decision.

Once user orientations are introduced to designers, they can start generating ideas for the ones they think appropriate for the project brief. Depending on the brief, a project team can either develop solutions for a particular orientation, or can choose multiple orientations at the same time and try to develop optimized solutions for all these orientations.

The idea generation study showed that, this way of representing user diversity provides designers and design researchers with inspiration, guidance and justification for generating ideas motivating sustainable behaviors. A detailed discussion on this topic can be found in the next section and at the end of Chapter 4. Nonetheless, it is worth discussing here the difference between the original representation method (user orientation map) and the one used for the idea generation study (user orientation cards). Compared to user orientation cards, it can be harder to digest all the information a user orientation map contains when designers have time pressure. Despite this shortcoming, user orientation maps provide recommendations for strategy selection which seems to be useful when a design brief lack detail and design directions. Such recommendations ensure a more structured and determined design process, which might encourage designers to focus on certain strategies for certain user orientations. However, at the same time they might limit designers' ability to explore other opportunities. Thus, depending on the project goal and time constraints designers have, a design team may choose one of these versions. When time is limited, it might be reasonable to use user orientation cards. But if the time is not the primary concern and the design brief does not provide designers with adequate information, a user orientation map can be preferred.

5.3. How would the proposed tool support designers' ideation for promoting sustainable behaviors?

The idea generation study showed that the students found the design tool proposed in this thesis useful, inspirational and easy to use. It increased the number of ideas generated, created an awareness of behavior change strategies and different users' orientations towards sustainable behaviors, and contributed a shared understanding which facilitates communication among team members. Above all, it supported design students' ideation in terms of guidance, inspiration and justification. It provided guidance on focusing on a desired problem space by helping them initiate idea generation. It provided inspiration through helping them explore various solutions for behavior change. It served as a base for justification by supporting their decisions. A detailed discussion on these three aspects can be found at the end of the previous chapter. Here in this section, it is preferred to further discuss one of the

most promising features of the tool for designing solutions promoting sustainable behaviors.

This feature is the tool's potential for providing designers with an opportunity to generate ideas for grounded innovation. Grounded innovation is a desired state for design innovation which requires generating solutions by focusing on a specific problem space to have relevance, but at the same time expanding in this space to have coverage (Ljungblad & Holmquist, 2007). This way of generating ideas is very essential for design for sustainability. This is because directing designers towards the problem areas which has not been explored previously has a potential to increase designers' impact on sustainability. Furthermore, once a desired problem space is chosen (e.g. changing people's behavior for the sake of sustainability), the exploration of different possibilities in this space can increase a design team's chance to find the most impactful solution for behavior change, because different strategies have their own strengths and weaknesses, which make them suitable for different type of users.

The idea generation study indicated that the proposed tool helped students achieve relevance by directing them towards solutions changing behavior and coverage by helping them explore different behavior change strategies and different type of users. Therefore design teams working on promoting sustainable behaviors can utilize this tool especially when their priority is exploring innovative solutions grounded in a desired problem-solution space. That is to say, along with students' enthusiasm for using the tool, their request for using it in their future projects is an indication of their satisfaction with it, its potential contribution to grounded innovation makes this tool promising for behavior change. Nonetheless, when designers and design researchers want to use the tool for this purpose, they should take two other aspects into consideration.

The first one is finding the most relevant strategies creating a bigger and long-lasting impact on behavior change. The literature review in Chapter 2 revealed that, so far design practitioners and researchers have commonly explored informational strategies, which are not always enough to maintain a long lasting change, and often fail to engage users in the long term. Thus, shifting their focus from informational strategies to other strategies has a great value for behavior change for sustainability. Developed with this goal in mind, the classification of behavior change strategies

contributed to this to some extent by increasing the number of ideas focusing on enable/disable, support and automate strategies. However, this contribution was not that big, as it was observed that inform was still the most preferred strategy for all the groups. But, this might be due to reasons external to the classification itself. For instance, students might have found much easier to inform users about their behavior through a simple interface giving feedback on fuel consumption than designing a smart car which can sense and learn users' driving patterns and automate change. It appears that the issue why designers are commonly preferring informational strategies over others is still worth exploring for behavioral change.

The second one is the trade-off between exploring different solutions for one specific user orientation thought to be the most important one for the brief and exploring solutions for different user orientations without differentiating them in terms of their importance. It was observed that although the user orientations encouraged students to explore potential solutions for different orientations, the amount of ideas generated was quite a few. A reason for this might be their tendency to choose the 'ready' user orientation as target user due to its higher percentage compared to others and their belief that these users will likely to comply with many solutions they generate as they are ready to do so. Furthermore, one of the teams tried to generate an idea for the 'peer pressure' orientation stated their motivation as its being the second biggest group among others. This implies that since the percentage is a dominant factor for selecting a user orientation as a target user, removing the percentages or replacing them with a more even distribution could motivate students to explore more orientations.

However, this does not mean that the percentages in user orientations were unnecessary. On the contrary, they helped evaluating the suitability of an idea even though they limited students' exploration of different user orientations. This observation shows that there is a trade-off between exploring solutions for different orientations regardless of the percentages and focusing on one single orientation selected based on the percentage. Therefore, design teams should utilize the user orientations differently based on a project goal. For instance, if the intention is to cover as many orientation as possible, then removing the percentages or having a more even distribution would help. But, if the intention is to justify a design decision,

deciding on an orientation and evaluating ideas based on their suitability for the selected orientation, the percentages would help.

5.4. Limitations and potential directions for future work

This study showed that, developed with the intention of supporting designers in developing solutions promoting sustainable behaviors, the design tool is promising for design for sustainable behavior. However, more studies are required to better understand its impact on behavior change and to make it more useful for designers. The reminder of the this section presents four directions that can be followed in order to develop the tool further.

5.4.1. Assessing the initial version of the tool with professional designers and for other behavioral domains

One possible direction for future work is conducting idea generation studies with professional designers and using the earlier version of user orientations in these workshops. Due to practical reasons, the workshops were conducted with design students by simulating a real idea generation process. Although this set-up allow understanding the potential impact of the tool, it is not enough to generalize the findings to design practice, a common limitation of design studies using students as participants.

The user orientations used in this study was the brief version of the original one, which was designed as a map showing user orientations, user personalities and recommendations for selecting suitable strategies for them. The brief version was used in this study because the pilot study showed that students need more time to digest the information in a user orientation map. Thus, the original version can be used in future workshops in which time pressure is not that intense.

This study investigated the tool's impact for a specific behavior type, eco-friendly driving. Due to this, the findings are limited to eco-friendly driving. In the future, its impact can be explored for other behaviors as well, in order to assess its ability to be utilized in different situations, a desired feature for an idea generation tool. A promising venue for this is design for well-being, another field with great potential

for design for behavior change. Assessing the tool with different behavioral domains and with professional designers would not only help understand the tool's potential for behavior better but also provide valuable insights for its further development.

5.4.2. Comparing user orientations derived from data and pre-determined orientations

Section 5.1 discusses an alternative method to create user orientations that can be used when there is time pressure. This method involves creating pre-determined user orientations through using the core constructs of TPB. As pre-determined user orientations do not rely on actual user data, they do not contain a relative percentage indicating the important groups in a target population. However, pre-determined user orientations can increase the range of orientations explored during the process. For instance, the idea generation study revealed that students had the tendency to select a user orientation based on its percentage among the entire population, which limits exploration of different user orientations during idea generation. Thus, comparing the pre-determined user orientations with user orientations a design team created by using actual user research data would be an interesting topic for future studies.

5.4.3. Representing a user orientation in a problematic situation

Another potential direction for future work is representing user orientations in different situations. It was observed that the students commonly imagine a scenario (or a situation) when trying to find a solution, to find an opportunity, to understand causes of undesired behaviors, and to evaluate ideas. Along with students' concern about integrating user orientations into their way of working, this observation indicates that there might be a value in exploring the relationship between a problematic situation and a user orientation, e.g., how the ready user group would behave when he or she waiting for a friend for more than five minutes in the car.

5.4.4. Using the tool to teach design for behavior change

One of the gaps discovered in the review of the literature is the lack of educational programs teaching behavior change for sustainability. Thinking about the proposed

tool’s contribution to the increase in students’ awareness of behavior change strategies and the diversity in user orientations towards sustainable behaviors, the tool can be used to teach design for behavior change in the context of sustainability.

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APPENDIX A

ECO-FRIENDLY DRIVING QUESTIONNAIRE (IN TURKISH)

Değerli katılımcı,

Bu araştırma Orta Doğu Teknik Üniversitesi, Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan "Hususi Otomobil Sürücülerini Çevreci Davranışlara İkna Eden Tasarım Çözümleri için Kullanıcı Çeşitliliği" adlı doktora tez çalışması kapsamında yapılmaktadır. Araştırmanın amacı sizlerin genel olarak çevresel sorunlar açısından kendinizi nasıl konumlandırdığınızı belirlemek ve araç kullanırken daha çevreci bir sürüş biçimini benimsemek ile ilgili görüşlerinizi almaktır. Dolduracağınız anket, çevreye duyarlılık, çevreci sürüş davranış biçimi, bu davranış biçimini teşvik eden veya engelleyen durumlar, kişilik özellikleri ve demografik bilgiler olmak üzere beş ana bölümden oluşmaktadır, anketin tamamlanması ortalama 20dk sürmektedir. Anketlerde yer alan maddelere vereceğiniz samimi cevaplar araştırmanın güvenilir sonuçlara ulaşması açısından önemlidir. Cevaplar yalnızca araştırma amacı ile kullanılacak ve üçüncü şahıs veya kurumlar ile hiç bir şekilde paylaşılmayacaktır. Katkılarınız için şimdiden teşekkür ederiz.

Çalışma hakkında daha fazla bilgi almak için Endüstri Ürünleri Tasarımı Bölümü öğretim üyelerinden Doç. Dr. Çiğdem Erbuğ (Oda: R19; Tel: 0 312 210 4219; E-posta: erbug@metu.edu.tr) ya da araştırma görevlisi Aykut Coşkun (Oda: R19; Tel: 0 312 210 4219; E-posta: aycoskun@metu.edu.tr) ile iletişim kurabilirsiniz.

