

## The Power Control User Interface Standard: Fall 2001 Testing Results and Conclusions

### Background and Overview

The PIER workplan for this project calls for testing of the user interface standard. An initial set of tests were conducted in the fall of 2001 and reported on previously<sup>1</sup>. The Professional Advisory Committee recommended that further testing address two parts of the standard—the power symbols and indicator light colors.

This document presents the results of user interface testing conducted in September, 2002 and a discussion of their implications. The appendix shows the results in more detail. Visit the project web site for the actual survey instrument to view the animated slides. A separate summary document will review all of the testing.

### Procedure

The intended procedure for this testing process was outlined in “Field Testing the User Interface Standard”, May 19, 2002<sup>2</sup>. Two topics were to be addressed: power symbols and indicator light colors and behavior.

A set of presentation slides (with Powerpoint v.X<sup>3</sup>) was created and copied to a Macintosh iBook notebook computer<sup>4</sup>. Three versions of the slides were used—one on each of the three days that data were collected. After the first day, some questions were dropped and one modified. Also, the order of slides was slightly changed between each version to try to eliminate some of the effect of presentation order.

A card table and two folding chairs were set up with signs asking people to participate in a survey about “office equipment”. The power connection was not mentioned until the fourth slide. All three testing days took about three hours each of data collection time to recruit and interview a dozen people, and all occurred between 11am to 3pm. Answers were recorded with pen and paper; some responses were “yes/no/don’t know” and for others the key word, phrase, or set of phrases in the response were written down. The typical time required for the survey was about five minutes. After the survey, the project purpose and standard content was offered to people to the extent they were interested.

The slide deck was pretested on several people (some LBNL staff) to eliminate obvious errors and ambiguities. The responses of those individuals were not included in the collected data.

### Results and Discussion

Thirty-six people took the survey over the course of three days, and all who started the survey also finished. There were slight differences in the instrument between the three days, mostly slide or image ordering, with a few text changes. This discussion makes no claims about statistical validity. Images from the instrument and the full results are presented in the appendix. Discussion is indented.

#### *Symbol Recognition*

The first slides asked whether the respondents recognized the current power symbols —  (“on/off”) and  (“standby”) — and whether they knew their meaning.

For both symbols, recognition of them as power-button-related (mostly *on-off* or *power*) was 44%. Only 31% of respondents recognized *both* reasonably correctly. A few people mentioned electrical terms not power-

<sup>1</sup> All project documents are available at: <http://eetd.LBL.gov/Controls>

<sup>2</sup> The characteristics of this test make it exempt from approval by the LBNL Human Subjects Committee and so the appropriate exemption forms were filed prior to beginning the testing.

<sup>3</sup> Some of the slides required animated GIF files which need newer versions of Powerpoint (2000 or later) to function.

<sup>4</sup> The power button on the iBook was taped over since it uses one of the symbols in question and is just below the screen.

button related). For those who didn't know the symbols' meanings, some remembered seeing the symbols in the past and some said they had *never* seen them before.

With the wide use of the symbols on office equipment and some use on consumer electronics, it is nearly certain that all respondees had successfully used power buttons with these symbols. It seems likely that people use design clues such as location, size, and relation to the power indicator to identify the power button rather than looking at the symbol itself. This casts doubt on using symbol variations to communicate user information in cases where it doesn't affect how one uses the product (and where safety is not at issue).

The presented symbols were large (about 4 inches across) and out of any context. This may have reduced the ability of people to connect them to power buttons and indicators, though people were told that the survey was about office equipment (so that the universe of possible symbols was limited).

### *Differentiating ⓪ and Ⓛ*

The next slide presented ⓪ and Ⓛ, explained that one is for zero power when off and the other for some power when off, and asked several questions: *Do you know which is which? Is the difference important to you? (For buying? For using?) and Which do you prefer to see?*

No one correctly knew that ⓪ is for zero power when off, but of the 33 who guessed, 79% were correct. Half of respondees said that having the two different symbols was important when buying a product with nearly the same importance assigned for when using a product<sup>5</sup>. For preference between the symbols, 42% chose ⓪ and 50% Ⓛ, with the rest having none.

