Persuasive Design Aid for Products Leading to LOHAS Considering User Type

Li-Hsing Shih

Abstract This study proposes an aid for generating new design that persuades users to more bodily movement for both health and energy harvesting, leading to LOHAS (lifestyle of health and sustainability) by using a behavior model that suggests users' motives and ability are keys for successful persuasion. The work consists mainly of three parts. Firstly, a questionnaire survey is conducted to gather users' basic information and users' motives and ability in conducting exercise and using products that require bodily movement. Regression models are built to identify potential user's motives and lack of ability based on their information. Secondly, a domain model for case-based reasoning is proposed that explains how design and technology can help persuade users to perform target behavior including moving upper limbs, lower limbs, and whole body. A case library contains more than 90 cases with information of five groups of attributes of the domain model. In the third part, a six-step procedure is proposed based on the concept of case-based reasoning to find useful suggestions on product design from retrieved cases by specifying target users and target behaviors. An illustrative example is presented at the end to demonstrate the proposed approach.

Keywords Case-based reasoning • Design for sustainable behavior • LOHAS • Persuasive design

1 Introduction

Designing products that influence more sustainable behavior is a current focus of many studies, instead of traditional focus on reducing environmental impact and energy use in material extraction and manufacturing stages. Example literatures on design for sustainable behavior (DfSB) include Lilley [1], Wever et al. [2], Lockton and Harrison [3, 4], and Pettersen and Boks [5]. The essence of the studies is establishing relationship between users' behavior change and design principle so

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that useful suggestion on design could be made for achieving target sustainable behaviors. But explicitly describing the cause-effect relationship is not easy since behavior change involves various interacting psychological and social factors. Shih and Hsin [6] tried to overcome the difficulty of describing relationship between design and behavior change based on two ideas: (1) the relationship may be easier to describe if we narrow down the scope and focus on certain type of product and (2) instead of establishing explicit rules to describe the relationship, case-based reasoning may work by properly retrieving past successful cases and getting useful suggestions from past experience. Shih and Hsin [6] and Shih and He [7] intentionally narrowed down the scope and focused on a type of products requiring more human bodily movement. The reasons of selecting this type of product design are twofold: (1) bodily movement could serve as a source of energy harvesting (or called human power) that helps reduce conventional energy consumption and (2) bodily movement often brings benefits in health as well as rehabilitation. Persuading users to more bodily movement could generate clean energy and get healthier body and could also be recognized as a mean leading to a lifestyle of health and sustainability (LOHAS), which was first introduced by Ray and Anderson [8] and often used to define a particular market segment focusing on sustainable living and ecological initiatives.

A case-based reasoning (CBR) approach that extracts knowledge from past cases to provide useful suggestions for new product design is proposed to facilitate DfSB for the underlined product. Concepts of case-based reasoning including setting domain knowledge model, retrieving, and reusing cases are utilized to extract knowledge and experience from existing cases (Aamodt and Plaza [9], Aha [10]). In this study, relationship between behavior change and useful design principles is highlighted via a case library that includes product cases leading users to more bodily movement. Several research such as persuasive technology proposed by Fogg [11, 12] and Fogg and Hreha [13]; persuasive system design (PSD) by Oinas-Kukkonen and Harjumaa [14]; and design with intent (DwI) by Lockton et al. [4, 15] were integrated and extended in building the domain knowledge model which eventually defines the information recorded in case profiling. Shih and Hsin [6] had shown some results of the above ideas. They proposed a domain knowledge model that includes a novel category of target behaviors, design principles, design patterns, and applicable technologies that work with design principles leading to behavior change. A case library was constructed accordingly where each case was expressed as a set of attributes of the domain knowledge model. Designers could therefore get useful suggestions on applicable technologies, design principles, and patterns from retrieved cases as target bodily movement are given as input of conditional search.

In this study, two additional key factors of a behavior model proposed by Fogg [12] including users' motives and ability are deliberately included in the domain knowledge model. Inclusion of users' motives and lack of ability expands and strengthens the power of the domain knowledge model in describing the relationship of behavior change and product design, especially when target users are known. The reason of including these two factors is twofold: (1) by knowing who

target users are and their motive and lack of ability could be identified, and (2) by knowing target behavior and target users with identified motive and ability, more suitable cases could be retrieved and more useful suggestions of design principles and applicable technologies could be found. Naturally, the inclusion increases the workload in case profiling, while why and how target users may use the case product requiring prior analysis and is then stored as case knowledge. The advantage of doing so is that more proper cases could be retrieved and more useful design suggestions could be found since motives and lack of ability of target users are identified as additional information in searching for "similar" cases.