Aykut Coşkun
Doktora Öğrencisi
Endüstri Ürünleri Tasarımı Bölümü
ODTÜ

A.1 Çevreye duyarlılık

Bu bölüm çevresel sorunlar ile ilgili görüşlerinizi almayı amaçlamaktadır.

	Kesinlikle katılmıyorum	Kısmen Katılmıyorum	Kararsızım	Kısmen katılıyorum	Kesinlikle katılıyorum
Dünyanın barındırabileceği insan sayısı üst sınırına yaklaşıyoruz.	1	2	3	4	5
İnsanların, doğayı kendi ihtiyaçlarına uygun şekilde düzenleme hakkı vardır.	1	2	3	4	5
İnsanlar doğa ile ters düştüğünde genellikle çok kötü sonuçlar ortaya çıkar.	1	2	3	4	5
İnsan aklı bir şekilde çevre sorunlarının da üstesinden gelecektir.	1	2	3	4	5
İnsanlar doğayı ciddi şekilde istismar etmektedir.	1	2	3	4	5
Eğer nasıl geliştirebileceğimizi bilebilirsek, dünyada bol miktarda doğal kaynak mevcuttur.	1	2	3	4	5
İnsanlar gibi bitkiler ve hayvanların da bu dünyada var olma hakları mevcuttur.	1	2	3	4	5
Doğanın dengesi modern sanayileşmiş ulusların etkileri ile başa çıkabilecek kadar güçlüdür.	1	2	3	4	5
Özel yeteneklerimize rağmen biz insanlar halen doğanın kanunlarına tabiyizdir.	1	2	3	4	5
İnsanların karşı karşıya oldukları sözü edilen ekolojik kriz çok fazla abartılmaktadır.	1	2	3	4	5
Dünya çok sınırlı sayıda odası ve kaynakları olan bir uzay gemisine benzemektedir.	1	2	3	4	5
İnsanlar, doğanın kendileri dışında kalan kısmına hükmetmek üzere yaratılmışlardır.	1	2	3	4	5
Doğanın dengesi çok kırılgandır ve kolayca bozulabilir.	1	2	3	4	5
İnsanlar doğayı kontrol edebilmek için onun nasıl işlediğine ilişkin yeterli bilgiyi er geç öğrenecektir.	1	2	3	4	5
Eğer işler şu an olduğu gibi devam ederse yakında büyük bir ekolojik felaket ile karşılaşacağız.	1	2	3	4	5

A.2 Çevreye daha duyarli sürüş biçimi

Bu bölüm daha çevreci bir sürüş davranışı benimsemek adına kendinizi nasıl değerlendirdiğinizi anlamayı amaçlamaktadır. Çevreci sürüş davranış biçimi; araç kullanırken çevreye verilen zararı azaltmak için yakıt tasarrufu yapmak, bekleme anında aracı durdurmak, aşırı hızdan, ani hızlanmadan ve yavaşlamadan mümkün olduğunca kaçınmak ve ideal aralıkta vites değiştirmek gibi davranışları içermektedir.

TUTUM

1. Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimsemek

Zordur	1	2	3	4	5	6	7	Kolaydır
Kötüdür	1	2	3	4	5	6	7	İyidir
Yararlı değildir	1	2	3	4	5	6	7	Yararlıdır
Keyifsizdir	1	2	3	4	5	6	7	Keyiflidir
Rahat değildir	1	2	3	4	5	6	7	Rahattır

NORM

2. Önem verdiğim birçok kişi çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimsemem gerektiğini düşünür.

Yanlış	1	2	3	4	5	6	7	Doğru

3. Düşüncelerine değer verdiğim birçok kişi çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimsememi onaylayacaktır.

Mümkün değil	1	2	3	4	5	6	7	Mümkün

4. Saygı duyduğum ve özendiğim birçok kişi çevreye verdiği zararı azaltmak için daha çevreci bir sürüş biçimi benimsemeye çalışacaktır.

Mümkün değil	1	2	3	4	5	6	7	Mümkün

5. Benim gibi olduğunu düşündüğüm birçok kişi çevreye verdiği zararı azaltmak için daha çevreci bir sürüş biçimi benimsemeye çalışıyor.

Katılmıyorum	1	2	3	4	5	6	7	Katılıyorum

DAVRANIŞSAL KONTROL

6. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimseyebileceğimden eminim.**

Yanlış 1 2 3 4 5 6 7 Doğru

7. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimseyip benimsememek tamamen bana bağlıdır.**

Katılmıyorum 1 2 3 4 5 6 7 Katılıyorum

8. **Eğer gerçekten isteseydim çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimseyebilirdim.**

Mümkün değil 1 2 3 4 5 6 7 Mümkün

9. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimseyip benimsememek tamamen benim kontrolüm altındadır.**

Katılmıyorum 1 2 3 4 5 6 7 Katılıyorum

NİYET

10. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimsemeyi deneyeceğim.**

Düşük ihtimalle 1 2 3 4 5 6 7 Yüksek ihtimalle

11. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimseme konusunda istekliyim.**

Yanlış 1 2 3 4 5 6 7 Doğru

12. **Çevreye verdiğim zararı azaltmak için daha çevreci bir sürüş biçimi benimsemeyi planlıyorum.**

Katılmıyorum 1 2 3 4 5 6 7 Katılıyorum

A.3 Kişilik Özellikleri

Aşağıda verilen ifadelere ne ölçüde katıldığınızı lütfen belirtiniz.

Genel Olarak Nasılım?	Kesinlikle katılmıyorum	Kısmen Katılmıyorum	Kararsızım	Kısmen katılıyorum	Kesinlikle katılıyorum
Konuşkanım.	1	2	3	4	5
Başkalarında hata arama eğilimindeyim.	1	2	3	4	5
İş yönelimliyim.	1	2	3	4	5
Karamsarım.	1	2	3	4	5
Orijinal ve yeni fikirlere açığım.	1	2	3	4	5
Çekingen biriyim.	1	2	3	4	5
Yardımsever biriyim.	1	2	3	4	5
Biraz dikkatsiz olabilirim.	1	2	3	4	5
Stresle iyi baş edebilen rahat biriyim.	1	2	3	4	5
Birçok şeye meraklıyım.	1	2	3	4	5
Enerji doluyum.	1	2	3	4	5
Ağız dalaşını başlatan biriyim.	1	2	3	4	5
Güvenilir bir çalışanım.	1	2	3	4	5
Gergin biriyim.	1	2	3	4	5
Dahiyim, derin düşünürüm.	1	2	3	4	5
Çok fazla hayranlık uyandırırım.	1	2	3	4	5
Affedici bir doğaya sahibim.	1	2	3	4	5
Düzensiz olma eğilimindeyim.	1	2	3	4	5
Çok kaygılı biriyim.	1	2	3	4	5
Aktif bir hayal gücüne sahibim.	1	2	3	4	5
Sessiz olma eğilimindeyim.	1	2	3	4	5
Genellikle güvenilir biriyim.	1	2	3	4	5
Tembelliğe eğilimliyim.	1	2	3	4	5
Duygusal olarak kararlı bir yapım vardır kolayca üzülmeyen biriyim.	1	2	3	4	5
İcat yapan biriyim.	1	2	3	4	5
Girişken bir kişiliğe sahibim.	1	2	3	4	5
Soğuk ve mesafeliyim.	1	2	3	4	5
İşi bitirene kadar azimle çalışırım.	1	2	3	4	5
Duygu durumu değişebilen biriyim.	1	2	3	4	5
Sanatsal değerleri, estetik deneyimleri olan biriyim.	1	2	3	4	5
Bazen utanır ve çekinirim.	1	2	3	4	5
Hemen hemen herkese karşı nazik ve düşünceliyim.	1	2	3	4	5
Her şeyi etkili yaparım.	1	2	3	4	5
Gergin durumlarda sakin kalırım.	1	2	3	4	5
Rutin işleri tercih ederim.	1	2	3	4	5
Dışa dönük ve sosyal biriyim.	1	2	3	4	5
Bazen başkalarına karşı kaba olurum.	1	2	3	4	5
İşlerimi planlar ve yaptığım planlara uyarım.	1	2	3	4	5
Kolayca sinirlenirim.	1	2	3	4	5
Fikir jimnastiği yaparım.	1	2	3	4	5
Sanatsal ilgilerim azdır.	1	2	3	4	5
Başkaları ile işbirliği yapmaktan hoşlanırım.	1	2	3	4	5
Kolayca dikkati dağılan biriyim.	1	2	3	4	5
Sanat, müzik ya da edebiyatla ilgilenen biriyim.	1	2	3	4	5

A.4 Diğer bilgiler

1. Cinsiyetiniz ☐ Kadın ☐ Erkek	**2. Yaşınız** ☐ 18-25 ☐ 25-35 ☐ 35-45 ☐ 45-55 ☐ 55+
3. Eğitim durumunuz ☐ İlkokul mezunu ☐ Ortaokul mezunu ☐ Lise mezunu ☐ Üniversite mezunu ☐ Yüksek lisans veya doktora	**4. Ortalama aylık kişisel geliriniz** ☐ 1000'den az ☐ 1000-2000 ☐ 2000-3000 ☐ 3000-4000 ☐ 4000-5000 ☐ 5000'den fazla

APPENDIX B

ECO-FRIENDLY DRIVING QUESTIONNAIRE (IN ENGLISH)

B.1 General environmental concern

This section aims to reveal your thoughts about environmental problems.

	Kesinlikle katılmıyorum	Kısmen Katılmıyorum	Kararsızım	Kısmen katılıyorum	Kesinlikle katılıyorum
We are approaching the limit of the number of people the earth can support.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
Human ingenuity will insure that we do not make the earth unlivable.	1	2	3	4	5
Humans are severely abusing the environment.	1	2	3	4	5
The earth has plenty of resources if we can learn how to develop them.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
The balance of nature is strong enough to cope with the impact of modern industrial nations.	1	2	3	4	5
Despite our special abilities humans are still subject to the laws of nature.	1	2	3	4	5
The so called ecological crisis facing humankind has been greatly exaggerated.	1	2	3	4	5
The earth is like a spaceship with only limited room and resources.	1	2	3	4	5
Humans were meant to rule over the rest of nature.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans will eventually learn enough about how nature Works to be able to control it.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

B.2 Eco-friendly driving

This section aims to reveal how you assess your adopting eco-friendly driving in order to reduce your environmental impact. To adopt an environmentally friendly driving style, the one should avoid fast acceleration, long idling times, excessive use of AC, instant break and spending too much time while searching for a parking spot.