We were interested to see if there was a correlation between the *recognition of each symbol* to the *importance cited for having two symbols*. These two responses were compared for each respondent, and we found that for those who thought it was not important to have two symbols, just over half of subjects recognized the symbols, but for those who thought it was important, just over two thirds did not recognize the symbols.

More people thought that *having* two different symbols (for zero and non-zero power when off) was important than *recognized* the current symbols as even related to the power button—let alone understand the details of their meaning. It seems likely that at least some people thought that they *should* favor retaining the two symbols lest they be seen as indifferent to energy waste (quite a few seemed familiar with the idea of standby power).

The difference in recognition between those who thought it important or not to have two separate symbols suggests several possible interpretations. One is that the interest in maintaining multiple symbols is associated with people who don't understand as well how the systems work and so want more cues to their operation. Another is that the population that doesn't want multiple symbols are more likely to be heavy users of technology who would have had more opportunity to notice the symbols.

We didn't ask people about how they might alter their behavior based on the difference in the symbols. The difference could be used in purchasing or in unplugging or using power strips to cut power to zero. However, since the size of the off-power consumption isn't known (the symbols don't distinguish between 10 W and 0.1 W) people don't have a rational way to decide when it is worth unplugging devices when off or not. Concern about standby power is real and worth harnessing, but it isn't clear that multiple power symbols is the most effective way to do this.

Almost 80% of respondees guessed that ⓪ is the symbol to go to zero power rather than Ⓛ. This is compelling evidence for reserving this symbol for situations in which knowing that power is zero is actually important for functional or safety reasons (⓪ would guarantee zero-power for off when it matters; Ⓛ would be used for all other cases). When the distinction isn't relevant to people's behavior, the distinction gets lost. Few people use equipment for which the distinction is important; those that do could be trained to recognize the difference.

<sup>5</sup> For the first third of respondees, the buying vs. using differentiation was not made.

The respondents from the university campus (the first two sites) recognized the symbols more frequently than those from the shopping area (the third site). This might have been due to greater use of office equipment for that sample.

### *Indicator Light Color Recognition*

The next 5 (or 6) slides showed a  symbol and a power indicator of various colors (including some blinking) and asked what people associated with it. They were told verbally and by text on the screen that it was specifically a power indicator.

The color green for a power indicator light was associated with *go* or *on* by 92% of people, and the indicator light off was recognized by 89% as *off*. We intentionally put green first to steer people to assuming that that is to mean *on*. When red was presented before light off, half of the people associated it with *off*, but when presented after light off, nobody associated it clearly with off. Stoplights were mentioned by several people, which seems like the obvious source of the association between red and off. 42% said red meant something bad, and for those who saw it after the light off slide, the portion was over half.

With red commonly indicating *on* on consumer electronics, the “priming” of people with green was quite effective at discouraging the “red = on” association. The association of red with error conditions is notable, but in general red is confusing for power indicators—in part this may be due to the fact that on office equipment its use on a power indicator is rare.

For the first round, flashing yellow was presented as the last slide (after flashing green) and most people said that it had the same meaning as flashing green. People seemed to not specifically recognize flashing yellow so it was dropped from the test for the second and third rounds.

Table 1 summarizes the associations people provided for yellow and flashing green indicator lights. The classification is necessarily judgmental (for example, that “caution” implies a minor problem).

**Table 1. Associations with Yellow and Flashing Green.**

Yellow	Fl. Green	Association
4	6	Transition Up
2	0	Transition Down
2	4	On / Active
13	3	Low-power
6	4	Minor Problem
2	4	Major Problem
1	9	Input – waiting for / wanting
7	7	Don't Know (and other)

For transition indicators, a power-up transition is more associated with flashing green and for power-down, yellow is. Over four times as many people associated yellow with low-power than did so for flashing green. Several results support the idea that flashing green calls attention to itself: a slightly greater association with major problems, more associations with an error, and many more that the device wants the user to do something. Several people said that the flashing was annoying, and several more cited this issue while answering the next (final) question. Combining these, 47% were annoyed, believed attention was wanted, or thought an error was indicated.