The research work includes three parts. Firstly, a questionnaire survey is conducted to gather local users' basic information (about who the users are) and users' motives and ability in conducting exercise and using products that require bodily movement. From the responses of the survey, regression models were built to identify user's motives and lack of ability by knowing user's basic information like age, gender, habit of exercise, and so on. Secondly, a new domain model for case-based reasoning is proposed that explains how design and technology can help persuade users to perform target behavior including moving upper limbs, lower limbs, and whole body. There are five groups of attributes in the domain model including target behavior, design principle, design pattern, applicable technology, and newly added user's motive and ability. A case library contains more than 90 cases with information of the five groups of attributes. Finally, a searching engine is written based on the concept of case-based reasoning to find useful suggestions on product design by specifying target users and target behaviors, while motives and lack of ability of the target users could be identified based on the results of regression analysis. Following sections will explain detail of the work and present an illustrative example.

2 Statistical Models for Identifying Users' Motives and Lack of Ability

Since products that require bodily movement are of interest, potential users' attitude, behavior, and habit regarding exercise and bodily movement are investigated as well as their motives and lack of ability in using products requiring bodily movement. A questionnaire containing questions about people's age, gender, education, vocation, time, and frequency of doing exercise, motive, and lack of ability were presented to local people to gather information about who the users are and their motives and lack of ability when they use products that require bodily movement. Statistical model based on regression analysis is built to describe the relationship between user information (independent variables) and their motives and lack of ability (dependent variables).

There were more than 45 questions containing four groups of questions:

1. Respondents' basic (demographical variables) information such as age, gender, education, and vocation.
2. Exercise habit including health condition, frequency, and average time for weekly exercise.
3. Motives for using products requiring bodily movement. A typical question is like: do you agree providing audio device (like playing music) is important in using product that requires bodily movement? Respondents can rate level of agreement on the statement with Likert 5-point scale.
4. Lack of ability. A typical question is like: if the product have some device to help you reduce complicated operation, would you be more willing to use it?

Questions in (1) and (2) were used to identify who the users are, while questions in (3) and (4) include various measures of users' motive and lack of ability for using product that require bodily movement. The measures were summarized into ten types of motives and five types of lack of ability as shown in Tables 2 and 3. The detail questionnaire design could be found in Sun [16].

The questionnaire survey was conducted in January of 2014 in Taiwan. More than 290 responses were collected, while 250 responses were identified as effective responses. Some statistics of the respondents are gender (male, 51 %; female, 49 %), age (under 25, 40 %; 25–40, 21 %; 40–60, 35 %; above 60, 4 %), self-assessed health condition (bad, 3 %; alright, 38 %; good, 44 %; very good, 15 %), frequency of exercise (none, 14 %; one to two times per week, 48 %; three to five times, 30 %; more than six times, 8 %), and average time per exercise (less than 30 mins, 47 %; 30–60 mins, 37 %; more than 60 mins, 16 %).

Regression models were built with 7 independent variables measured in question groups (1) and (2) and 15 dependent variables measured in question groups (3) and (4). For each motive or ability, a regression model was built and tested for significance. For example, M1 stands for the first motive: pursuing visual pleasure (ranging from 1 to 5 where 5 means the strongest) and seven independent variables (x1–x7) including age, gender, education, vocation, health condition, frequency, and time of weekly exercise. The regression models can be used to express relations between levels of the motives or lack of ability and types of target users. In other words, by having target users' information such as age, gender, frequency, and time of weekly exercise, their level of motives and lack of ability can be estimated via the regression models.

