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Do-it-yourselfers as Lead Users for Environmentally Conscious Behavior

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Abstract

Much engineering effort has focused on developing more resource-efficient products. However, use behavior is clearly relevant to resource conservation. Wasteful behavior offsets at least part of the anticipated gains in resource efficiency intended by resource-saving modes and technologies. Therefore, in addition to creating more efficient products, designers should also develop products that encourage and enable users to behave in more resource-efficient ways. We identified do-it-yourselfers as lead users to gain insights on product design to support Environmentally Conscious Behavior (ECB). Specifically, we studied do-it-yourselfers who repurpose rather than replace furniture items when their original functions are no longer required.

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Keywords: sustainable behavior; pro-environmental behavior.

1. Introduction

The long-term objective of our work is to increase sustainable, or environmentally conscious behavior (ECB) in individuals. Much engineering effort has focused on developing more resource-efficient products. However, use behavior is clearly relevant to resource conservation. Also, technically efficient products may cause consumers to be more complacent about their use, such that overall resource consumption continues to rise after an initial decline, described as the rebound effect (Sorrell, 2007). That is, resource-efficient devices may be used longer and remain left on unnecessarily more so than their less-efficient predecessors. Such behavior offsets at least part of the anticipated gains in resource efficiency intended by resource-saving modes and technologies. Therefore, in addition to creating more efficient products, designers should also develop products that encourage and enable users to behave in more resource-efficient ways. Our short-term objectives are to determine and further develop methods that 1) identify innovative principles relevant to ECB, 2) incorporate such principles through product affordances and 3) investigate the effectiveness of affordances and other interventions.

2. Literature Review

In his Environmentally Significant Behavior framework, Stern (2000) categorized people's behavior that affects the material and energy flows of the environment as: active vs. passive, intentional vs. unintentional, and public vs. private. Shove & Warde (1998) noted that although the consumption of utilities, e.g., electricity and water, is a private matter, the trend toward higher consumption rates makes related behaviors increasingly relevant. Abrahamse et al. (2005) review the many types of socio-psychological interventions aimed to encourage pro-environmental behavior. Steg & Vlek (2009) identify two categorizations for such interventions, antecedent vs. consequence, and informational vs. structural. Antecedent strategies target factors that precede behavior, by increasing problem awareness, giving information about options and positive or negative consequences. Consequence strategies aim to change consequences after behavior and include feedback, rewards and penalties. Informational

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strategies are effective when the desired behavior does not significantly inconvenience, cost, or constrain individuals. Structural strategies are more suitable when the desired behaviors are costly or difficult, as they aim to change the circumstances, e.g., costs and benefits, under which behavioral choices are made. While rewards are observed as more effective than penalties in encouraging pro-environmental behavior, they tend to have short-lasting effects, i.e., only as long as the reward is available. Due to the persistent barriers to pro-environmental behavior, we wish to exploit product design to supplement the above intervention categories, and increase the rate of ECB participation.

From a product design perspective, Zachrisson & Boks (2010) discuss the range of interventions for sustainable behavior with respect to how much the user versus product is in control. At the informing end, information / feedback allows the user to be in full control. At the determining end, forcing / automatic performance of desired actions gives control to the product. In the middle, persuading includes enabling, encouraging, guiding, and steering. Lilley et al. (2005) describe the same range as: eco-feedback, scripting and behavioral steering, and 'intelligent' products / services. Lockton et al. (2008) categorize interventions as feedback / persuasion versus affordances / constraints / mistake proofing, and describes context-based approaches as those that combine the two categories. Zachrisson & Boks (2010) and Lockton et al. (2010) agree that the cognitive workload required is proportional to the amount of user control. Table 1 shows various terminologies for interventions along the spectrum of user / product control. An ontology was developed to unify behavior-change literature (Srivastava & Shu, 2014a).

As the basis of persuasive technologies, Fogg (2003) identifies strategies including: simplifying or guiding through a procedure, tailoring / individual customization, conditioning / reinforcement and opportune suggestion / intervention, self-monitoring vs. allowing others to track users' behavior.