ATTITUDE

1. **Adopting an environmentally friendly driving to reduce my impact on environment,**

Difficult	1	2	3	4	5	6	7	Easy
Bad	1	2	3	4	5	6	7	Good
Not useful	1	2	3	4	5	6	7	Useful
Unpleasant	1	2	3	4	5	6	7	Pleasant
Uncomfortable	1	2	3	4	5	6	7	Comfortable

SUBJECTIVE NORM

2. **Most people who are important to me think that I should adopt an environmentally friendly driving to reduce my impact on environment.**

False	1	2	3	4	5	6	7	True

3. **Most people whose opinions I value would approve of my adopting an environmentally friendly driving to reduce my impact on environment.**

Improbable	1	2	3	4	5	6	7	Probable

4. **Most people I respect and admire will adopt an environmentally friendly driving to reduce my impact on environment.**

Unlikely	1	2	3	4	5	6	7	Likely

5. **Most people like me have adopted an environmentally friendly driving to reduce my impact on environment.**

Disagree	1	2	3	4	5	6	7	Agree

PERCEIVED BEHAVIORAL CONTROL

6. **I am confident that I can adopt an environmentally friendly driving to reduce my impact on environment.**

   False 1 2 3 4 5 6 7 True

7. **My adopting an environmentally friendly driving to reduce my impact on environment is completely up to me.**

   Disagree 1 2 3 4 5 6 7 Agree

8. **If I really wanted to do, I could adopt an environmentally friendly driving to reduce my impact on environment.**

   Unlikely 1 2 3 4 5 6 7 Likely

9. **For me to adopt an environmentally friendly driving to reduce my impact on environment is under my control.**

   Disagree 1 2 3 4 5 6 7 Agree

INTENTION

10. **I will adopt an environmentally friendly driving to reduce my impact on environment.**

    Unlikely 1 2 3 4 5 6 7 Likely

11. **I am willing to adopt an environmentally friendly driving to reduce my impact on environment.**

    False 1 2 3 4 5 6 7 True

12. **I plan to adopt an environmentally friendly driving to reduce my impact on environment.**

    Disagree 1 2 3 4 5 6 7 Agree

B.3 Personality traits

Please, indicate to what extent you agree-disagree the following statements.

I am someone who…	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Is talkative *(Extraversion)*	1	2	3	4	5
Tends to find fault with others *(Agreeableness reversed)*	1	2	3	4	5
Does a thorough job *(Conscientiousness)*	1	2	3	4	5
Is depressed, blue *(Neuroticism)*	1	2	3	4	5
Is original, comes up with new ideas. *(Openness)*	1	2	3	4	5
Is reserved *(Extraversion reversed)*	1	2	3	4	5
Is helpful and unselfish with others *(Agreeableness)*	1	2	3	4	5
Can be somewhat careless *(Conscientiousness reversed)*	1	2	3	4	5
Is relaxed, handles stress well. *(Neuroticism reversed)*	1	2	3	4	5
Is curious about many different things *(Openness)*	1	2	3	4	5
Is full of energy *(Extraversion)*	1	2	3	4	5
Starts quarrels with others. *(Agreeableness reversed)*	1	2	3	4	5
Is a reliable worker *(Conscientiousness)*	1	2	3	4	5
Can be tense *(Neuroticism)*	1	2	3	4	5
Is ingenious, a deep thinker *(Openness)*	1	2	3	4	5
Generates a lot of enthusiasm *(Extraversion)*	1	2	3	4	5
Has a forgiving nature. *(Agreeableness)*	1	2	3	4	5
Tends to be disorganized *(Conscientiousness reversed)*	1	2	3	4	5
Worries a lot *(Neuroticism)*	1	2	3	4	5
Has an active imagination. *(Openness)*	1	2	3	4	5
Tends to be quiet *(Extraversion reversed)*	1	2	3	4	5
Is generally trusting *(Agreeableness)*	1	2	3	4	5
Tends to be lazy *(Conscientiousness reversed)*	1	2	3	4	5
Is emotionally stable, not easily upset *(Neuroticism reversed)*	1	2	3	4	5
Is inventive *(Openness)*	1	2	3	4	5
Has an assertive personality *(Extraversion)*	1	2	3	4	5
Can be cold and aloof *(Agreeableness reversed)*	1	2	3	4	5
Perseveres until the task is finished *(Conscientiousness)*	1	2	3	4	5
Can be moody *(Neuroticism)*	1	2	3	4	5
Values artistic, aesthetic experiences *(Openness)*	1	2	3	4	5
Is sometimes shy, inhibited *(Extraversion reversed)*	1	2	3	4	5
Is considerate and kind to almost everyone *(Agreeableness)*	1	2	3	4	5
Does things efficiently *(Conscientiousness)*	1	2	3	4	5
Remains calm in tense situations *(Neuroticism reversed)*	1	2	3	4	5
Prefers work that is routine *(Openness reversed)*	1	2	3	4	5
Is outgoing, sociable *(Extraversion)*	1	2	3	4	5
Is sometimes rude to others *(Agreeableness reversed)*	1	2	3	4	5
Makes plans and follows through with them *(Conscientiousness)*	1	2	3	4	5
Gets nervous easily *(Neuroticism)*	1	2	3	4	5
Likes to reflect, play with ideas *(Openness)*	1	2	3	4	5
Has few artistic interests *(Openness reversed)*	1	2	3	4	5
Likes to cooperate with others *(Agreeableness)*	1	2	3	4	5
Is easily distracted *(Conscientiousness reversed)*	1	2	3	4	5
Is sophisticated in art, music, or literature *(Openness)*	1	2	3	4	5

B.4 Other details

1. Sex ☐ Female ☐ Male	**2. Age** ☐ 18-25 ☐ 25-35 ☐ 35-45 ☐ 45-55 ☐ 55+
3. Educational level ☐ Primary school ☐ Secondary school ☐ High school ☐ Bachelor's degree ☐ Master's degree ☐ Doctorate degree	**4. Monthly personal income** ☐ Less than 1000 ☐ 1000-2000 ☐ 2000-3000 ☐ 3000-4000 ☐ 4000-5000 ☐ More than 5000

APPENDIX C

CONSENT FORM FOR THE QUESTIONNAIRE

Bu çalışma, Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü doktora öğrencisi Aykut Coşkun tarafından doktora tezi kapsamında yürütülmektedir. Çalışmanın amacı katılımcıların çevresel sorunlara ve araç kullanımında çevreci sürüş biçimini benimsemeye yönelik tutumları, niyetleri ve davranışları ile ilgili bilgi toplamaktır. Çalışmaya katılım gönüllülük temelinde olmalıdır. Ankette, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır. Dolduracağınız anket, çevreye duyarlılık, çevreci sürüş davranış biçimi, bu davranış biçimini teşvik eden veya engelleyen durumlar, kişilik özellikleri ve demografik bilgiler olmak üzere beş ana bölümden oluşmaktadır. Anketin tamamlanması ortalama 20 dakika sürmektedir.

Anket, genel olarak kişisel rahatsızlık verecek soruları içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda anketi uygulayan kişiye, anketi tamamlamadığınızı söylemeniz yeterli olacaktır. Anket sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Endüstri Ürünleri Tasarımı Bölümü öğretim üyelerinden Doç. Dr. Çiğdem Erbuğ (Oda: R19; Tel: 210 4219; E-posta: erbug@metu.edu.tr) ya da araştırma görevlisi Aykut Coşkun (Oda: R19; Tel: 210 4219; E-posta: aycoskun@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim/Soy isim	Tarih	İmza
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APPENDIX D

CLUSTER ANALYSIS

D.1 Significant clusters

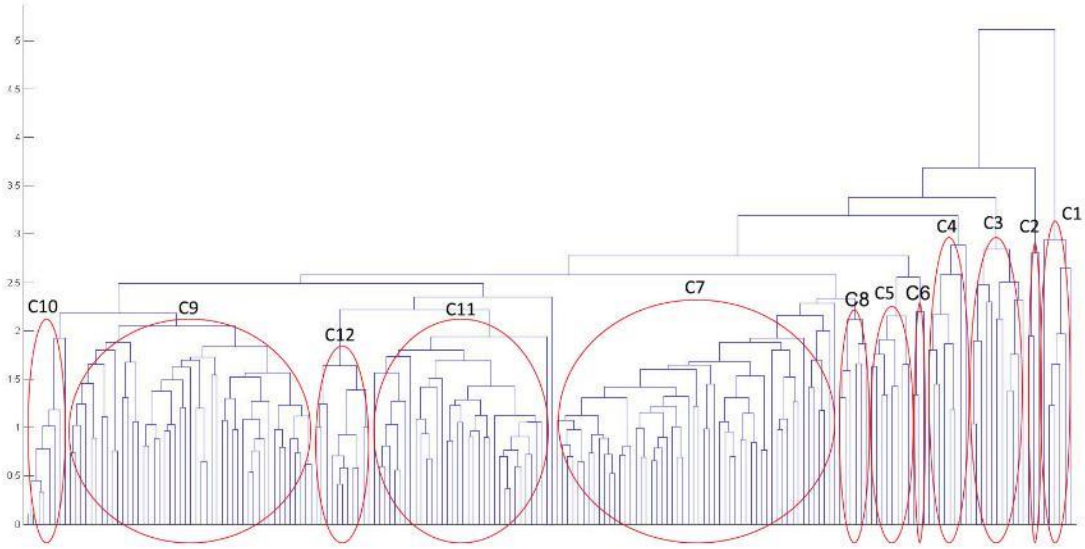


Figure D.1 Dendrogram showing each significant cluster with a red circle

D.2 Significant differences

Table D.1 Significant differences between clusters at numerical and categorical level

