Behavioral economics and the design of a dual-flush toilet

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Dual-flush toilets, which use a high-volume flush for solid waste and a lower-volume flush for liquid waste, can reduce water consumption. Principles from the field of behavioral economics were used to analyze the design of the dual-flush mechanism of the Sloan Uppercut® toilet. The default option, pushing the handle down, results in a large flush. Because people in the United States have been "conditioned" to push the toilet handle down, it was expected that most users would push the handle down out of habit. A field experiment measuring up flushes versus down flushes in eight women's toilets in a municipal building confirmed expectations. Whereas Sloan predicted a 2:1 urination-to-defecation ratio, the observed ratio during the control period was 1:4, i.e., the ratio was the opposite of what would occur if people used the toilets correctly. Adding signage to each stall only increased the ratio to 2:5, emphasizing the importance of the default.

As global population grows, so does the need for water conservation. This article focuses on water efficiency in a commercial setting and how the design of water fixtures—dual-flush toilets in particular—can affect the overall amount of water used. It is not sufficient that the toilet be designed to reduce water consumption; the dual-flush mechanism must also be clearly marked and easy to operate correctly—that is, the behavior of the user must be taken into account as part of the design process.

This project (1) tested the hypothesis that the design of the flush mechanism on a dual-flush toilet has a significant effect on human behavior and thus water usage, (2) examined the effect of instructional signage on the use of the toilet, and (3) estimated how much water can be saved by improving this design to account for the user's default behavior.

Although many types of water-efficient toilets exist, it is important to note that dual-flush toilets are the only type that present the user with a choice. They require a specific decision or action by the user, and some models of dual-flush toilets may make a "correct" decision more difficult than others. If the user flushes the toilet incorrectly or does not understand its design, the toilet may not be saving as much water as expected. It was thus hypothesized that the design of the flush mechanism affects the amount of water saved. This highlights the importance of human decision-making and the field of behavioral economics.

BEHAVIORAL ECONOMICS

The field of behavioral economics integrates both economics and psychology in an attempt to better understand human behavior and how people make decisions. Simply put, it is unrealistic to assume that a decision-maker has the desire, time, and/or ability to carefully weigh the advantages and disadvantages of each decision he or she makes. Therefore, one factor that affects behavior is the choice or design of the default, i.e., what happens if the person makes no decision or is operating on autopilot. For example, the habit of flushing a toilet in a certain manner (e.g., by pushing a handle down) is virtually ingrained. From standard economic theory, decision-makers have an incentive (e.g., saving money) to make choices that benefit themselves. But when an individual's decision has no effect on him or her personally—for example, the decision whether to flush a dual-flush toilet correctly in a commercial or public setting, the only incentive would be the sense of ethical or altruistic satisfaction an individual receives from saving water. As such, design is arguably most useful in situations in which the decision-maker has little or no personal incentive to "do the right thing" and in which the design of the default option strongly influences user choice.

SUBJECT OF STUDY

The Sloan Uppercut (SU) flushometer, model number WES-111, was selected as the research focus because it presents the user with a choice and is designed for use in commercial and/or public buildings. The SU, unlike some other dual-flush mechanisms, presents the user with a "default" option. More specifically, the handle is pulled up for a low-volume flush (1.1 gpf) and pushed down for a large-volume flush (1.6 gpf). The primary design flaw, as far as water savings, is that the default option—pushing the handle down—produces the larger flush. Because virtually all toilet users in the United States have been taught to push toilet handles down from childhood, it is hypothesized that much water is wasted because people inadvertently and automatically choose the "incorrect" flush for their needs. Logically speaking, based on Sloan's

own 2:1 or 3:1 expected urination/defecation ratio (Sloan Valve Company, 2010), individuals need a low-volume flush most of the time. The SU, by virtue of its design, requires users to "retrain" themselves to use the toilet in the intended manner. If saving water is the desired outcome, reversing the flush mechanism, so that pushing the handle downward produces a small flush, should produce far superior results. At least one other company manufactures a dual-flush flushometer that is designed in precisely this way.

HYPOTHESES

The hypotheses of this study are given below. In order to test these hypotheses, the 2:1 up-to-down ratio used by Sloan was used as a benchmark, i.e., the null hypothesis is that the percentage of up flushes will be equal to or greater than 66.667%.

Hypothesis 1. The default option of an SU flushometer often causes users to inadvertently choose the incorrect flush type for their needs, thus wasting water. That is, during the control period, the actual ratio of up-to-down flushes are hypothesized to be less than the company-projected ratio of 2:1 or 66.667%.

Hypothesis 2. Adding instructional wall plates above the toilet and on the back of stall doors will reduce user error, but still not reach the level of projected water savings. Therefore, during the treatment period, the actual ratio of up-to-down flushes are hypothesized to be greater than during the control period, but still less than the projected ratio of 66.667%.

Hypothesis 3. Because of the flushometer's design, projected water savings are overestimated, so water usage would be higher than expected.

METHODS AND PROCEDURES

The restrooms selected for the experiment are located in the city hall building of a small city in the US Midwest. The building was newly constructed and opened to the public Mar. 16, 2011, about three months before the start date of this study. Flushometers were installed as part of the new construction and therefore were not retrofitted to existing toilets. Additionally, no signs were not posted to alert the user as to the handle's specialized functions. The exclusive use of women's restrooms was deemed necessary because men typically utilize urinals rather than toilets if they desire a low-volume flush. Data were collected from a total of eight women's toilet stalls (two restrooms on different floors of the same building with a total of four stalls each). The toilets were fitted with sensors that count the number of up-and-down flushes and were monitored for seven weeks. During the first four weeks (the control period), there were no instructional signs in the stalls other than the small stickers attached to the flush handles. The "treatment" for this experiment took place during the final three weeks of the seven-week trial and involved installing two instructional wall plates in each stall, one on the wall directly above the flushometer and the other on the rear of each stall door.

RESULTS

The results of the study supported the hypotheses. Average flush counts were well below the expected 2:1 up-to-down ratio during the control period; only 26.6% of total flushes were up flushes, which is much less than the expected percentage of 66.67%. The difference between projected and actual percentages of up flushes is stark; the ratio is essentially the exact opposite of what is predicted by Sloan. During the treatment period, the average percentage of up flushes for the treatment period was 38.8%, which was an improvement from the control period but still did not reach the projected level of 66.67%. Even with instructional signage, the actual percentage of up flushes is far below the company projection. The effects of this flush design appear more substantial when extrapolated over a year's time. Even with additional instructional signage, more than 3,200 gallons of water would be wasted each year because of the flushometer's design.

CONCLUSIONS

The results of this study indicate that the design of the SU prevents the mechanism from maximizing water savings. Given that individuals need a low-volume flush a majority of the time, a more intuitive design would be to reverse the mechanism so that pushing the handle down results in a low flush. Alternatively, those seeking to conserve water could also choose a different design of dual-flush mechanism. Those that have two separate buttons eliminate a default option altogether; the user must choose between one button or the other, rather than using the same mechanism to perform two distinct functions. Alternatively, a nondual-flush, high-efficiency 1.28 flushometer would also save a considerable amount of water over the SU.

The overall goal of this project was to determine the relationship between the design of a fixture intended to save water and the impact on user behavior and thus on water consumption. The specific conclusion drawn was that for the purpose of saving water, the Sloan Uppercut® should be redesigned in order to take advantage of the default, ingrained flushing behavior. Unless actual, real-world human behavior is taken into account by those who design and market water fixtures and/or other appliances, the maximization of water savings (or that of any other scarce resource) will not be achieved.

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