After significant testing for the 15 regression models, regression models for M2, M3, M4, M6, and M7 passed the significant tests, while regression models for five abilities (A1–A5) passed significant tests. To use these regression models, one can substitute independent variable values describing target users to obtain the level of motive and lack of ability. For example, one of the regression models is like

$$M2 = 3.317 + 0.580*x1 - 0.183*x2 \quad (1)$$

where M2 denotes the motive of audio pleasure, x1 denotes gender (x1 = 0 denotes male; x1 = 1 denotes female), and x2 denotes age. Other independent variables did

not pass significant t-test in this regression model. Once target user is identified with gender and age, the regression model can help estimate the level of motive M2. The regression coefficients of model (1) indicate that female and young people significantly prefer product providing more audio pleasure like music playing. Please ensure that all figure and tables are cited in the body text consecutively. Figure and tables are placed near the cited point.

3 Knowledge Extraction from Cases with Domain Knowledge Model

In case-based reasoning, a domain knowledge model is needed to describe the relationship between target behavior and applicable design principles and extract past experiences from cases. The model contains knowledge to answer questions like what kinds of design would influence user behavior leading to bodily movement and what types of design or technology used would be more effective in persuading users for using the new product.

To establish the domain model, this research begins with reviewing relevant literatures and defining the scope. The second step is to propose a domain model with case attributes later used in building a case library. The third step is to cross-check the proposed domain model with collected information of existing cases. After the three steps, a domain model with five sets of attributes that describe the cases is defined, including:

1. Target behavior involving bodily movement
2. Motives and lack of ability of users
3. Design principles modified and extended from the list in PSD
4. Design patterns modified and extended from the list in DwI method
5. Technology used together with design for effective persuasion

The following are detail discussion of the five sets of attributes contained in the proposed domain model:

1. Target behaviors. The idea of Behavior Wizard by Fogg and Hreha [13] was referred herein to present target behavior while Shih and Hsin [6] suggested it composed by two axes: three types of behavior changes and three moving parts of user's limbs that were specifically proposed for the underlined product design. Three types of behavior changes adopted from Behavior Wizard were chosen including (a) users try out new behavior, (b) users re-perform beneficial actions, and (c) users increase behavior intensity. Since the essence of this study is to persuade people into more bodily movement, it is crucial to identify which parts of the body exercise may be classified into upper, lower limb, or whole-body movement. This classification provides a simple and more objective way on viewing the different bodily movement and assists in retrieving cases in further applications. This target behavior is depicted with a 3×3 matrix in Table 1.

Table 1 Target behavior matrix

	Do new behavior	Do familiar behavior	Increase behavior intensity
Upper limb			
Lower limb			
Whole body			

Table 2 Motives of users for having more bodily movement

M1. Visual pleasure	M6. Accomplishment
M2. Audio pleasure	M7. Fashion
M3. Physical excitement	M8. Cooperation or friendship
M4. Learning	M9. Competition
M5. Health	M10. Sustainability (energy generation)

Table 3 Ability needed for more bodily movement

A1. Saving time
A2. Less physical effort
A3. Less brain cycle
A4. Less social deviance
A5. Turning behavior to routine

2. Motives and lack of ability of users. Fogg [12] stated that motive, ability, and trigger are three factors for behavior change. Since more understanding of users' motives and lack of ability could help choose effective design principles and patterns in DfSB, these two factors were included in the domain model as well as case profiling. For each case, why (motives) and how (ability) target users use the case product are described in the case profile. In retrieving cases, if potential users' motives and lack of ability are known via prior investigation (as shown in Sect. 2), more appropriate cases and useful suggestions can be found. For the underlined-type product, ten types of motives and five types of lack of ability were proposed and shown in Tables 2 and 3.
3. Design principles: The 28 design principles presented in persuasive system design (Oinas-Kukkonen and Harjumaa [14]) provided a checklist in case knowledge extraction. Since this study only focuses on the specified type of product design, not all design principles would be useful. After checking with collected cases, 17 out of 28 design principles were found appearing in the 98 cases.
4. Design patterns. The 101 design patterns from DwI method (Lockton et al. [4, 15]) were examined and inspected with case products related to this domain. Forty-three out of the 101 design patterns were used in the 98 cases, while additional six design patterns were added by this study. The six additional design patterns include full recording, virtual reality, energy feedback, virtual rewards, system praise, and public exhibition, which were useful in persuasive design for the underlined product. For example, "energy feedback" means there

is energy generated by human bodily motion and usually the energy can be used by users. "Public exhibition" means that product could be placed in public places like airport or rail station on purpose since some users are more willing to try it because other people can see them using the product.

