Automation in the Washroom:

Hand Dryers

BY WILLIAM F. MORONEY

Poor design of commonly used devices like automated towel dispensers may not prevent you from achieving the desired end, but it sure can cause confusion.

Photo 1. Moisture sensor towel dispenser. Note: In this and all other photographs in this article, the manufacturers' names and logos have been removed.

WHEN I RECENTLY VISITED A LOCAL public building, I noticed that men's room users were having problems obtaining paper towels from the dispenser (see Photo 1). They recognized it as a paper towel dispenser but had trouble activating it, despite the fact that the manufacturer provided both written instructions ("Place hand over sensor to dispense towel") and a symbol of a hand in motion. The manufacturer used a large blue dot to indicate the location of the "No-Touch Sensor" and provided a label identifying it as a trademarked "No Touch Sensor."

Providing a surface area that looks like a button encourages people to depress that area. However, the blue circle is not a push button but indicates a sensor area that responds to *changes in moisture levels*. The device dispenses a single pull-down towel when an individual moves his or her *wet* hand past the sensor, which was not designed to be touched.

Despite the manufacturer's efforts, the dot (originally royal blue) indicating the sensor location was eroded through contact by multiple users (see Photo 2). It appears that the implied button activation convention led users to push the "button" despite the label around the No Touch Sensor. The erosion progression images in Photo 2 were gathered at different units and do not represent a chronology of single-site erosion, but all units initially looked like the unit shown in Photo 1. The restroom users were misled and frustrated.

In the following sections, I discuss the erroneous user behavior and describe alternative interactive strategies and implications for design.

FEATURE AT A GLANCE: Automation is ubiquitous – found even in washroom faucets and toilets. In this article, I describe various types of activation strategies used in hand dryers. The interactive characteristics of seven types of hand dryers are described. Dryers ranged from push-button–activated hot-air dryers to integrated soap-wash-dry systems. Their ease or lack of ease of activation is discussed and compared. Some activation strategies are not intuitive and induce errors. Designers should (a) maximize the use of stereotypes, affordances, and constraints and (b) develop and test instructions or pictorial information.

KEYWORDS: affordances, constraints, intuitive design, user-centered design

The Button That Is Not a Button

Until recently, the most common nonelectrical paper towel dispensers were activated by a crank or lever (see Photo 3, next page). These models are gradually being replaced with more sanitary sensor-activated dispensers, which reduce soiled hand contamination. No-touch activation dispensers also allow individuals with some disabilities to obtain the desired product. These dispensers can be activated by sensors that are temperature or motion sensitive (similar to those used on outdoor patios and security systems) or that emit infrared, visible light, or acoustic waves and then respond to a change in their ambient environment.

About two million people use the aforementioned facility annually. Although it is not possible to determine precisely how many people actually used the towel-dispensing units throughout the facility, they all had access to the dispensers. The surface erosion of the sensor area can be attributed to the

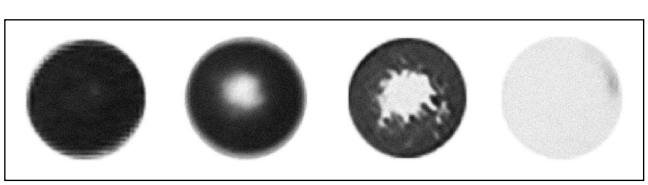

Photo 2. Progression of erosion of the label.

Photo 3. Lever-activated dispenser.

cultural model/convention of using buttons to activate hardware. Norman (1999, p. 41) described a convention as "a constraint in that it prohibits some activities and encourages others." In this case, the round shape and the color contrast apparently encouraged users to erroneously depress that area as opposed to following the instruction to "Place hand over sensor to dispense towel."

The No Touch Sensor button is what Norman (1999) has described as a *perceived affordance* – that is, "visual feedback that advertises the affordances" (p. 40). Apparently, users perceive the No Touch Sensor area as a touch-to-activate button that, when touched, provides the desired paper towel. The functional similarity of the No Touch Sensor area to the start button, which activates the hot-air dryer (see Photo 4), matches conceptual models and learned conventions, which led to the "press to activate" behavior. Additionally, the gradually eroding area may suggest to restroom users that others had previously depressed that pseudo-button, and if they do likewise, they will obtain the desired towel.

Paradoxically, individuals who touched the No Touch Sensor were rewarded with a towel, so their undesirable (according to the manufacturer) behavior was reinforced. The eroded surface provided the critical cue for obtaining the paper towel, but it did not provide the appropriate cues for operating the system as designed by the manufacturer.