Variable	Clusters	P (α=.05)	CD	*Variable*	Clusters	P (α=.05)	CD[14]
Environmental concern	C9> C11	.022	-	*Attitude (Continued)*	C91> C12	.000	-
	C9> C3	.038	-		C92> C12	.000	-
	C5> C3	.036	-		C5>C3	.000	-
					C5> C90	.000	+
Intention	C7> C9	.000	-		C4 > C90	.002	+
	C5> C9	.018	-		C92 > C3	.000	-
	C9> C3	.000	-		C2>C90	.003	+
	C9> C90	.000	+		C91>C90	.034	+
	C10> C3	.000	-		C92>C90	.000	+
	C10> C3	.000	-		C9 > C10	.000	+
	C7> C11	.000	-				
	C11> C5	.027	-	*Subjective norm*	C9 > C11	.015	-
	C11> C3	.000	-		C9 > C12	.041	-
	C11> C90	.000	+		C7 > C9	.000	-
	C12>C5	.015	-		C9 > C3	.000	+
	C12>C3	.000	-		C9 > C2	.000	+
	C12>C90	.000	+		C9 > C90	.000	+
	C7> C5	.000	-		C9 > C92	.000	-
	C7> C3	.000	-		C11 > C10	.000	+
	C7> C90	.000	+		C12 > C10	.001	+
	C2 > C5	.001	-		C7 > C10	.000	+
	C91 > C5	.001	-		C5 > C10	.000	+
	C4> C3	.001	-		C4 > C10	.005	+
	C4> C90	.000	+		C10 > C2	.000	+
	C2> C3	.000	-		C7 > C11	.000	-
	C91> C3	.000	-		C11 > C3	.000	+
	C3> C90	.000	+		C11 > C2	.000	+
	C92> C3	.000	-		C11 > C90	.000	+
	C2> C90	.000	+		C7 > C12	.000	-
	C91> C90	.000	+		C12 > C3	.000	+
	C92> C90	.000	+		C12 > C2	.000	+
					C12 > C90	.000	+
Attitude	C9> C11	.000	-		C7 > C4	.000	-
	C9> C12	.000	-		C7 > C3	.000	+
	C9> C3	.000	-		C7 > C2	.000	+
	C9> C90	.000	+		C7 > C90	.000	+
	C7> C9	.009	-		C7 > C91	.000	-
	C10> C11	.000	-		C7 > C92	.000	-
	C10> C12	.000	-		C5 > C3	.000	+
	C10> C3	.001	-		C5 > C2	.000	+
	C10> C90	.000	+		C5 > C90	.000	+
	C7> C11	.000	-		C5 > C92	.045	-
	C5> C11	.000	-		C4 > C3	.000	+
	C4> C11	.000	-		C4 > C2	.000	+
	C2> C11	.003	-		C4 > C90	.000	+
	C92> C11	.000	-		C3 > C2	.015	-
	C7> C12	.000	-		C92 > C3	.009	+
	C2> C12	.000	-		C92 > C90	.020	+

[14] Differences at the categorical level. (+) signifies a difference, (-) signifies no difference.

Variable	Clusters	P (α=.05)	CD
Perceived behavioral control	C9 > C12	.000	+
	C7 > C9	.000	-
	C9 > C90	.000	+
	C9 > C91	.019	+
	C11 > C10	.000	-
	C7 > C10	.000	-
	C4 > C10	.042	-
	C10 > C90	.025	+
	C11 > C12	.000	+
	C11 > C5	.016	-
	C11 > C3	.000	-
	C11 > C90	.000	+
	C11 > C91	.000	+
	C7 > C12	.000	+
	C4 > C12	.000	+
	C2 > C12	.002	+
	C92 > C12	.000	+
	C7 > C3	.000	-
	C7 > C90	.000	+
	C7 > C91	.000	+
	C5 > C90	.001	+
	C4 > C90	.000	+
	C4 > C91	.001	+
	C3 > C90	.000	+
	C2 > C90	.000	+
	C2 > C91	.004	+
	C92 > C90	.000	+
	C92 > C91	.002	+
Extraversion	C9 > C11	.000	-
	C9 > C7	.000	-
	C9 > C5	.000	+
	C9 > C4	.000	+
	C9 > C3	.000	-
	C9 > C90	.000	+
	C9 > C91	.000	+
	C10 > C11	.000	-
	C10 > C5	.000	+
	C10 > C4	.000	+
	C10 > C3	.002	-
	C10 > C90	.000	+
	C10 > C91	.001	+
	C11 > C5	.000	+
	C11 > C90	.041	+
	C12 > C5	.000	+
	C12 > C4	.001	+
	C12 > C90	.000	+
	C12 > C91	.012	+

Variable	Clusters	P (α=.05)	CD
Extraversion (Continued)	C7 > C5	.000	+
	C7 > C4	.030	+
	C7 > C90	.014	+
	C3 > C5	.027	+
	C2 > C5	.000	+
	C92 > C5	.000	+
	C2 > C4	.002	+
	C92 > C4	.049	+
	C2 > C3	.028	-
	C92 > C90	.021	+
Agreeableness	C9 > C11	.000	-
	C9 > C7	.000	-
	C9 > C5	.003	-
	C9 > C4	.000	+
	C9 > C3	.000	-
	C9 > C90	.000	+
	C9 > C92	.032	-
	C10 > C4	.000	+
	C10 > C90	.000	+
	C11 > C4	.000	+
	C11 > C90	.000	+
	C12 > C4	.000	+
	C12> C90	.000	+
	C7 > C4	.000	+
	C7> C90	.000	+
	C5 > C4	.000	+
	C5> C90	.000	+
	C3 > C4	.000	+
	C2 > C4	.000	+
	C91 > C4	.002	+
	C92 > C4	.000	+
	C3 > C90	.000	+
	C2 > C90	.000	+
	C91 > C90	.002	+
	C92 > C90	.001	+
Conscientiousness	C9 > C11	.000	-
	C9 > C7	.000	-
	C9 > C5	.002	-
	C9 > C4	.000	+
	C9 > C3	.000	-
	C9 > C90	.000	+
	C9 > C91	.037	-
	C9 > C92	.000	-
	C10> C4	.000	+
	C10> C3	.002	-
	C10> C90	.000	+
	C10> C92	.022	-

Variable	Clusters	P (α=.05)	CD	*Variable*	Clusters	P (α=.05)	CD
Conscientiousness (continued)	C11 > C4	.000	+	*Openness*	C9 > C11	.000	-
	C11 > C90	.000	+		C9 > C7	.000	-
	C12 > C4	.000	+		C9 > C5	.003	-
	C12 > C3	.016	-		C9 > C4	.000	+
	C12 > C90	.000	+		C9 > C3	.000	-
	C7 > C4	.000	+		C9 > C90	.000	+
	C7 > C90	.000	+		C10 > C11	.000	-
	C5 > C4	.000	+		C10 > C7	.000	-
	C5 > C90	.000	+		C10 > C5	.000	-
	C3 > C4	.000	+		C10 > C4	.000	+
	C2 > C4	.000	+		C10 > C3	.000	-
	C91 > C4	.007	+		C10 > C90	.000	+
	C92 > C4	.002	+		C10 > C91	.032	-
	C3 > C90	.000	+		C10 > C92	.010	-
	C2 > C90	.000	+		C12 > C11	.000	-
	C91 > C90	.003	+		C12 > C7	.000	-
	C92 > C90	.001	+		C12 > C5	.000	-
					C12 > C4	.000	+
Neuroticism	C11 > C9	.000	-		C12 > C3	.000	-
	C7 > C9	.000	-		C12 > C90	.000	+
	C5 > C9	.000	-		C12 > C91	.030	-
	C4 > C9	.000	+		C12 > C92	.007	-
	C3 > C9	.000	-		C2 > C4	.004	+
	C2 > C9	.032	+		C2 > C90	.026	+
	C90 > C9	.000	+				
	C91 > C9	.005	+				
	C92 > C9	.000	+				
	C11 > C10	.000	-				
	C7 > C10	.000	-				
	C5 > C10	.000	-				
	C4 > C10	.000	+				
	C3 > C10	.001	-				
	C2 > C10	.011	+				
	C90 > C10	.000	+				
	C91 > C10	.002	+				
	C92 > C10	.000	+				
	C11 > C12	.002	-				
	C4 > C11	.043	+				
	C7 > C12	.000	-				
	C5 > C12	.002	-				
	C4 > C12	.000	+				
	C3 > C12	.006	-				
	C2 > C12	.042	+				
	C90 > C12	.000	+				
	C91 > C12	.008	+				
	C92 > C12	.000	+				