5. Technology is another major ingredient in persuasive technology. Fogg [12] pointed out that technologies can play roles in three ways, as tools, media, and social actors, thereby presenting various functions and influencing behaviors differently. Applicable technology was included in the domain model because it often works together with design means in persuading people to behavior change. Therefore it is important to sort out the technologies that are commonly used in underlined products to understand their effect. Eighteen modern technologies, mainly information and communication technologies, used in the collected cases were summarized including video display, recording, audio player, health condition detecting, vibration, motion detector, internet connection, energy harvesting, etc.

4 A Case Library

A case library is built up by case products that are carefully gathered to present actual examples of the designated type of products; therefore these cases must be chosen and conform the following criteria:

(a) Case product goal must relate to health or sustainability (human power energy harvesting) domains; characteristics in these cases somewhat fit the idea of lifestyle of health and sustainability (LOHAS), examples include healthcare systems, exercise and fitness, and energy harvesting.
(b) The behaviors performed in using these case products must include human bodily movement, which is defined by the World Health Organization as any body movements produced by skeletal muscles that require energy expenditure.
(c) Each case has applied modern information and communication technologies.

A total of 98 cases were collected for the case library, and the major sources of these cases are websites like Yanko designs, Gizmag, and Inhabitant that introduce new green-designed product, fitness products, and other ingenious designs of modern designers. Other sources of cases are reviewing literature of different research that matches the scope of this study. These 98 cases varies differently from health to sustainability perspective like fitness or "exergaming" products, physical therapy, healthcare systems for the elderly, and energy harvesting from human motion.

Besides basic information like name, picture, and source, each case profile must include information of the five sets of attributes mentioned in Sect. 3. The followings are some notes in establishing case profile.

1. Which part of bodily movement is involved in the case? Upper body, lower body, or whole body? And what kind of behavior change?

2. What users' motives are expected by the designer of the case for using the case product? What kind of ability for behavior change is the case product enhancing? To answer these questions, one needs to know who the target users of the case product are. If there are multiple groups of target users, all possible motives and abilities should be included in the case profiling.
3. Check which design principles are used in the case product. Detail descriptions of 28 candidate design principles can be found in Oinas-Kukkonen and Harjumaa [14]. For the 98 cases, 17 design principles were found useful.
4. Check which design patterns are used in the case products, while detail descriptions of 101 candidate design patterns can be found in Lockton et al. [15]. After observing the 98 design cases, 43 out of 101 design patterns were found useful, while additional six design patterns were proposed by this study.
5. Check what kinds of information and communication technologies are used in the case products.

To make an appropriate case profile, authors carefully collected product description and sometimes tried out the product before profiling and extracting information bearing in mind the domain model. After case profiling, indexing was conducted to transform the descriptions into indices denoting different attribute levels. Indices break down the descriptions of attributes into codes and help sort out the differences between cases, which is very important for case search and retrieval.

Another worth noting issue is that these cases were collected from websites, market commercials, and product brochures. It is difficult to verify how successful the case products actually persuade users, let along knowing effects to various types of users. This may be seen as a drawback of the proposed method applying the case library since the effectiveness of the retrieved knowledge applied in new design cannot be verified.

5 An Aid for Retrieving Useful Cases and Providing Design Suggestions

In this section, an approach for generating design concept is proposed based on concepts of case-based reasoning, while an information system based on data management software ACCESS was written to aid the process, making case retrieval and proposing suggestions easier and faster.

Product designers may begin by identifying their design requirement through specifying target behavior with the 3×3 behavior matrix (Table 1), depending on which parts of the body are required to be active and what kinds of behavior flavors are expected. If target users are specified, prior analysis could be conducted to find corresponding motives and lack of ability to use the new product so that retrieval of useful cases could be more effective. With specified target behavior and target users, suitable cases could be retrieved for providing past experiences in design principles and design patterns. When multiple cases are retrieved, frequently used