The indications of the results support the current incarnation of the user interface standard in that the population seems to lean towards it, though clearly not in an overwhelming way.

### *Choice for Indication of Sleep*

The final slide showed three options for sets of indicators for on, sleep, and off. In all three cases, on was signified by green, and off by the light off. The options were steady yellow, flashing green, and “breathing” green. The presentation order was rotated each time to eliminate that as a factor.

Two-thirds of the subjects preferred yellow to indicate sleep status; 19% chose flashing green, and 14% liked breathing green. For why people chose the solutions they did, most of those were naturally from yellow partisans. Many said that using the same color for both on and sleep would be confusing. Some noted that a quick glance at a flashing or breathing indicator would always provide the wrong answer—they require maintaining one’s attention on the power indicator for several seconds to be sure of the correct state. Flashing was sometimes associated with a transition or activity in progress—neither a stable state. Several specifically said that flashing was annoying. Those who favored one of the green indications were few and no clear patterns among their reasons is apparent.

### **Conclusions**

The sample size for this survey was large enough to produce the results needed for this project, showing a combination of clear preferences and confusion. Clear results include:

- Most people use power buttons without recognizing the symbols on them — Ⓢ and Ⓣ.
- A majority of people want to maintain two different power symbols, though how they would use this in practice is not clear. The interest seems to be motivated in part by concern over standby power.
- Some associations are widespread, such as Ⓢ meaning a switch for zero power (when explained), green for indicating *on*, and the light off for *off*.
- Red, flashing green, and yellow have diverse associations, but there seems to be fertile ground for the associations in the user interface standard.
- Yellow is the dominant choice for a sleep indicator, and a significant number of people find flashing annoying and/or calling attention to itself.

These results are consistent with the rationale and design elements in the interface standard with the exception of whether it is desirable to maintain two different symbols for power buttons.

There are two approaches to the use of testing in any design process including this one: generating the designs from user preferences, or picking a design and then checking to see that user preferences are not at odds with it. This project uses the latter approach.

In some cases, user beliefs seem clear and so that result determines the content of the standard. The steady green and off indications are examples of this.

The results from two other indications illustrate an alternative approach—to confirm that people do not have clear prior associations. In the case of yellow and flashing green, it is clear that at present people do not have a consistent interpretation of their meaning. Thus, the role of standardization in this case is impose an understanding on people that does not conflict with their current associations. The associations revealed by this testing do suggest that use of the meanings in accordance with the interface standard would tap into existing leanings, and so easier to make successful. Specifically, up transitions are more associated with flashing green, and down with yellow. Low-power is significantly more associated with yellow than flashing green.

**Appendix: Detailed Results**

*General Procedure*

A card table was set up with the sign at right taped on its top and sides. The investigator sat in a folding chair at the back and a second folding chair was at the side for the survey subject. A small bowl of candy was offered as an attraction, but not specifically tied to taking the survey. Business cards for the investigator were laid out. Brochures about the project were hidden until after the survey was complete, then offered. Some subjects stopped at the table on their own, and others were solicited verbally as they walked past.



Hi. I am Bruce Nordman, from Lawrence Berkeley National Laboratory, doing research on office equipment.

Can you spare a few minutes for some questions?

- I would like to ask you about how colors and symbols can be used to make office machines easier to use.
- I will record only your answer—not information about you.
- The information will help improve the design of future products.

If you have any questions, see: <http://eetd.LBL.gov/Controls> or contact Bruce Nordman, 510-486-7089, BNordman@LBL.gov Thank you.