APPENDIX E

RECOMMENDATIONS FOR STRATEGY SELECTION

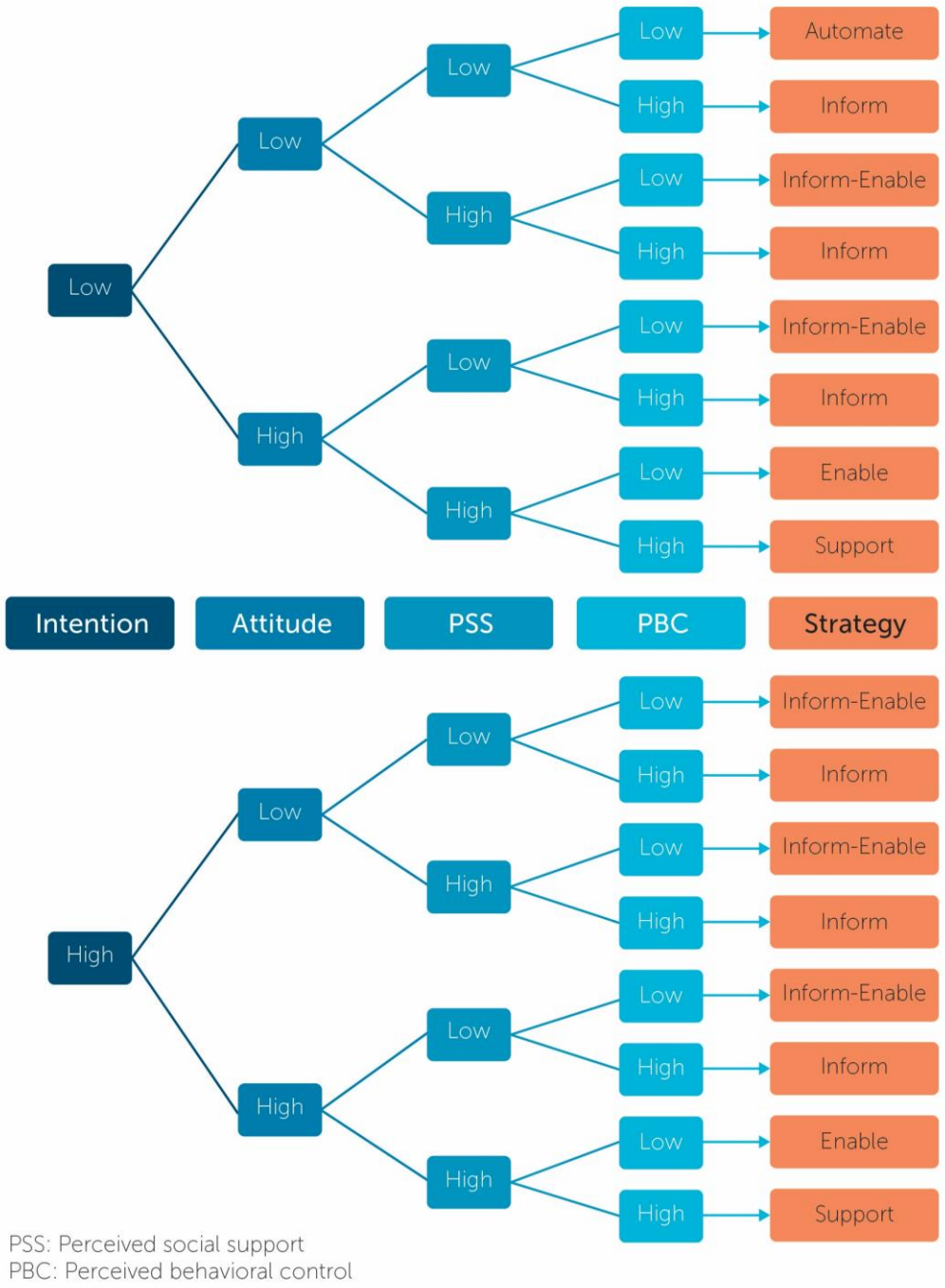


Figure E.1 The decision tree showing the recommendations for strategy selection

APPENDIX F

DESIGN BRIEFS

F.1 Design brief for CMU workshops

IDEA GENERATION WORKSHOP

redesigning Ford Escape's interaction with users
with the intention to encourage eco-friendly driving

Problem background

Reducing environmental impact occured during product use, e.g. electricity consumption, is one of the goals of design for sustainability. Research shows that previous approaches such as designing energy efficient products is not sufficient to achieve this goal, as user behaviour has a major influence on use impact besides product characteristics. To respond this challange, recently designers have been interested in designing products meant to change user behaviour for sustainability. One of the fields that design for behavior change can have an impact is personal transportation, which creates a significant impact due to fuel consumption and carbon emissions. Evidence showed that between 6% and 18% reductions can be achieved in fuel consumption and carbon emissions by influencing driver behavior, which makes 'driving' a good candidate for behavior change and sustainability.

Design challenge

Considering the importance of 'driving' for behaviour change and sustainability, in this workshop, you are asked to redesign Ford Escape's interaction with users with the goal of encouraging eco-friendly driving, which refers to driving efficiently for decreasing ones' fuel consumption and carbon emissions. You are asked to come up with design solution(s) that encourage desired behaviours and discourage undesired ones for eco-friendly driving. Since this is a design task, you are also expected to consider developing concepts that people want to buy.

Deliverables

As a response this design challange, you are expected to generate three product concepts as a group, and present these ideas to the other workshop participants. You will be provided a power point template to integrate your ideas. In your presentation you should elaborate on the following aspects in relation to each solution:

1. *What is the solution? Which behavior(s) it targets?*
2. *Who is it for? Who do you design for?*
3. *How does it work? how it encourages or discourages target behaviour(s)?*

Target behaviours

Target users

Ford Escape is one of the most common small sized SUVs in USA, owned by variety of users, who can be individuals and families belong to different socio-economic groups (low middle, middle, upper-middle), different age groups (young, middle aged and elderly), different genders (male and female).

Workshop procedure

Introduction-15 minutes:
A short introduction will be made at the beginning of the session explaining the design brief and the concept of design for behavior change for sustainability.

Idea generation-30 minutes:
You will be asked to develop ideas as a response to the brief by using post-it notes and sketches. In this phase, the quantity and diversity are important. Try to come up with as many ideas as possible.

Discussion on ideas and refinement – 45 minutes:
As a group you will decided on three promising ideas based on your discussion. You will be asked to refine and transform these ideas into product concepts.

Presentation and discussion – 30 minutes:
As a group, you will present your top three concepts to the entire group. You will be asked to explain each solution in terms of your target user(s), target behaviour(s) and the mechanism to infleunce these behavior(s) as well as rationale for your decisions.

Figure F.1 Front page of the design brief for CMU workshops

2014 Ford Escape Exterior and Interior

source: http://www.ford.com/suvs/escape/

Figure F.2 Back page of the design brief for CMU workshops

F.2. Design brief for METU workshops

IDEA GENERATION WORKSHOP

redesigning Fiat Linea's interaction with users
with the intention to encourage eco-friendly driving

Problem background

Reducing environmental impact occured during product use, e.g. electricity consumption, is one of the goals of design for sustainability. Research shows that previous approaches such as designing energy efficient products is not sufficient to achieve this goal, as user behaviour has a major influence on use impact besides product characteristics. To respond this challange, recently designers have been interested in designing products meant to change user behaviour for sustainability. One of the fields that design for behavior change can have an impact is personal transportation, which creates a significant impact due to fuel consumption and carbon emissions. Evidence showed that between 6% and 18% reductions can be achieved in fuel consumption and carbon emissions by influencing driver behavior, which makes 'driving' a good candidate for behavior change and sustainability.

Target behaviours

Target users

Fiat Linea is one of the most common cars in Turkey, owned by variety of users, who can be individuals and families belong to different socio-economic groups (low middle, middle), different age groups (young, middle aged and elderly), and different genders (male and female).

Design challenge

Considering the importance of 'driving' for behaviour change and sustainability, in this workshop, you are asked to redesign Fiat Linea's interaction with users with the goal of encouraging eco-friendly driving, which refers to driving efficiently for decreasing ones' fuel consumption and carbon emissions. You are asked to come up with design solution(s) that encourage desired behaviours and discourage undesired ones for eco-friendly driving. Since this is a design task, you are also expected to consider developing concepts that people want to buy.

Deliverables

As a response this design challange, you are expected to generate three product concepts as a group, and present these ideas to the other workshop participants. You will be provided a power point template to integrate your ideas. In your presentation you should elaborate on the following aspects in relation to each solution:

1. *What is the solution? Which behavior(s) it targets?*
2. *Who is it for? Who do you design for?*
3. *How does it work? how it encourages or discourages target behaviour(s)?*

Workshop procedure

Introduction-15 minutes:
A short introduction will be made at the beginning of the session explaining the design brief and the concept of design for behavior change for sustainability.

Idea generation-45 minutes:
You will be asked to develop ideas as a response to the brief by using post-it notes and sketches. In this phase, the quantity and diversity are important. Try to come up with as many ideas as possible.

Discussion on ideas and refinement – 45 minutes:
As a group you will decided on three promising ideas based on your discussion. You will be asked to refine and transform these ideas into product concepts.

Presentation and discussion – 30 minutes:
As a group, you will present your top three concepts to the entire group. You will be asked to explain each solution in terms of your target user(s), target behaviour(s) and the mechanism to infleunce these behavior(s) as well as rationale for your decisions.