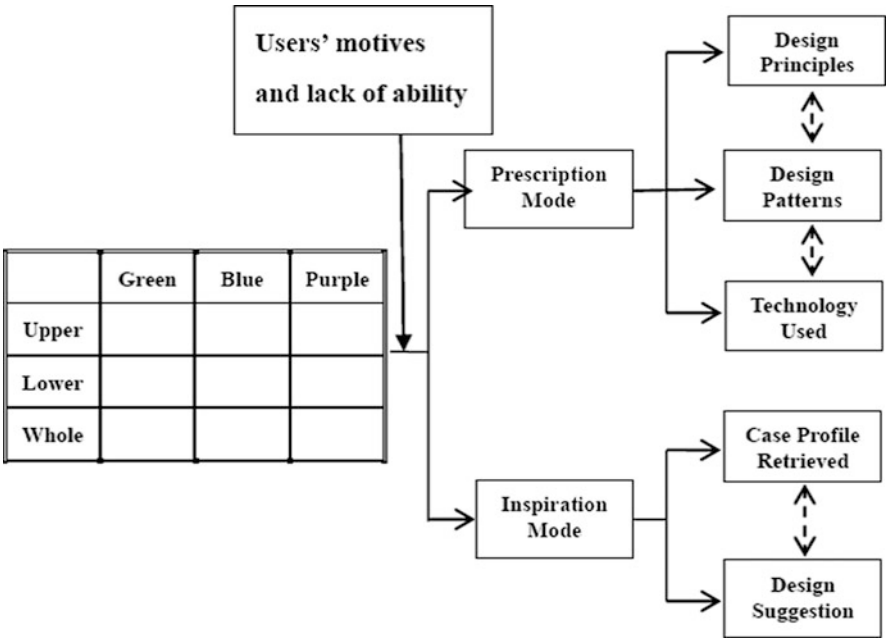

Fig. 1 Application flowchart of the proposed method

design principles and patterns for particular target behaviors are identified and presented. Technologies that often cowork with design principles and patterns are also identified. Designers can refer directly to retrieved case profiles or get inspired by the design suggestions including applicable technology, design principles, and design patterns. Please refer to Fig. 1 illustrating the idea of applying the proposed approach. In inspiration mode, retrieved case profiles could provide inspiration, while in prescription mode, suggestions on design principles and patterns and applicable technologies appeared in retrieved cases are summarized and deliberately presented for stimulating new design ideas.

To summarize, a six-step procedure is proposed to use the case library and to find useful suggestions on design principles, design patterns, and applicable technologies:

1. Specify goal of the project either an existing product that needs new idea to improve or a completely new product starting from conceptual design.
2. Specify target behaviors including expected part of the body moving and behavior flavors. In other words, see which cell in Table 1 (a 3×3 matrix) applies to describe the target behavior.
3. Conduct prior analysis on target users to find their potential motives and lack of ability in performing the target behavior. This is not easy and may require a lot of effort and detail consideration in a case-by-case basis. Section 2 tried to reduce the working load of prior analysis to some extent and established in advance

several regression models to estimate levels of motive and lack of ability of target users described with seven independent variables (x1–x7) including age, gender, education, vocation, health condition, frequency, and time of weekly exercise.
4. Use results of (2) and (3) as input conditions to search for similar cases and retrieve case profiles and indices that include design principles, patterns, and technologies. Relax minor condition if no case could be retrieved and conduct the search again. The information of design and technology contained in the retrieved cases may provide inspiration in getting new design concepts. Other information of retrieved cases like product description and picture may be helpful in inspiring ideas.
5. When multiple cases are retrieved in the search, summarize the frequency of appearance of each design principles, design patterns, and technologies used. More frequently used design principles, patterns, and technologies should be recommended with priority. This is a simple and logic way to highlight useful suggestions out of multiple retrieved cases.
6. Find ideas of product design using combinations of recommended design principles, design patterns, and applicable technologies. An information aid based on data management software ACCESS was written to help conduct steps (4) and (5), making case retrieval and summarizing useful suggestions easier and faster.

As mentioned at the end of Sect. 4, detail study of the effectiveness of using the proposed approach is not included in this study. The proposed procedure cannot guarantee the generated ideas are better. This is also a drawback of using the concepts of case-based reasoning since old experience (retrieved knowledge) may be useful but may not perfectly suit for new problem. Designer needs to make judgment after new ideas are generated.