3. Our Approach

Our approach focuses on the use of affordances to persuade, i.e., enable, encourage, guide, or steer desired behavior. McCalley and Midden (2002) conclude that information/feedback is effective only if it helps a user achieve a preexisting goal. However, greater impact is possible if designers can affect the consumption behaviors of those who do not have a preexisting goal of resource conservation. While behavior is believed to follow attitude, a change in behavior may also lead to a change in attitude, perhaps to reduce cognitive dissonance (Lockton, 2012, Festinger & Carlsmith, 1959). Therefore, persuading users to perform the desired behavior may have benefits over simply performing the desired behavior for them. Automation has other limitations (Srivastava & Shu, 2014b). Lack of standardization may cause users to neglect performing the required action, e.g., turning off a manual faucet, when they've become accustomed to such actions being automated by sensor-operated faucets. Sensor-operated faucets require batteries/electricity, with both environmental and logistical implications. Also, faulty sensors waste resources, e.g., auto-flush toilets triggered to flush 3 times instead of once.

3.1. Our Recent Work on Lead-user Strategies and ECB

We had identified lead users (von Hippel, 1986) in resource conservation to abstract principles that may encourage conservation in mainstream users. For example, we observed how Old-Order Mennonites in Ontario, whose discrete-unit resources, e.g., logs of firewood, buckets of water, and cans of kerosene, contrast with the continuously flowing electricity and water of the mainstream. Next, we confirmed experimentally that participants performing a washing task using discrete quantities of water (in containers) used less water than when using continuous-flow water from a faucet. We then studied how these strategies may be transferable to mainstream users by developing products that incorporate them. For example, we studied how discretization can be incorporated in practical ways into mainstream products such as faucets and showers, as shown in Figure 1 (Srivastava and Shu, 2013a). We next plan to validate the effectiveness of such products by studying how and whether they reduce resource consumption over extended periods.

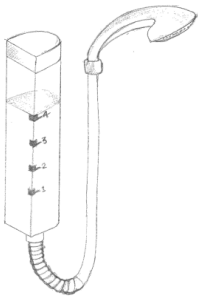

Figure 1. Water-conserving shower concept that incorporates discretization.

	User in control (high cognitive load)		*Product in control (low cognitive load)*
Zachrisson & Boks	Informing	Persuading	Determining
	Information, Feedback	Enabling, Encouraging, Guiding, Steering	Forcing, Automatic
Lilley et al.	Eco-feedback	Scripting and behavioral steering	Intelligent products
Lockton	Context-based = Feedback & persuasion +Affordances, constraints, mistake-proofing		

Table 1. Intervention terminology of various researchers with respect to user versus product control

3.2. Our Recent Work on Affordances and ECB

While studying products that support ECB, we noted that characteristics of products that enable ECB tend to be more accurately described as affordances than functions. Thus, we became interested in affordances, and specifically how they can be used to design products that support ECB. Affordances have been described as possible ways of interacting with products, which may be independent of designer intention. For example, all physical objects with a horizontal flat surface allow users to place objects upon them. We abstracted affordances that correspond to lead-user insights, and developed the affordance-transfer method to add desired features from products that support resource conservation. Affordances corresponding to resource discretization (e.g. Figure 1) include imparting a suggested quantity for consumption, awareness of the rate of use, and the amount of resource remaining. We performed initial validation of the affordance-transfer method and observed that it can improve the usefulness of the concepts that novice designers generate to support ECB (Srivastava & Shu, 2013b).

4. Do-it-yourselfers (DIYers) as Lead Users

This paper reports continuing work on how lead users may uncover affordances that are not obvious to everyday users, thus revealing principles relevant to ECB. We focused this study on home furniture products. The online community known as "IKEA Hackers" (www.ikeahackers.net) comprised our main source of lead users. Users on the website are do-it-yourselfers (DIYers) who post "hacks" or modifications that consist of reusing or repurposing IKEA products and putting them to new uses. A differentiating feature of IKEA hackers is that users sometimes build a DIY project purely from newly purchased products instead of reusing existing items. IKEA hackers are familiar with IKEA's product range and many take part in a continuous cycle of customizing IKEA's standard products and tailoring them to their unique individual needs. The IKEA Hacker DIY community of expert lead users, who provide continued input and improvements to existing projects, leads to a fast-paced and evolving understanding of how products can be altered. Other online DIY communities studied include www.reddit.com/r/DIY and www.lifehacker.com. Such environments provide ample opportunity to discover affordances and other factors involved with DIY projects.