Figure F.3 Front page of the design brief for METU workshops

2014 Fiat Linea Exterior and Interior

source: http://www.fiat.com.tr/modeller/sayfalar/YENILINEA

Figure F.4 Back page of the design brief for CMU workshops

APPENDIX G

PRODUCT EXAMPLE SHEET

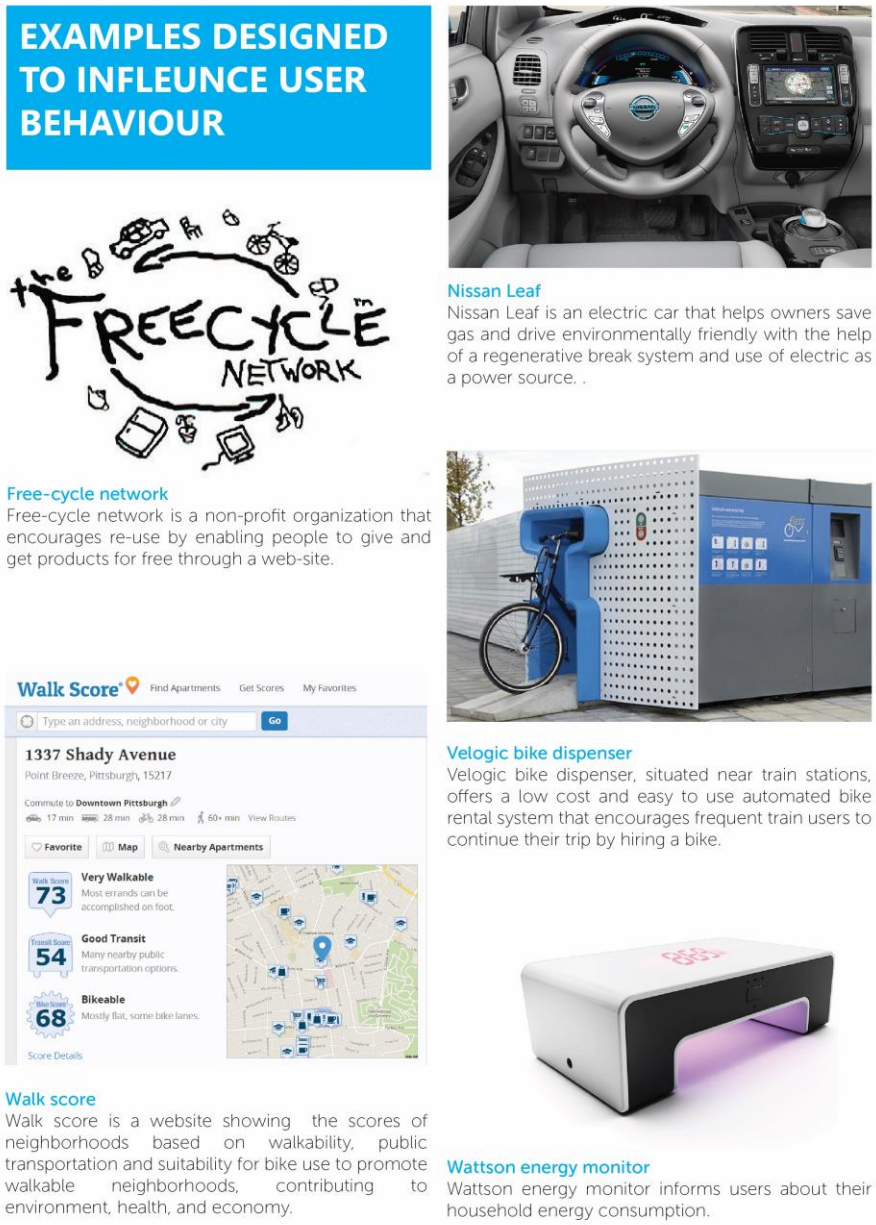
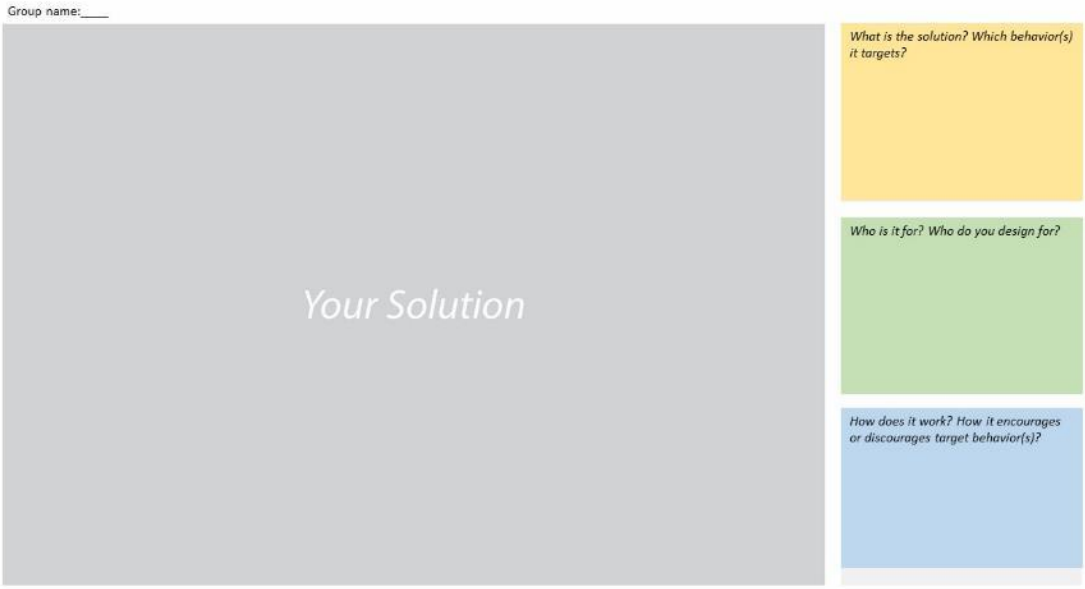


Figure G.1 Product example sheet

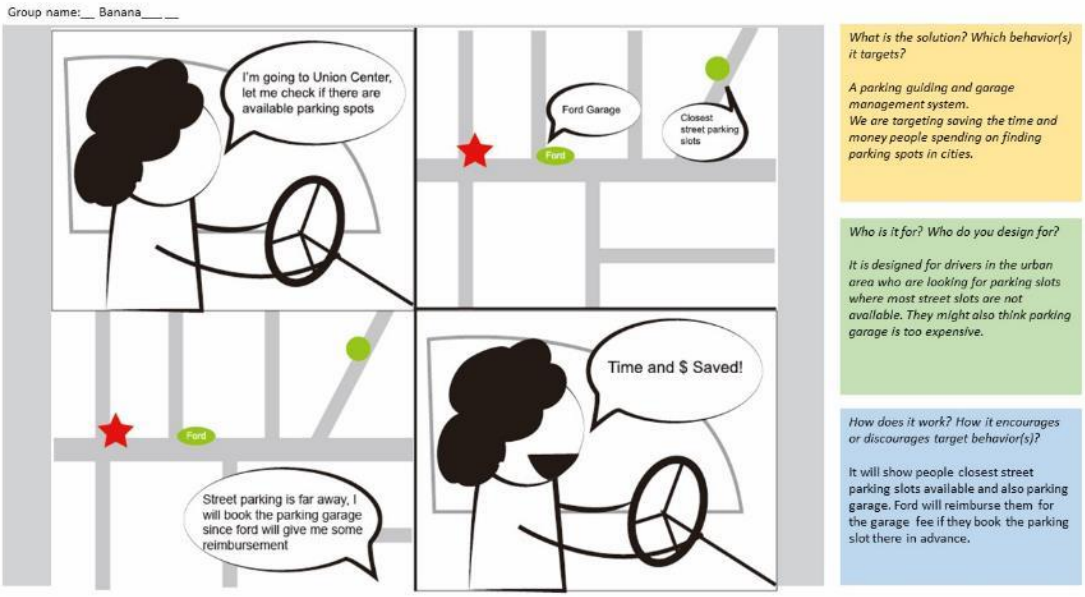
APPENDIX H

PRESENTATION TEMPLATE

H.1 Blank template given to students during the workshops



H.2 A filled template



APPENDIX I

POST-WORKSHOP QUESTIOANNAIRE

I.1 Questions for the design brief

IDEA GENERATION WORKSHOP

redesigning Ford Escape's interaction with users
with the intention to encourage eco-friendly driving

Problem background

Reducing environmental impact occured during product use, e.g. electricity consumption, is one of the goals of design for sustainability. Research shows that previous approaches such as designing energy efficient products is not sufficient to achieve this goal, as user behaviour has a major influence on use impact besides product characteristics. To respond this challange, recently designers have been interested in designing products meant to change user behaviour for sustainability. One of the fields that design for behavior change can have an impact is personal transportation, which creates a significant impact due to fuel consumption and carbon emissions. Evidence showed that between 6% and 18% reductions can be achieved in fuel consumption and carbon emissions by influencing driver behavior, which makes 'driving' a good candidate for behavior change and sustainability.

Design challenge

Considering the importance of 'driving' for behaviour change and sustainability, in this workshop, you are asked to redesign Ford Escape's interaction with users with the goal of encouraging eco-friendly driving, which refers to driving efficiently for decreasing ones' fuel consumption and carbon emissions. You are asked to come up with design solution(s) that encourage desired behaviours and discourage undesired ones for eco-friendly driving. Since this is a design task, you are also expected to consider developing concepts that people want to buy.

Deliverables

As a response this design challange, you are expected to generate three product concepts as a group, and present these ideas to the other workshop participants. You will be provided a power point template to integrate your ideas. In your presentation you should elaborate on the following aspects in relation to each solution:

1. *What is the solution? Which behavior(s) it targets?*
2. *Who is it for? Who do you design for?*
3. *How does it work? How it encourages or discourages target behaviour(s)?*

Target behaviours

Target users

Ford Escape is one of the most common small sized SUVs in USA, owned by variety of users, who can be individuals and families belong to different socio-economic groups (low middle, middle, upper-middle), different age groups (young, middle aged and elderly), different genders (male and female).

Workshop procedure

Introduction-15 minutes:
A short introduction will be made at the beginning of the session explaining the design brief and the concept of design for behavior change for sustainability.

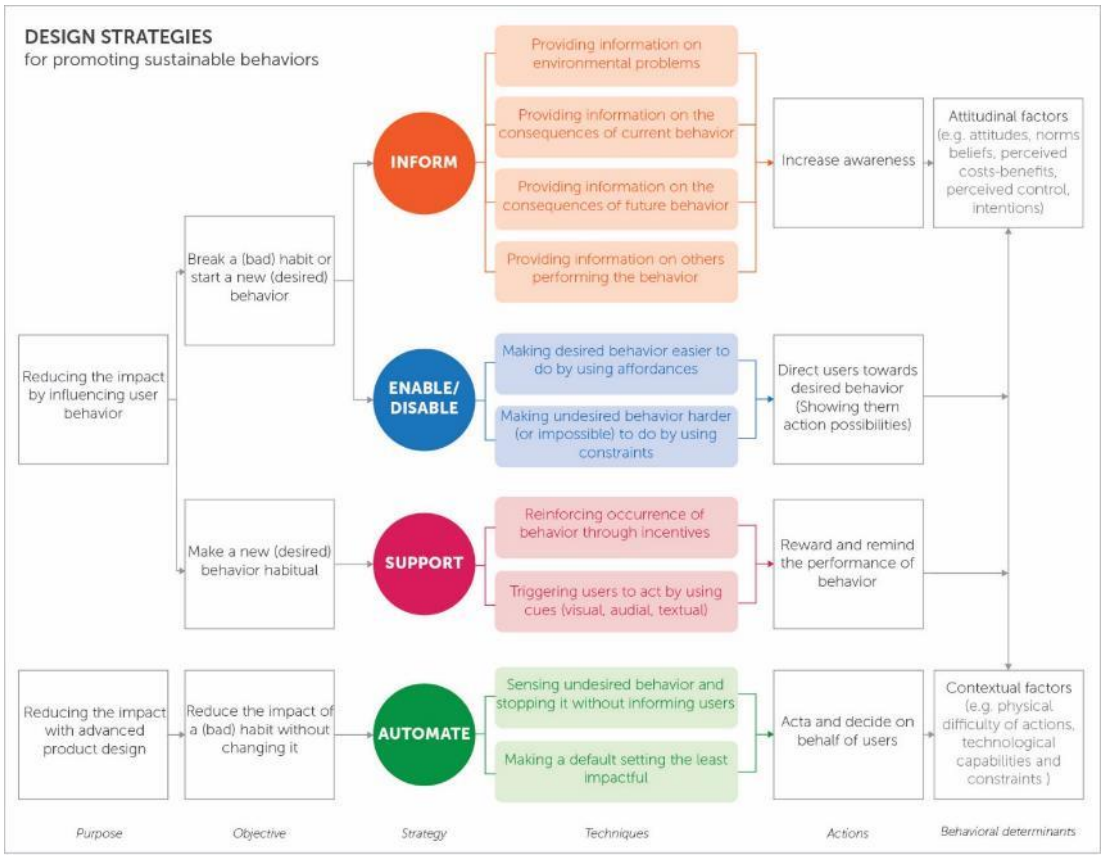
Idea generation-30 minutes:
You will be asked to develop ideas as a response to the brief by using post-it notes and sketches. In this phase, the quantity and diversity are important. Try to come up with as many ideas as possible.