Problems and Alternative Strategies

The symbol of the hand in motion did not discourage users from placing their finger *on* the sensor to obtain their towel. It is what Norman (1999) described as an attempt at symbolic communication. Symbolic communication "works only if it follows a convention understood by the user" (p. 40). In this case, the users relied primarily on the button-pushing convention and either ignored the symbolic waving hand and the no-touch instructions or pressed the sensor area rather than wait for the moisture detection system to detect the moisture and provide the towel.

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Joyce Cameron (personal communication, December 8, 2005) noted that immuno-suppressed individuals would have difficulty operating a dispenser activated by a moisture sensor. To avoid contamination, they are taught to place a paper towel on the faucet handle before turning it. However, because their hands would be dry – not wet – when they needed the towel, they could not activate a moisture detection system.

There are at least two problems associated with the dispenser shown in Photo 1: (a) the public's lack of familiarity with moisture-detecting sensors, and (b) the inability of the

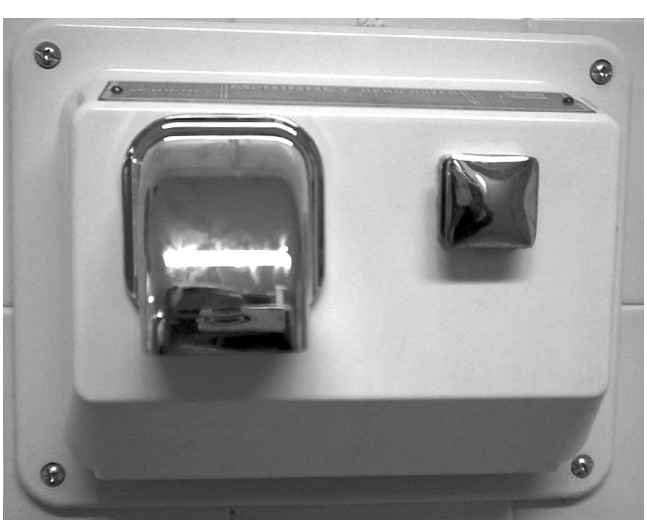

Photo 4. Hot-air dispenser.

Photo 5. Motion-sensor–activated unit.

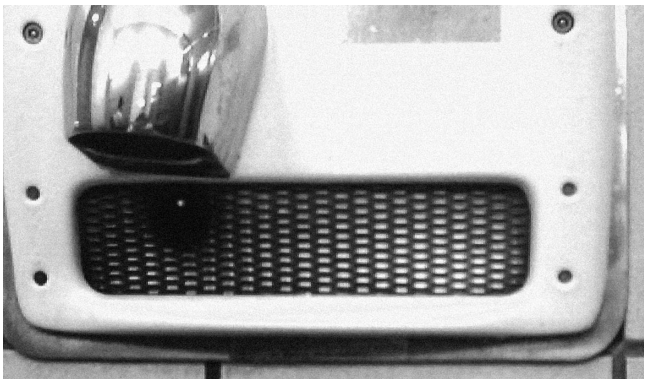

Photo 6. Covert sensor.

symbolic communication to inform the user to wave his or her moist hand within the look window of the no-touch moisture-detecting sensor.

An alternative and less problematic activation strategy is shown in Photo 5. In this case, the user simply waves his or her hand in front of the darkened area under the waving-hand symbol and the label "Motion Activated." After the request (conveyed by hand motion) is detected by the motion sensor, a red light in the center of the darkened area illuminates and a single sheet of paper is dispensed. These types of sensors are found in a variety of areas, including store entrances and sales areas and for exterior lighting. Indeed, some energy-conscious facilities managers use covert motion detectors to activate indoor area lighting.

Covert sensors such as those used for lighting have also been installed on restroom towel dispensers. As shown in Photo 6, a motion detection sensor has been placed beneath the hot-air outlet on this hand-drying device. The sensor, located at standing elbow height, cannot be seen by an adult unless he or she looks under the chrome outlet.

The most desirable situation is one in which the designer incorporates the user's stereotypes into the design and provides the appropriate affordances.

Covert sensors without written or iconic instructions induce some initial confusion, particularly because similar units (see Photo 4) have a prominent press-to-activate button. However, confusion is reduced on devices that provide verbal or pictorial instructions. The instructions for these devices are located on top of the unit and have a message such as "Place hands beneath nozzle, dryer starts and stops automatically" or "Place hands under nozzle to dry hands. Unit will shut off automatically." Without these instructions, the "desired, relevant actions" mentioned by Norman (1999) are not readily perceived.

One can only wonder if, as these covert devices become more common, they will eventually become cultural conventions. Like many of our current conventions, they will have to be tested over time in the marketplace.