One long-term goal of our research is to identify design principles that suggest novel usage or interactions with customers. By studying IKEA hackers, we investigate users in their own domestic settings and also glean affordances and other factors that encourage ECB. An IKEA hacker's mentality has the effect of prolonging product life, which greatly reduces resources used in product manufacture, delivery, and disposal. Novel uses of products may lead to niche, or even widely marketable, improved products.

Although we had noticed that past lead users, i.e., the Old-Order Mennonites, also repaired and repurposed their furniture, DIYers may provide ideas and strategies that are relevant to more modern users.

5. Categories of DIY projects

An initial search led us to identify the following categories for DIY projects: 1) Change in Aesthetics, 2) Change in Form and 3) Change in Function.

Change in Aesthetics involves altering the appearance of the original product with no motive other than to make it more aesthetically pleasing for the user. The other two categories of DIY projects overcome functional fixedness to varying extents. German and Barrett (2005) define functional fixedness as "difficulty in considering an item for a function other than the one for which it is typically used." The effects of fixation have been studied by design researchers and are highly relevant in the user-to-designer role of DIYers.

Change in Form describes a modification where the user aims to meet a similar or related function of the original product by reconfiguring, reorganizing, or performing substitutions. The function generally remains closely related, and the form is modified to adapt. We include examples below where DIYers modified product forms in response to minor updates in required functions.

Change in Function describes product repurposing to fulfill a function that is entirely different from the original. This is the category we believe leads to the most novel forms of DIY, and thus the category where affordances can most readily be extracted. Here the user is not fixated with the original function of the product, and maximizes utility of its resources by applying them anywhere that is appropriate.

We expected fewer DIY projects in the Change in Function category due to users' prolonged exposure to their products. As noted by German and Barrett (2005), users develop functional fixedness and find it difficult to think of purposes beyond original product functions. It would be interesting to also compare the length of project time between Change in Form and Change in Function DIY outcomes. We would expect that Change in Function DIY projects would occur over more time compared to their Change in Form counterparts, which allows more opportunity for incubation and external stimuli to overcome fixation.

We developed our DIY categories by studying postings on the IKEA Hackers website submitted in the month of October 2013. We chose to sample a month of submissions to reduce bias in sample selection. The selection of October 2013 was arbitrary other than being most recent to paper submission.

Of the 57 hacks posted in that month, 9 involved change in aesthetics, 34 involved change in form, 13 involved change in function, and 1 posting referred to a museum installation.

5.1. Change in Aesthetics

Changes in aesthetics from the sampled month include painting and adding/replacing handles of a dresser for an updated look. The same strategy can be used with dramatic results to update rather than replace kitchen cabinetry as well.

Figure 2 shows a cover crocheted for a lounge chair to avoid buying a new cushion. The associated hacker noted the difficulty of producing a sewn cover that fits the cushion well. Replacement seat covers have also been used to postpone replacement of more significant furniture items, e.g., sofas.

Figure 2. Crocheted cover for chair. Image used with permission. www.ikeahackers.net/2013/10/field-of-flowers-crochet-poang-chair.html

Figure 3 shows solid-maple cutting boards substituted for the standard white tops of a set of nesting tables.

Figure 3. Replacing white tops of nesting tables with maple cutting boards. Image used with permission. www.ikeahackers.net/2013/10/klassy-butcherblock-tops-for-klubbo-tables.html

There were fewer purely cosmetic hacks in the sampled month than we anticipated, as these appear to be the simplest hacks to perform. While changes in aesthetics provide fewer insights on affordances, they likely increase product life significantly, as furniture is often replaced purely due to aesthetic preferences.