Discussion on ideas and refinement – 45 minutes:
As a group you will decided on three promising ideas based on your discussion. You will be asked to refine and transform these ideas into product concepts.

Presentation and discussion – 30 minutes:
As a group, you will present your top three concepts to the entire group. You will be asked to explain each solution in terms of your target user(s), target behaviour(s) and the mechanism to influence these behavior(s) as well as rationale for your decisions.

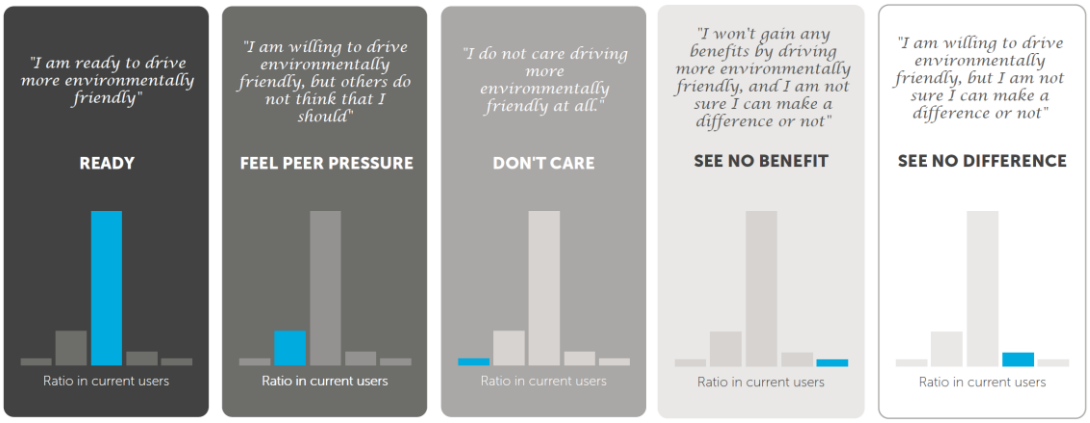
The design brief…	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
was useful for the task	1	2	3	4	5
was easy to understand	1	2	3	4	5
was inspirational to use	1	2	3	4	5
helped us understand the problem	1	2	3	4	5
was easy to integrate into how we usually work	1	2	3	4	5

I.2 Questions for the classification of strategies and strategy cards



Design strategies for promoting sustainable behaviors…	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
was useful for the task	1	2	3	4	5
was easy to understand	1	2	3	4	5
was inspirational to use	1	2	3	4	5
helped us understand different ways of influencing user behavior	1	2	3	4	5
helped us select behavior change techniques	1	2	3	4	5
was easy to integrate into how we usually work	1	2	3	4	5

I.3 Questions for user orientations



User orientation cards…	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
was useful for the task	1	2	3	4	5
was easy to understand	1	2	3	4	5
was inspirational to use	1	2	3	4	5
helped us consider user diversity when generating ideas for behavior change	1	2	3	4	5
helped us select target users	1	2	3	4	5
was easy to integrate into how we usually work	1	2	3	4	5

APPENDIX J

CONSENT FORM FOR THE IDEA GENERATION STUDY

Consent form for participation in research

Study Title: Investigating methods for designing for behavior change supporting sustainability

Principal Investigator: Aykut Coskun, Visiting researcher, Human Computer Interaction Institute, 5000 Forbes Avenue, Pittsburgh, PA 15213, 412 961 4619, aykutc@andrew.cmu.edu

Other Investigator(s): John Zimmerman, Assoc. Prof. Human Computer Interaction Institute, 5000 Forbes Avenue, Pittsburgh, PA 15213, (412) 608-8181, johnz@cs.cmu.edu

Purpose of this Study
The purpose of this study is to inform development of design tools that support designers to devise better solutions encouraging sustainable behaviors. Idea generation workshops facilitated with various design tools will be conducted to achieve this purpose. Researchers will use two data sources derived from these workshops: design ideas that you will generate during the workshops and the video recording of these workshops. Design ideas will be analyzed in terms of quantity and diversity, and the video will be analyzed in terms of how you use the design tools during ideation.

Procedures
You will be given to a design brief during the workshops, redesigning a car dashboard with the intention to encourage environmentally friendly driving, and asked to generate ideas as a group in response to this brief. You will be given design tools to facilitate idea generation process. After generating ideas, as a group you will decide the most promising three and refine them. At the end of the session, you will present these ideas to the entire group. If you are a participant from CMU, the workshops will be held in an allocated classroom located on CMU campus. If you are a participant from METU, the workshops will be held in al allocated classroom located on METU Campus. The workshops take approximately 2 hours and they will be video-recorded to understand how you use the design tools during ideation. The recordings will be kept in a secure computer and no access will be given except authorized researchers.

Participant Requirements
You are required to be above 18 years old and a student enrolled to CMU or METU to participate in this study.

Risks
The risks and discomfort associated with participation in this study are no greater than those ordinarily encountered in daily life. The only risk for you is your breach of confidentiality, someone could know you are participating in this study. This risk will be reduced by using anonymous names and codes for you for all the materials will be used in the study. The materials will be kept on a secure computer that only authorized researchers can access. Specifically, they will be stored in a secured file in CMU BOX cloud storage.

Benefits
There may be no personal benefit from your participation in the study but the knowledge received may be of value to design community, it will enable to develop tools for designers contributing to better designs that encourage sustainable behaviors.

Compensation & Costs
There will be no cost to you if you participate in this study. You will be provided with snacks during the workshops.

Confidentiality
By participating in the study, you understand and agree that Carnegie Mellon may be required to disclose your consent form, data and other personally identifiable information as required by law, regulation, subpoena or court order. Otherwise, your confidentiality will be maintained in the following manner:

Your data and consent form will be kept separate. Your consent form will be stored in a locked location on Carnegie Mellon property and will not be disclosed to third parties. By participating, you understand and agree that the data and information gathered during this study may be used by Carnegie Mellon and published and/or disclosed by Carnegie Mellon to others outside of Carnegie Mellon. However, your name, address, contact information and other direct personal identifiers in your consent form will not be mentioned in any such publication or dissemination of the research data and/or results by Carnegie Mellon. The researcher will take the following steps to protect participants' identities during this study: (1) Each participant will be assigned a number; (2) The researchers will record any data collected during the study by number, not by name; (3) Any original recordings or data files will be stored in a secured location accessed only by authorized researchers.

Optional Permission
I understand that the researchers may want to use a short portion of any video recording for illustrative reasons in presentations of this work for scientific or educational purposes. I give my permission to do so provided that my name and face will not appear.

Please initial here: _____YES _____NO

Rights
Your participation is voluntary. You are free to stop your participation at any point. Refusal to participate or withdrawal of your consent or discontinued participation in the study will not result in any penalty or loss of benefits or rights to which you might otherwise be entitled. The Principal Investigator may at his/her discretion remove you from the study for any of a number of reasons. In such an event, you will not suffer any penalty or loss of benefits or rights which you might otherwise be entitled.

Right to Ask Questions & Contact Information
If you have any questions about this study, you should feel free to ask them now. If you have questions later, desire additional information, or wish to withdraw your participation please contact the Principal Investigator by mail, phone or e-mail in accordance with the contact information listed on the first page of this consent.

If you have questions pertaining to your rights as a research participant; or to report concerns to this study, you should contact the Office of Research Integrity and Compliance at Carnegie Mellon University. Email: irb-review@andrew.cmu.edu . Phone: 412-268-1901 or 412-268-5460.

Voluntary Consent
By signing below, you agree that the above information has been explained to you and all your current questions have been answered. You are encouraged ask questions about any aspect of this research study during the course of the study and in the future. By signing this form, you agree to participate in this research study.

_____
PARTICIPANT SIGNATURE DATE

I certify that I have explained the nature and purpose of this research study to the above individual and I have discussed the potential benefits and possible risks of participation in the study. Any questions the individual has about this study have been answered and any future questions will be answered as they arise.

_____
SIGNATURE OF PERSON OBTAINING CONSENT DATE

APPENDIX K

WORKSHOP OUTCOMES

K.1 Ideas generated during the workshops

Table K.1 Ideas generated during the workshops classified according to behavior and strategy

Target behavior	*Strategy*	Solution
Combination of various behaviors (driving in general)	*Inform*	• Informing about various aspects of current driving patterns (e.g. fuel consumption, energy consumption, savings, violation of following distance, fast acceleration, instant break, AC use, the days remaining for refueling, rpm value, car's health based on current driving patterns • Showing the values (e.g. fuel consumption) for ideal driving and comparing it with current values • Suggesting the most fuel efficient routes • Giving recommendations for eco-friendly driving • Social interaction platforms in which drivers compete against their friends
	Enable	• Different driving modes (highway, city, long vs short route) • Trip planning system enabling drivers to plan their trip based on fuel consumption and time required to arrive at a destination
	Support	• Rewarding drivers who improved their performance through virtual rewards (growing tree, eco-score), financial rewards (a free song from iTunes, discounts for maintenance and parking, donations to environmental charities)
	Automate	• Self-driving car

Target behavior	*Strategy*	Solution
Excessive use of Air conditioning	*Inform*	• Informing drivers about the amount of consumption associated to use of AC • Informing drivers about the time required to adjust the temperature inside the car for both cooling and warming, • Recommending the most energy efficient AC usage for the outside temperature.
	Enable/disable	• Disabling AC usage by making the button hard to access, e.g. hiding the button glove box • Limiting the use of boost mode for warming and cooling gradually by making it harder to press • Making harder to open the windows when AC is on. • Additional AC controls for other passengers • Having an alternative energy source for the AC, e.g. hand-powered AC
	Automate	• A smart AC system which collects user data on their cooling and warming temperatures, adjusts the desired temperature based on this data and outside temperature. • Turns itself automatically when the desired temperature is achieved • Turns itself automatically when car windows are opened by the user.
	Others	• Improving the energy efficiency of AC • Front glass absorbing heat and warm itself • Different interior colors for different seasons • Reflective windows tinting automatically in a sunny day
Fast acceleration	*Inform*	• Informing about how fast the driver accelerates in the dashboard • Exaggerating the engine sound when they boost the acceleration pedal • Vibrating the steering wheel to warn them about fast acceleration
	Enable/Disable	• Increased pedal resistance to discourage fast acceleration • Giving an option to turn on/off fast acceleration and instant break • Disabling acceleration when the car reached the speed limit • Giving an adjustable accelerating time • Tightening seat belt when the driver accelerate faster
	Support	• Rewarding the driver due to gentle acceleration through virtual rewards (e.g. eco-score)
	Others	• Play soothing music when stopped in the light