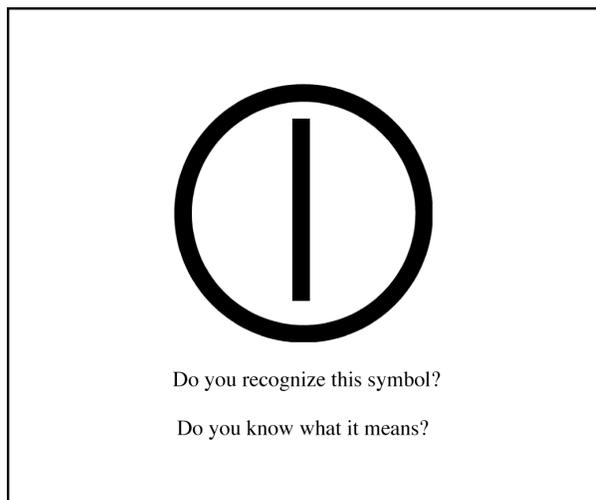
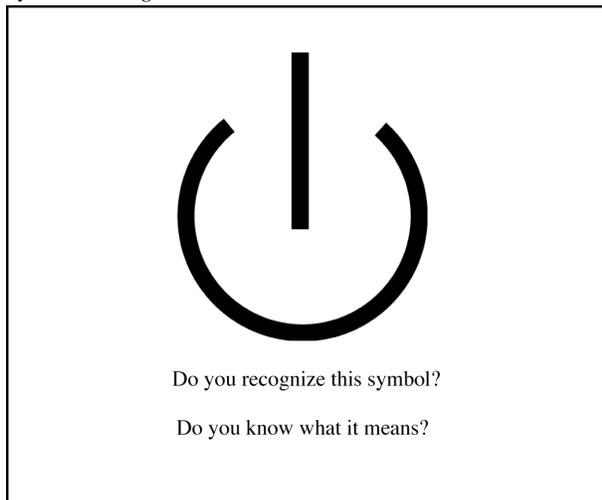
When a subject agreed to do the survey, the notebook computer was opened facing the subject with the slide at left<sup>6</sup> shown and the paper disclaimer form (with similar text) offered below. The connection to “power” was not mentioned until several slides in.

The location of tests and gender of respondees are shown in Table 2.

**Table 2. Testing Locations and Gender Balance**

Day	Location	Men	Women
1	UC Berkeley	4	8
2	UC Berkeley	8	4
3	4 <sup>th</sup> St. Berkeley	5	7

*Symbol Recognition*



The first two question slides asked about symbol recognition. The order of these was varied to not introduce a bias, but there did not seem to be pattern in responses based on the order.

Only 16 people associated the **on/off** symbol — ① — with *power* or *on/off* (this includes “on”, “off”, and “on-off indicator”). Others said “info”, “eyeball”, “socket”, “outlet”, “reset”, and 16 “don’t know”.

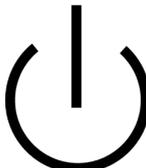
<sup>6</sup> Due to software (printing) problems, these figures are close reproductions of the slides, not the precise images.

For the “standby” symbol —  — a similar 17 recognized it as *power* or *on/off*. Other responses included “open system”, “battery”, “clock or timer”, “timer / computer waiting”, “clock, waiting”, “washing machine”, “knob for mixer (e.g. volume)” and ten “don’t know”.

*Differentiating  and *

**Power Buttons**

One of these is for devices that use no electricity when off, and the other is for ones which use some electricity when off.

Do you know which is which?

Is the difference (on a power button) important to you:  
When buying a device? When using it?

Which do you prefer to see? (on a power button)

No one correctly *knew* which symbol was which (*no* electricity when off versus *some* electricity when off). One person said that they knew, but that person was wrong. All but three people were willing to guess, and of those 33, 26 chose (correctly)  for zero power when off. One person said that  was more “definite”, and another that  was for a broken electrical circuit.

On the “importance” of having two symbols, for the first round, the buying vs. using difference was not mentioned and two people brought up the value of knowing the difference when buying. Because of this, the distinction was added to the second and third rounds. For the first round, six said it was important and four not. For the rest, 10 said it was important for buying, and 11 for using. Only 13% people answered differently for the two

issues. Other responses for the first round: the goal to “conserve”, that it is “good to know”, and “I don’t pay the electricity bill.