5.2. Change in Form

We categorized as Change in Form, when an existing product is reconfigured to better meet updated or slightly modified functions. When the original function becomes less relevant, the form of the product is modified to make the product relevant again. The hack fulfills the same or similar functions as the original product, but with an updated form. Examples include reconfiguring an unused wardrobe into a cleaning cupboard to store mops, vacuum cleaners, and cleaning supplies. Figure 4 shows an old coffee table converted into an ottoman by attaching a top cushion.

Figure 4. Coffee table converted to ottoman. Image used with permission. www.ikeahackers.net/2013/10/klubbo-turns-lovely-peony-printed-ottoman.html

A third example repurposed a TV unit as a seating bench, and bookcase as storage in a mudroom, shown in Figure 5.

Figure 5. Repurposing furniture for a mudroom. Image used with permission. www.ikeahackers.net/2013/10/ikea-hemnes-mudroom-hack.html

Two reddit users also described how they reconfigured and repurposed furniture originally intended for obsolete products and media. For example, an old television cabinet made for a Cathode-Ray Tube television was reconfigured to accommodate a newer and larger flat-screen television. (www.reddit.com/r/DIY/comments/15sjeb/altered_my_old_impractical_tv_cabinet_to).

An old compact-disk rack was repurposed, with paint and new shelving, into a wine bottle holder. The modified product still performs the same function of storing items, but now wine bottles instead of no-longer needed compact disks. (http://www.reddit.com/r/DIY/comments/1wkqud/diy_what_to_do_with_an_old_cdrack/).

As consumer electronics and associated media become obsolete so quickly, making the furniture that store and display them reconfigurable increases its useful life.

5.3. Change in Function

We used Change in Function to describe when a user re-purposes a product to fulfill a significantly different function than intended for the product. For example, Figure 6 shows an inexpensive, stainless-steel breadbox repurposed into a mail box because existing similar products were too expensive.

Figure 6. Mailbox repurposed from breadbox. Image used with permission. www.ikeahackers.net/2013/10/ordning-stainless-steel-breadbox-to-modern-mailbox.html

Figure 7 shows custom lampshades made using fruit bowls to emulate expensive lampshades.

Figure 7. Fruit bowl repurposed into lampshade. Image used with permission. www.ikeahackers.net/2013/10/a-fruitful-bit-of-hacking-for-a-lamp.html

Figure 8 shows a crib transformed into a children's table by installing a hard surface at the preferred height in lieu of the mattress. This hacker overcame the functional fixation that cribs are for sleeping in, and recognized that significant parts of an existing, no longer useful product can form the basis of a more useful product. The rectangular shapes of both the sleeping and working surfaces facilitate this transition.

The 3 categories overlap in multiple ways. A change in function may result in changes to both aesthetics and forms. Change in Form often involves the same function acting, e.g., storing, supporting, etc., on different objects. However, a literal modification in form is often required to accommodate the shape and weight of different objects, e.g., clothes vs. cleaning supplies vs. books. Change in Function applies a product to different uses, sometimes primarily by using in a different orientation, e.g., sideways (breadbox to mailbox), inverted (fruit bowl to lampshade), etc. Other cases involve the use of products as partially finished raw material (crib to table). An inexpensive coffee table provided the raw material for many hacks, e.g., headboard, coat rack, etc.

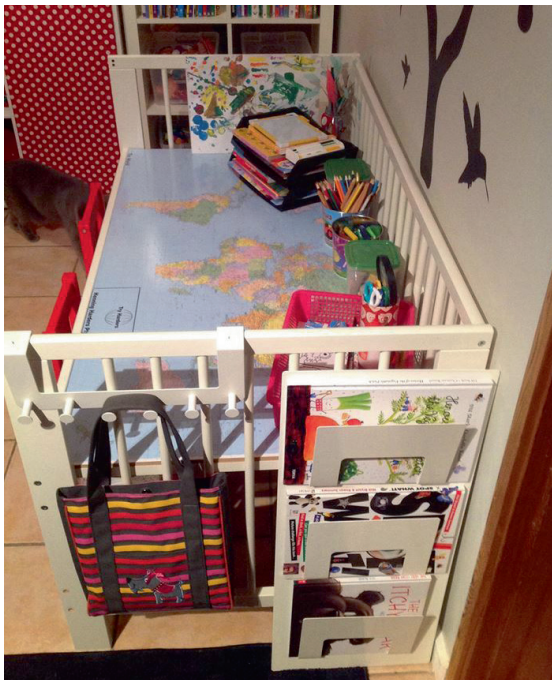

Figure 8. Children's table repurposed from crib. Image used with permission. www.ikeahackers.net/2013/10/kids-artcrafthomework-table-from-ikea-gulliver-cot.html