Target behavior	*Strategy*	Solution
Idling	*Inform*	• Informing about various aspects of idling including idling time (instant and cumulative), the routes requiring less idling (e.g. less traffic lights), and the fuel consumption associated to idling,
	Enable/Disable	• Giving user the option to preheat/or cool the car remotely • Providing an instant on/off button • Giving an option to use the car in sleep mode (or eco-friendly mode) during idling
	Automate	• Automatically turning of the engine due to excessive idling
	Others	• An alternative radio battery to prevent idling caused by waiting in the car and listening music
Spending too much time to find a parking spot	*Inform*	• A GP integrated parking system showing available parking lots nearby
	Enable	• Parking reservation system allowing users to reserve a spot • Making parking easier (through sensors and a total new wheel type)
	Support	• The car company pays for valet parking
	Others	• Creating more parking spots
Regular maintenance	*Inform*	• Simulating a car preventing itself from operating for 5 minutes if the driver does not go to regular maintenance • Showing the predicted cots of not going to maintenance in the long term • Showing tire pressure in the dashboard and its impact on fuel consumption • Reminding that the car needs maintenance and showing the closest maintenance garage
	Support	• Reminding the car maintenance through direct feedback, you are consuming too much fuel fix your car • Reminding the maintenance through emotional feedback, e.g. siri and personification of the car • Providing an enjoyable maintenance experience, • Loaner delivery until the maintenance complete • Integrating maintenance and shopping mall, giving a theater ticket or a coupon
	Others	• Making the car durable, for increased maintenance period

Target behavior	*Strategy*	Solution
Safe following distance	*Inform*	• Informing about the safe following distance (safe zone indicator) • Alarming when it is too short (front glass or dashboard, projecting onto the car in front)
	Enable/disable	• Cruise control • Disabling acceleration when the safe following distance is violated through front bumper sensory restricting speed
	Automate	• Sensing the following distance and automatically decreases the car speed
Instant break	*Inform*	• Informing about the suitable break time • Showing the car health based on breaking patterns • Saying the driver to keep calm • A warning system which reminds the driver to slow down when approaching to traffic lights and other areas like cross walks and schools
	Enable/Disable	• Disabling acceleration when approaching to a traffic light
	Automate	• A car reduces the speed automatically when it is approaching to schools, crosswalks, traffic lights etc.
	others	• Higher car body and wheels to give a more distant vision to drivers
Excessive load	*Inform*	• Informing about the excessive load and consumption associated to this load • Showing the available gas stations to avoid travelling with full tank
	Enable	• Preventing engine from starting when it is heavily loaded • Making harder to close the baggage door when it is heavily loaded
	Support	• Reminding the excessive load remained in the car luggage for a long time

K.2 Ideas refined to product concepts

Table K.2 Ideas refined to product concepts classified according to behavior, strategy and user

Group	Solution	*Strategy*	Target behaviors	Target users
Control group	Advertising leisure car; a different desirable lifestyle change built of "traditional" values	*Inform*	Eco-friendly driving in general	Lower middle class to middle class income households
	Pleasurable maintenance experience: communal spot to hang out, have a coffee and appreciate your car.	*Support*	Regular maintenance	Younger/new lower middle class or middle class
	Seatbelt and pedal resistant against fast acceleration	*Disable*	Fast acceleration	Aggressive drivers in general
	Parking system detecting available lots nearby	*Inform*	Spending time with parking	Urban citizens
	A system Informing about the next traffic light and suggesting a desired speed	*Inform*	Fast acceleration, instant break	Urban citizens
	A smart AC system learns user heating/cooling habits and adjust itself to users' preferences	*Automate*	AC	Personal car user
	An in-vehicle system integrated with a mobile app making suggestions about healthy living, walking and biking	*Non-driving*	Non-driving	18-40 age people
	A system informing about the ideal driving habits to extend the cars' lifespan	*Inform*	Eco-friendly driving in general	Middle age people with limited information on their cars
	Carpooling system	*Non-driving*	Non driving	Young people
	Automatic speed limit(user can adjust the limit) warns the user when the limit is achieved	*Inform& Enable*	Fast acceleration	Drivers who love driving fast
	Safe following distance feedback system sensing the distance between two cars and giving feedback through the back and front of the car	*Inform*	Safe following distance	Experience drivers with high self-confidence
	Personal car assistant reminding regular maintenance with emotional feedback	*Inform*	Regular maintenance	For unexperienced drivers with busy schedule

Group	Solution	*Strategy*	Target behavior	Target users
Strategy group	A system giving one's fuel consumption feedback along with others' fuel consumption, allowing drivers to compete	*Inform& Support*	Eco-friendly driving in general	Anyone who wants to save money, especially effective for competitive people.
	A road rage soothing system discourage fast acceleration	*Inform*	Fast acceleration	Urban citizens
	A parking guide and garage management system, in which booking a parking spot in advance is rewarded through discounts	*Inform& Support*	Spending time with parking	Urban citizens
	An indicator for turn off engine which becomes visible during idling	*Inform*	Idling	For people who idles too much
	A car heating system allows user to set a pre-determined temperature and adapts itself this temperature automatically	*Automate*	Idling	People who are in hot or cold climates
	A system giving one's fuel consumption feedback along with others' fuel consumption, allowing drivers to compete	*Inform& Support*	Eco-friendly driving in general	People who like gaming and competition
	Giving feedback on fuel consumption associated with excessive load	*Inform*	Excessive load	People with low environmental concern
	Carpooling	*Non-driving*	Non-driving	Age 18-40 car owners with environmental concern
	Giving information on traffic lights so that drivers does not need to do instant break	*Inform*	Instant break	Anyone
	Giving feedback through front glass when safe following distance is violated	*Inform*	Safe following distance	Careless drivers
	Tracking users' driving performance and giving suggestion on how to improve	*Inform*	Eco-friendly driving in general	For people willing to improve their driving but not aware of the reasons and solutions
	Sensing long idling times and reminding the drivers to turn of the engine	*Support*	Idling	People who idles too much

Group	Solution	*Strategy*	Target behavior	Target user
Orientation group	A game rewarding gentle acceleration and punishing instant break	*Support*	Fast acceleration	The "Ready" user
	An emotional car which gets upset due to bad driving	*Inform*	Eco-friendly driving in general	The "Ready" user
	Physical feedback discourages poor braking habits by making the driver uncomfortable	*Inform*	Instant break	The "Ready" user
	Different ignition modes to save fuel consumption.	*Enable*	Eco-friendly driving in general	Ready users, people with high environmental concern and are aware of their fuel emissions.
	Interactive system that shows a user's driving quality, rewards good driving with gift cards	*Inform& Support*	Eco-friendly driving in general	Young drivers
	A system calculating a car's life based on driver's behavior	*Inform*	Eco-friendly driving in general	People who care for their cars too much
	An indicator of rpm value with three levels, green, yellow and red to discourage fast acceleration	*Inform*	Fast acceleration	People 18-50 ages
	An application showing drivers the most time and fuel efficient route	*Inform*	Eco-friendly driving in general	People who travel a lot
	Rewarding good driving with gamification and giving discounts for maintenance	*Support*	Eco-friendly driving in general	Young people
	An application showing the need for maintenance and available maintenance stores nearby	*Inform*	Regular maintenance	Ready users
	A smart feedback system augmenting the places drivers need to slow down (crossings slopes bumps)	*Inform*	Instant break	Ready users
	A feedback system which creating an artificially exaggerated engine noise for fast acceleration	*Inform*	Fast acceleration	Ready users

APPENDIX L

EXAMPLE QUOTATIONS FROM METU WORKSHOPS

Table L.1. The original and translated versions of the example quotations from METU workshops

Turkish (original)	**English (Translated)**
Şimdi bizden şuradaki davranışları teşvik etmemizi veya önlememizi istiyorlar. Bence bu davranışların her birine bir çözüm düşünerek başlayabiliriz.	So there is these target behaviors they want us to encourage and discourage. We can think of solutions for each of them. (P19)
Hmm, fast acceleration üzerinde çok fazla düşünmemişiz. O nedenle biraz da ona yoğunlaşabiliriz.	Let's see, we do not have any for 'fast acceleration'. May be we can focus on this next. (P24).

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Coşkun, Aykut
Nationality: Turkish (TC)
Date and Place of Birth: 30 March 1985, Ankara
Marital Status: Married
Phone: +90 312 210 4219
Fax: +90 0 312 210 7963
email: aycoskun@metu.edu.tr, aykutcoskuntasarim@gmail.com

EDUCATION

Visiting student researcher, 2014
Human Computer Interaction Institue, Carnegie Mellon Univeristy, Pittsburgh, PA-US

M.Sc. in industrial design, 2008-2010
Department of Industrial Design, Middle East Technical University, Ankara, Turkey
Advisor: Assist. Prof. Çağla Doğan
Thesis title: Post-use design thinking for product design process and sustainability: a study on an educational project on glass packaging

Erasmus Exchange Student. 2007
Department of Industrial Design, Politecnico di Torino, Turin, Italy

B.Sc. in industrial design, 2003-2008
Department of Industrial Design, Middle East Technical University, Ankara, Turkey

WORK EXPERIENCE

Teaching Assistant, 2008 (ongoing)
Department of Industrial Design, Middle East Technical University, Ankara, Turkey

Design Researcher, 2011 (ongoing)
METU-BILTIR/UTEST Product Usability Unit, Ankara,Turkey

Graphic Designer, 2008
Graphic Design Unit, Middle Technical University, Ankara, Turkey

FOREIGN LANGUAGES

Advanced English, Elemantary italian

PUBLICATIONS

Journal articles

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