Explaining the Erroneous Behavior

How does one explain the "erroneous" behavior noted with the moisture sensor? At the simplest level, it might have been explained by this quotation (circa 1950) attributed to labor leader Walter Reuther: "If it looks like a duck, walks like a duck, and quacks like a duck, then it may just be a duck" (Rees, 2003, p. 146). Clearly, the sensor surface looked like a button.

Norman (1983) might have described the inappropriate activation of the no-touch sensor as a slip resulting from faulty activation of schemas. In this case, the erroneous activation strategy would be considered a slip by the designer, but it would not be considered a slip by the user who obtained the desired towel despite misuse of the product.

Reason's (1990) Generic Error Modeling System might have attributed the error to perceptual confusion at the skill-based level. According to McGrenere and Ho (2000), J. J. Gibson, of visual ecological fame, might claim that the designer had provided an affordance but had not adequately designed the perceptual information that specified the affordance.

Norman (1999) might claim that the designer had provided a perceived affordance but had not done it very well. Norman might describe the interface in Photo 1 as an attempt at symbolic communication that did not adequately consider users' cultural conventions, as evidenced by observing their behavior in their normal environment.

The critical issue is well stated by McGrenere and Ho: "The usefulness of a design is determined by what the design affords (that is, the possibilities for action in the design) and whether those affordances match the goals of the user and allow the necessary work to be accomplished" (2000, p. 6).

Photo 7. Integrated hand-washing and drying system.

Photo 8. Integrated sensor-dispenser unit (located in the top of the device shown in Photo 7).

Toward a Better Dispenser

A newer, more integrated hand-washing-drying system based on human-centered design principles (or activity-centered design principles, as described by Norman, 2005) is shown in Photo 7 (see previous page). This wall-installed unit colocates the soaping, washing, and drying tasks. A sensor-dispenser unit (Photo 8) mounted in the top of the alcove detects the presence of the user's hands and initiates the soaping/washing/drying sequence. Soap is dispensed first, then water is sprayed, and, finally, hot air is dispersed over the user's hands. This vandal-resistant, integrated design meets the needs of the majority of users, but it does not meet the needs of individuals who wish to accomplish other tasks, such as washing their faces or filling a cup or bottle with water. Such is the nature of trade-offs.

While reviewing the literature on paper dispensers and hand contamination, I became aware of a related need. According to the American Society for Microbiology (September 2005), 91% of American adults claim that they wash their hands after using public restrooms, but only 83% actually do. In an August 2005 study, 6,336 individuals were observed at a variety of public locations within the United States. It was determined that 90% of the women and 75% of the men actually washed their hands. Thus, no matter how well we wash our hands, we are likely to use a door handle that has been contaminated by the 17% of the American population who don't wash their hands. Perhaps there is an entrepreneur among us who could develop a contamination sensor for a system that would prevent these individuals from leaving until they washed their hands. Somehow, the acronym MOM (Microbe Observation and Monitoring system) seems appropriate.

Photo 9. "Pull down to advance next sheet" dispenser.

It is noteworthy that at the sites examined, all the units shown in Photo 1 have been replaced by either hot-air units with large, square buttons (see Photo 4) or with dispensers that provide a new towel after a user has removed the clearly visible towel (Photo 9). Unlike the dispenser operated with a moisture detection sensor, the appropriate action matches the user's conceptual model for both of these types of dryers. In the case of the moisture detection sensor, the improper use of conventions and the lack of appropriate usability testing had an economic impact, as these units were subsequently removed and replaced.

Apparently, in new situations, individuals will rely on their stereotypes or cultural conventions. If those don't work, users *may* read the instructions. The most desirable situation is one in which the designer incorporates the user's stereotypes into the design and provides the appropriate affordances. In addition, the need for realistic test and evaluation cannot be ignored.

References

American Society for Microbiology. (2005, September 21). *Women better at hand hygiene habits, hands down.* Press release retrieved April 24, 2007, from http://www.asm.org/Media/index.asp?bid=38075.

McGrenere, J., & Ho, W. (2000). Affordances: Clarifying and evolving a concept. *Proceedings of Graphics Interface 2000* (pp. 179–186). Mahwah, NJ: Erlbaum.

Norman, D. A. (1983). Design rules based on analyses of human error. *Communications of the ACM*, *4*, 254–258.

Norman, D. A. (1999). Affordances, conventions and design. *Interactions of the ACM*, *6*(3), 38–41.

Norman, D. A. (July/August, 2005). Human-centered design considered harmful. *ACM Interactions*, *12*(4), 14–19.

Reason, J. (1990). *Human error*. Cambridge, England: Cambridge University Press.

Rees, N. (2003). *Cassell's humorous quotations*. New York: Sterling.

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