# Designing Products to Encourage Conservation: Applying the Discretization Principle

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**Abstract**

We applied lead-user methods to identify product design principles that encourage environmentally significant behavior (ESB) in individuals. Previous work studied Mennonites as lead users due to their low consumption lifestyles, and found that resources in discrete units instead of continuous flows facilitated resource conservation. This paper describes our efforts to apply the discretization principle to product design. We identified how discretization is evident in current products, and discovered challenges in applying discretization while considering user and facilitator needs. Revised concepts were produced to combine various needs, and preliminary tests on one prototype appear promising for encouraging water conservation.

**Keywords:**

Design for environment; Environmentally significant behavior; Discretization

## 1 INTRODUCTION

### 1.1 Motivation

The costs of energy and fresh water are expected to increase greatly in the future because of both the rise in demand for resources and stricter regulation of emissions and pollution [1]. Therefore, over the past few decades, a great deal of effort has been devoted to designing more efficient products that help users perform the same tasks with less energy and/or other resources. Nevertheless, national energy consumption in all industrialized countries has risen unabated for the last 25 years. One reason for this continual increase is the phenomenon termed by researchers as the **rebound effect**. Studies into this effect have found that improving energy or resource efficiency lowers the implicit price of energy or the resource and hence makes its use more affordable, motivating people to use it more [2]. Therefore, to be effective over the long term, products must not only be more efficient in their use of energy and resources, as has been the goal of traditional life cycle engineering [3], but must also encourage users to reduce their consumption of energy and other resources. The purpose of our work is to design products that encourage or facilitate conservation.

### 1.2 Environmentally Significant Behavior

We used the **Environmentally Significant Behavior** framework to formulate our design problem [4]. The term environmentally significant behavior broadly describes any human behavior that aims to affect and/or actually affects the balance of matter or energy in the natural environment. These behaviors can be: active (participation in environmental causes) or passive (acceptance of environmental regulation), intentional (use of public transportation) or unintentional (purchasing a fuel efficient vehicle to save money, when it also reduces emissions) and public (contacting elected officials to enact environmental regulations) or private (using a less environmentally harmful laundry detergent).

The focus of our work is household energy and resource use behaviors. Cumulative domestic energy and water use contributes significantly to a country's overall energy and resource expenditure. For example, American households were responsible for 1,220 million metric tons of carbon dioxide emissions in 2008, which accounted for roughly 21% of total U.S. emissions that year [5].

### 1.3 Lead-User Theory

To look for solutions to the problem of household energy and resource use, we employed the lead-user method. Lead-user theory was originally outlined by von Hippel [6] who studied people and companies that adopted and experimented with technologies and products well in advance of the mainstream. These **lead users** had needs that would be faced by mainstream users in the future and often created their own novel solutions to problems they encountered. Studying their needs served as an effective way of predicting the needs of the mainstream. Examining their make-do solutions also provided a fertile basis for concept generation.

More recently, Hannukainen and Hölttä-Otto [7] demonstrated that users who experienced needs in more extreme ways than the mainstream could also be suitable lead users. Building on this, we studied the Old Order Mennonites, who were extreme in their usage of energy and water due to their partly pre-industrial lifestyle [8].

### 1.4 Discretization

An ethnographic study was performed in two Old Order Mennonite households [9]. When examining how Old Order Mennonite families met their needs, a pattern emerged. Old Order Mennonite solutions for meeting needs often involved a resource that existed in discrete units, e.g., firewood for generating heat, cans of kerosene for lighting lamps, buckets of water for washing dishes. Conversely, in more modern mainstream settings, these same needs are met by using continuous sources of water and energy.

We were interested in knowing whether the use of discrete energy and resource units was somehow related to the Old Order Mennonites' extraordinary ability to conserve these resources. We performed a repeated measures experiment where participants were given a task of washing paint off a table tennis ball. Water was provided to participants in three forms: continuous (using a tap), discrete (using water from provided containers) and discrete with added work (using water from containers, each of which were to be earned by performing exercise). Participants used significantly less water when it was provided in containers, while the effect of adding work to the conditions was statistically insignificant. We concluded that breaking down resources into discrete units promoted and facilitated conservation behavior. We then hypothesized that discretization may encourage conservation by allowing the user to track the rate of resource use as well as how much of the resource is "remaining", thus enabling one to set goals for conservation [9].

In this paper, we describe the process of developing product concepts by applying the principle of discretization.

## 2 DISCRETIZATION IN EXISTING PRODUCTS

In our preliminary work, we noticed that the function of many existing resource-conserving products could be described using