6. Factors contributing to hacks

6.1. Material

Product material is an important factor that affects hackability. For example, a metal rather than wooden television stand was modified into a toolbox/bike stand. Metal works better for this purpose, as it is generally more durable and easier to clean than other furniture material. Wood on the other hand is preferable to laminated particle board for ease of cutting, drilling, as well as repairing.

6.2. Modularity, Geometry and Symmetry

Modular and simple products, with regular and symmetric parts, afford hacking. For example, rectangular drawer fronts can be more easily replaced or fitted with new knobs and handles than the ones with handle cutouts. Rectangular shapes also make furniture pieces work better next to or on top of each other. Flat edges are easier to clamp during repairs and afford hanging of items when in use. Symmetry enables the use of another side when one side is damaged.

6.3. Overcoming Fixation

Key to their ability to transform products is how users perceive objects. A more recent hacker used a set of head- and foot- boards as an extra-wide dog gate. This hacker recognized that normally stationary items may be made moveable to accomplish the gates' function.

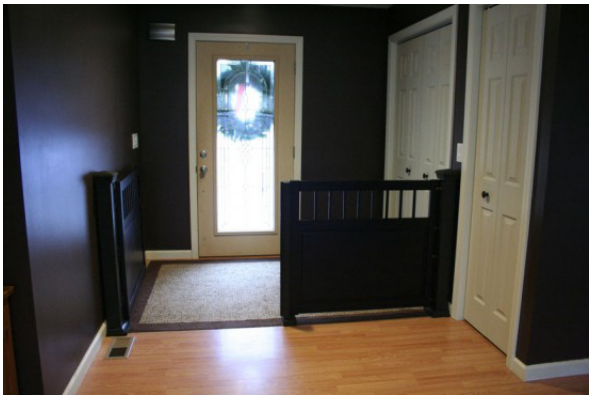

Figure 9. Dog gate repurposed from head- and foot- boards. Image used with permission. http://www.ikeahackers.net/2013/12/hemnes-dog-gate.html

7. Conclusion on Affordances, DIY, and ECB

Not only are DIYers lead users for ECB, they also often manage to overcome functional fixedness by examining affordances of products. Affordances guide DIYers to repurpose rather than replace products. We originally became interested in affordances as a way of devising product concepts that encourage resource-efficient behavior. We have since become interested in finding ways to identify novel affordances and propose three approaches (Shu et al., 2015). Common themes include involving lead users, conserving resources, and overcoming functional fixedness.

Due to the limited end-of-life options for furniture products especially, reuse is likely the most environmentally sound option. However, most consumers require more support in pursuing this option. For instance, many repairs to even low-cost furniture are simple, reliable, and do not necessarily affect appearance, yet many consumers do not perform such repairs. Perhaps repair instructions and replacement parts can be made available online. The existence of online resources such as IKEAhackers.net provides similarly minded consumers ideas for repurposing, rather than replacing furniture. In addition to enabling consumers to feel more attached to personalized rather than generic pieces, the skills learned may also enable them to perform more repairs. By emphasizing affordances of products that hint towards certain paths for alteration, a product's life could be lengthened, significantly reducing its environmental impact.

Shove & Warde (1998) highlight the shifting standards and norms in expectations of cleanliness, comfort and convenience. Much consumption behavior is driven by commercial interests, e.g., advertising that prescribe what people desire and require. Our long-term goal is to effect more objective and resource-conserving standards. Ando et al. (2007) observed that personal behavior is significantly affected by others' behaviors. By using product design to increase the number of people who take part in ECB beyond a critical mass, other people will follow, further increasing the proportion of participation needed to justify corresponding shifts in infrastructure and thus set new norms in behavior.

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