On the first round only, people were also asked “Which is most common”; six said , and four said . With so many people saying they didn’t recognize the symbols at all, the “most common” question seemed of dubious value and was dropped.

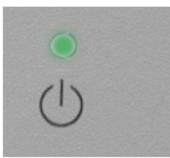
For which symbol they prefer, 13 said  and 18 said .  was said to be “more definite”, “looks better, less complex”, and “not cut up” by those who preferred it and “too similar” [to ] by someone who didn’t like it.  was “clear, more distinct;  just a circle and line” by a partisan of it.

We were interested to see the correlation between symbol recognition and whether people felt it was important to maintain two symbols. Summing responses for both symbols, for those who thought it important to maintain two symbols, only 11 recognized symbols and 23 did not. For those who thought it not important, 18 recognized the symbols and 16 didn’t.

*Indicator Lights*

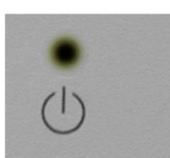
**Power Indicators**

What do you associate with Green?



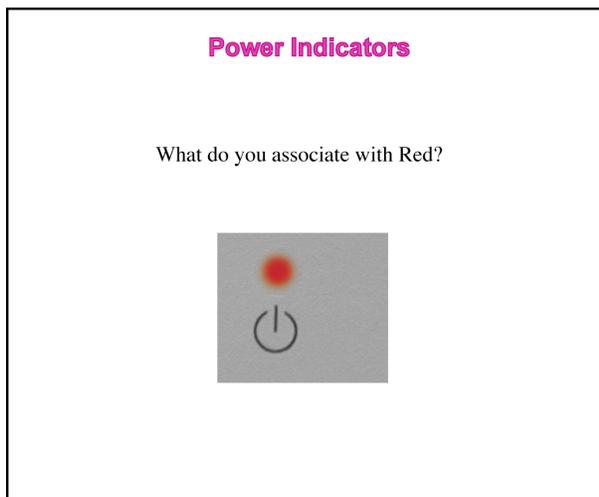
**Power Indicators**

What do you associate with the light off?



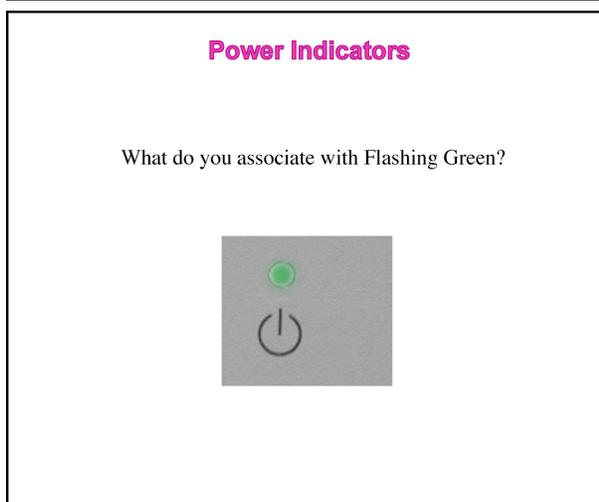
For **green**, 33 people said variants of *on* (including one each of “go/on”, “go”, “functioning”), two mentioned variants of *ready* (“electricity used whether on or off” and “attached, plugged in, charging”), and one “off”.

For “**off**”, it seemed important to say “with the light off” (this was changed from the first round which said only “with off”). 32 said “off” (including one “non-functioning”), and the other five said “off or standby”, “don’t know”, “disconnected”, and two “broken”. There was little difference whether off was presented before or after red.



For **red**, the responses differed considerably depending on whether it was before or after “off”. When red was presented first, six included “off” as part of their answer (“either on or off”, “off”, “off or hazardous”, “off (but still some energy) or booting”, two “stop/off”), with the others “on”, “could be on”, “caution”, and three “don’t know”.

When red was presented after “light off” we got three transitions (“transition”, “starting up or not plugged in”, “warming up, non-functioning”), two low-power (“reduced power”, “standby”), two “on”, “working, doing something, something wrong”, “malfunction”, “problem”, three “something wrong”, two “problem”, “something bad”, “stop, danger”, “error” and “running short on power” and four no associations. At least thirteen of these have error involved.