6 An Illustrative Example

To illustrate the approach, an illustrative example is presented herein. The following are the results of conducting the proposed six-step procedure with the case library:

1. For illustration, suppose one wants to develop a new product to help elder women in Taiwan keep lower body moving and healthy.
2. Target behavior is taking lower body movement assuming that users want to increase intensity of familiar exercise rather than try new exercise. A good example of familiar exercise is riding a bicycle. So, the problem may be specified as to find innovative ideas to persuade elder women to more indoor cycling.
3. Assume target users are elder women who seldom exercise. Assuming users' motive of using the new product is "physical excitement" and also assuming they lack all five abilities in Table 3. In other words, they want to make it easy,

simple, less physical effort, easy to get used to, and so on. Regression models developed in Sect. 2 could be used to find significant motives and lack of ability when more information (seven independent variables) of the target users are provided.

4. With given information from the above three steps, one can conduct conditional search for cases meeting the attributes above. Seven cases out of 98 cases were retrieved. They are Wii Fit Rhythmic Game, Wii Fit Jogging, Wii Fit Snow Skiing, Piezoelectric Harvester shoe, POWER Leap Power Floor, Piezoelectric Floor in Tokyo Station, and FitWet. One can look over the detail case profiles of the seven to get inspiration or go to the next step.
5. Highlight design principles, design patterns, and ICT technologies in the seven retrieved cases and conduct statistical analysis. Find the frequency of appearance of each of them in the seven cases, highlight the most frequently appeared ones. For example, Table 4 shows the top three recommended design principles, patterns, and technologies from the seven retrieved cases where the number in parenthesis denotes the number of times they appeared in retrieved cases.
6. With the suggestions of design principles, design patterns, and applicable technologies, one may get inspiration from each individual suggestion or combinations of them to obtain new design concepts. For example, inspired by the suggestions in Table 4, new product concepts may emerge and contain the following ideas:

   (a) Let the pedal vibrate as a reminder whenever users stop cycling (use design pattern "real-time feedback" and technology "vibration").
   (b) Let pedal generate heat in winter to keep users' feet warm (use design principle "rewards"). This is important since local senior users believe keeping feet warm is essential for a healthy body. Designer may add a pair of boots attached with pedals that can warm users' feet.
   (c) Turn the cycling into energy generation source that provides electricity for music playing, but music may stop once cycling stops (use technology "energy harvesting" and design principle "tunneling").
   (d) Let users know her health conditions such as blood pressure and calories consumption by setting sensors on the pedals (use design pattern "summary feedback" and technology "health condition monitor").

Table 4 Frequently used design principles, patterns, and technologies in retrieved cases

Design principle	Design pattern	ICT technology
Tunneling (7)	Real-time feedback (4)	Energy harvesting (4)
Reduction (6)	Summary feedback (4)	Visual display (4)
Rewards (6)	Energy feedback (3), Matched affordance (3)	Health condition monitor (3), Vibration (3)

7 Conclusion

A case-based approach is proposed to aid persuasive design for a specified type of products that persuades users to conduct more bodily movement. A domain model describing cause-effect relationship between design and behavior change is established and helps extract knowledge from past cases, thereby facilitating finding useful design suggestions. Two key factors including users' motives and ability are deliberately included in the domain model which expand and strengthen the power of the domain model in describing the relationship of behavior change and product design, especially when target users are specified. A case library that includes more than 98 cases containing experience of persuasive design is constructed so that cases meeting searching conditions can be retrieved for design suggestions. For each case, information specified in the domain model such as target behaviors, users' motives, users' lack of ability, design principles, and applied technologies are extracted and stored in the case library.

A six-step procedure is recommended for step-by-step execution with the established case library. Conditional search is conducted where target behavior, user's motive, and ability are input conditions, and cases meeting these conditions are retrieved. Target users' motives and lack of ability can be obtained in advance by using regression models that include seven independent variables describing target users. When there are multiple retrieved cases, frequently used design principles, patterns, and technologies are recommended with priority. One can either get inspiration directly from case profiles of retrieved cases or devise new design concept based on the recommended design principles and patterns and technology. A computer program based on ACCESS is written to promptly conduct the conditional search, retrieve useful cases, and identify design principles and applicable technologies for facilitating product conceptual design. An illustrative example is presented at the end demonstrating application potential of the proposed approach.

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