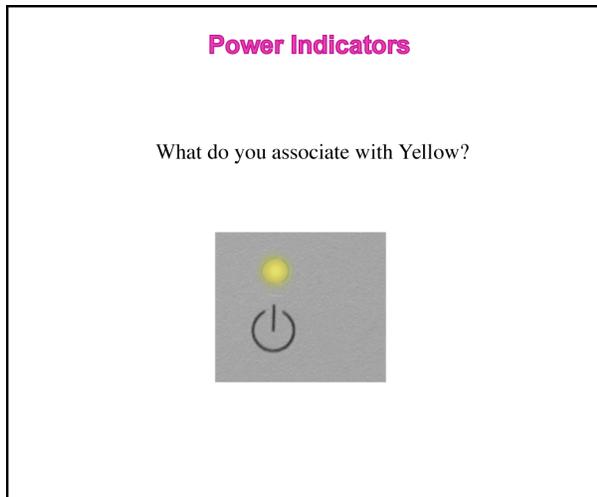


The order of yellow and flashing green was varied. For flashing, the symbol was *on* for 1 second, then *off* for 1 second, for a 2 second total cycle.

For **flashing green**, responses were six power-up transitions (“almost there” “doing something or booting up”, “warming up”, “about to come on”, “warming up, on way to solid green”, “starting up”), nine signaling input (“waiting for something” “better do something, need to do something”, “if push button will start”, “on, needs attention”, “waiting for something from user”, “get help (but never seen)”, “the device wants someone to use it”, “annoying, device wants me to be aware of something”, “a problem, wants attention, but still working”), four on/active (“confusing, on”, “running”, “working, doing something”, “processing”),

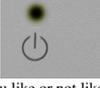
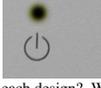
three low-power (“standby”, “standby, between on and off”, and “between on and off”), four minor problems (“may not be working”, “caution”, “careful, caution”, “running short on power”), four major problems (“a problem, wants attention, but still working”, two “problem”, “something wrong”), and finally, “don’t like flashing”, “screensaver”, and five “don’t know”. (“a problem, wants attention, but still working”, counted twice).

In summary, ten people were annoyed or thought that the device wanted to draw attention. Eight of the responses indicate an error. Combining these, 47% were annoyed, believed attention was wanted, or thought an error was indicated.



For **yellow**, the responses were two “on”, two major problems (“frozen”, “problem”), six minor problems (“warning”, “caution, not working well”, “running out of power, warning”, “power surge, out of ordinary”, “caution”, “in between, caution”), four power-up transitions (“starting up”, “startup”, “warming up”, “booting up, intermediate”), two power-down transitions (both “slow down”), 13 low-power indications (six “standby”, four “sleep”, “in between on and off”, “in between, caution”, “some electricity”), “waiting”, “not fully charged”, and six “don’t know”. (“in between, caution” is counted twice).

*Last Question!* **Power Indicators –**  
**What would be best for ‘Sleep’ for future products?**

<b>On</b>			
	Steady Yellow	Flashing Green	Breathing Green
<b>Sleep</b>			
<b>Off</b>			

What do you like or not like about each design? Which are OK or not OK?

The flashing cycle was as above; the breathing total cycle length was 5.8 seconds, longer than the four seconds used on new Apple Macintosh computers.

For what indication to use for sleep, 24 said yellow, 7 said flashing green, and 5 breathing green.

Of the yellow partisans, twelve said that using the same color for on and sleep would be confusing and could easily be misinterpreted if one didn't stare at it long enough. Two others said yellow was “least confusing” and “function is clear”. Others comments were that blinking meant alternating between on and off, was “ready to turn on or off”, “something wrong or bad about to happen”, “go crazy”, and “confusing”.

Flashing green partisans said “different” and “makes sense”. Two thought that the breathing was “cool” but still preferred a different solution.

And the final slide:

