Appendix VII — Testing[1]

1.1 Introduction and Background

Any design process that touches on human interaction should include testing of candidate designs on "ordinary" people. For *products*, these can be elaborate and drawn out — particularly for complex interfaces such as software or web sites. For *standards*, the process is necessarily more granular and limited, as just specific elements of the interface are being tested (if a test becomes complex, then the results will say more about the testbed than the elements themselves).

This appendix reviews the testing exercises conducted in the development of the Power Control User Interface Standard. Four separate tests were done at three locations, covering a variety of aspects of the power control standard.

Four separate testing exercises were conducted: two at the University of California, Berkeley (UCB1 and UCB2); one at Cornell University (Cornell); and one at Lawrence Berkeley National Laboratory (LBNL). Most of the testing addressed the meaning and usage of the power symbols and indicator lights. The UCB2 test probed selected issues from UCB1 in more detail. The Cornell test built on both UCB tests, and explored many of the same issues but in slightly different ways. The LBNL test addressed the two issues that were most important at that stage of the standard development. Table 1 summarizes key information about each test. A total of 190 people were surveyed.

Table 1. Testing Summary

Topic	UCB1	UCB2	Cornell	LBNL
# Respondents	37	12	105	36
# Questions	27	43	33	11
Power Symbols	X	X	X	X
Indicators	X	—	X	X
Sleep Associations	X	—	X	—
Use of Sleep Modes	X	—	X	—
Changing States	X	X	X	—
Assessing State	X	—	—	—

The results of all four tests supported the User Interface Standard as proposed, and provided additional insights. All four tests were conducted with the aid of a computer, with all but the Cornell test guided by an experimenter.

[1] This appendix provides detailed background information about the development of the Power Control User Interface Standard. For the full report and more about the Standard, see http://eetd.LBL.gov/Controls

1.2 Test methods for ISO/IEC standards

ISO 9186, "Graphical Symbols — Test methods for judged comprehensibility and for comprehension" (ISO 2001a) specifies procedures to be used in advance of establishing international standard symbols. Some of the principles can be extended to the other interface elements. It was not our intention to conduct tests according to this standard, but it is a useful reference.

Per ISO 9186, tests can be of two types: "comprehension judgment", what percent of others will understand a symbol; and "comprehension", whether the subject herself / himself understands it correctly (our tests included both types). The "referent" of a symbol is the "idea or object that the graphical symbol is intended to represent".

Depending on the test, testing in two or three countries is required, with the goal that they be of substantially different cultures. The standard provides for computer display based testing. Symbols are to be presented in random orders. At least 50 "respondents" are required for each country a test is done in. Respondents are to be:

- Representative of the user population.
- Presented with both test types about the same symbol or referent.
- Told the context in which the symbol will usually be used in, then asked what they think it means, and (if applicable) what action they should take.
- Asked for their age (by a broad range), gender, education, cultural background, and where relevant, physical ability.

2.0 UCB Results

The two UCB tests (UCB1 and UCB2) were conducted in the fall of 2001, by groups of graduate students at UC Berkeley. They worked from the initial recommendations about the static interface (Nordman, 2001a), and some ideas about device behavior. While the data from this collaboration were useful, the process of creating the survey instruments themselves was also instructive. The sample sizes were small, so the results may not be decisive, but they are indicative and provide good anecdotal evidence. The detailed reports on both tests are published online (Chamarbagwala et al. 2001c)[2]. In both tests, many questions were multi-part.

The full reports contain much quantitative information about the survey results. This presentation mostly avoids specific percentage values for ease of reading, because of the small sample sizes, and to cope with sometimes ambiguous or obtuse results. A complicating factor is that two different meanings for ⏻ were being tested — this can lead to confusion both for survey subjects and those interpreting the results. Some issues were addressed by more than one set of questions, particularly when both surveys are considered together. The results were not always self-consistent or reconcilable with a clear mental model. The reporting of the first

[2] This was in the context of SIMS 271, a course in the School of Information Management and Systems about Quantitative Research Methods for Information Management. The instructor was Rashmi Sinha, a lecturer in the department. As of April 5, 2002, the reports and the original survey instruments were still available online (Chamarbagwala et al., 2001c).

study was not always clear, but the second was quite well done. Both tests were web-based, allowing good use of graphics, color, and blinking.

2.1 UCB Test 1

This test (Chamarbagwala et al. 2001) addressed the existing IEC standard symbols and our replacements, their usage, the color indications, and the sleep metaphor and moon symbol. The sample of subjects was 37 UC Berkeley students, none of which reported being color-deficient.

Over a third of subjects reported actively disabling power management, and others reported never using it (this suspicious as ENERGY STAR labeled equipment is supposed to always be shipped enabled). The most common reason reported for disabling was not failure to properly awaken after sleep, but that power management occurred too soon. This problem should have led them to extend the delay time rather than entirely disabling power management, so something that an improved user interface should help. Almost half of disabling was due to excess delay time or people unsure how to use the controls.

Some of the testing referred to a notebook or a copier to see if expectations for how to change device state differed by device type. No significant difference was observed. Pairs of buttons were shown — ⏻ / ⏽ and ⏽ / ☾. Subjects were asked to change a device from *sleep* to *on*, *on* to *sleep*, and *sleep* to *off*[3]. Interestingly, ⏽ was preferred by most subjects for all cases. The proposed symbol set was always implemented more reliably than the current pairing, both for consistency and correctness of responses. However, the number of people who reported not being sure was large (25-32% in four of the six cases). It appears that: people are confident pressing ⏽ to control power states; they differentiate ☾ much more than ⏻ from ⏽; and there is considerable confusion in general.

For some questions, rather than use verbal descriptions, subjects were shown images of a notebook in a variety of states (two options for sleep — amber and blinking green). Subjects were asked to change to a new state. While most subjects acted in accord with current typical PC operation, the number that didn't was suspiciously high.

Several tests were done to gauge the pairing of power and sleep buttons. Interestingly, in some of the tests there was a clear preference to use ⏽ to turn devices on, with little interest in ⏻, but a large desire to use ⏻ to turn devices off. This is in accord with anecdotal U.S. perception of ⏽ meaning "power on" — connoting both "power" and "on". The moon symbol elicited little interpretation contrary to sleep. There was considerable more clarity between functions for ⏽ / ☾ as compared to ⏻ / ⏽.

Some further questions addressed how people assess device states. For notebooks, about half would "prod" or "poke" the machine to see what it did (with the mouse or keyboard), and half would look at it or listen. Only a sixth relied on indicator lights. For a copier, only 9% would take an action (perhaps because it might cause a copy or delay), with most either looking at the control panel screen or indicator lights. That indicators do not rate higher in general might be due to their current inconsistency.

---

[3] This is not quite a fair question, as for notebook PCs, people are instructed to turn them off via software not via the power button. This will likely change in future, but is not part of many people's present experience.

Another set of questions addressed the correspondence between device state and indicator color. Questions were asked both ways — what color corresponds to a particular state, and what state corresponds to each color. Green was overwhelmingly the choice for *on*, and "no light" was the dominant choice for *off*. For the latter, red made a respectable showing, which may have been due to subjects reading the question as addressing the color of an on/off button (like a STOP sign) rather than an indicator light. For *sleep* there was the least clarity, with blue rating higher than yellow (possibly this is due to yellow not standing out on the white background of the survey). This is odd as we have never seen blue as a sleep indicator on any device.

The reverse associations (what state each color implies) were asked with green, orange, yellow, and red, and blinking versions of each. Why the students chose to ask about both orange and yellow isn't clear; the fact that both were present may have led some subjects to think that yellow should mean something different from orange. Green was overwhelmingly identified with *on*. Interestingly, red was never identified with Attention/Input or Error, but rated the highest on Don't Know. Non-blinking was rarely identified with Attention/Input, Error, or Transitions, which is good evidence for blinking for these indications. Aside from red, blinking rated well for *sleep*, but not as high as constant orange or yellow.

Another set of questions asked subjects to rate their association of the idea of sleep with various symbols including the word "sleep", beds, moons, stars, "Zzzz"s, and some combinations of these. Interestingly, the crescent moon rated in the middle of the full set of choices, with the word "Sleep" the highest, followed by some beds. Icons with multiple elements rated higher than those with just one.

2.2 UCB Test 2

The second UC Berkeley test (Chamarbagwala and Rixford, 2001) focused primarily on user expectations of device behavior. It covered some of the same ground as the first phase as well as some new topics and approaches. Subjects were presented with images and questions on-line (guided by an experimenter) and asked questions about the meaning of interface elements and what they would do to accomplish certain actions. Because PCs are the most problematic device, three types (notebook, desktop, and tablet) were the models used to illustrate the elements.

One of the findings was that the type of computer did not significantly affect people's actions and expectations — good news for standardization. For taking a device from *sleep* to *on*, most subjects chose some action other than pressing a button — consistent with most current machines for which mouse or keyboard input will wake it up. People were most likely to press the ⏻ button regardless of whether it was in a "Standby" or "Power" context, suggesting that prior associations with the symbol overrode other information about the situation.

Another part of the test involved moving from *sleep* to *off*, which is something that people generally don't do to a PC — they wake up the device, then turn it *off*. However, as hibernate is used more widely as a form of *off*, this will become more viable[4]. In this case, pushing a button

[4] The fact that an ACPI PC will always go through the full on state internally when going from sleep to off is not important to the user interface.

was the preferred way to perform the action. When both the ⏻ and ⏻ were options there was confusion as to which to use, but when ⏻ and ☾ were presented, there was near certainty about which to use. When the question (how to move from *sleep* to *off*) was asked in a different way, there was less certainty that button-pressing was the appropriate action (but again this is a sort of trick question as it not how people presently use PCs).

When asked about the meanings of the various buttons, the subjects' responses varied with the actions they were trying to accomplish. This internal inconsistency shows that people don't have a clear underlying model of how the device behaves. People were confident that the ⏻ button would do something, though there was less consensus on what it does. The fact that they tended towards ⏻ meaning to turn it *off* may have been influenced by the earlier questions of how to move from *sleep* to *off* in which they chose the ⏻ button when in fact no action would accomplish that. For the ☾ button, subjects were split on whether it would move a device from *sleep* to *on* or do nothing, but almost no one associated it with *off*.

People were grouped into four types depending on their expectations for the ⏻ and ☾ buttons as shown in Table 2. Almost 20% were found in each type showing a lack of consensus about their expectations and the underlying model. More people were found in the types for which only one of the two buttons brings it out of the sleep mode, suggesting that people might be discounting the idea of redundant controls.

Table 2. General User Expectations for Power Controls

ACTION		**Pressing Proposed Sleep Button ☾**	
	Expected Behavior of Device	Only puts device into *sleep* mode	Puts device into *sleep* mode & brings it out of *sleep*
Pressing Proposed Power Symbol ⏻	Only turns device *on* and *off*	18 %	36 %
	Turns device *on* and *off* & brings it out of *sleep*	27 %	18 %

Source: Chamarbagwala and Rixford, 2001.

2.3 Summary of UCB Test Results

While the sample sizes in these experiments were not large enough to be definitive, some clear results emerge.

- User expectations and preferences largely ratify the standard.
- No fundamental problems with the standard were raised.
- The subjects expectations were similar across device types.
- Subjects are comfortable pressing the ⏻ button — it rated highly as the solution for any power state change task.
- The moon rated only in the middle of eleven sleep symbols tested for its association with the idea of *sleep*, but nevertheless, its meaning is clear.

- People readily understood that the sleep button puts the device into *sleep*, but relied on the power button for wake up.
- No clear common mental model was apparent across the subjects, so it seems safe to impose one that makes sense to product designers so long as it is not inconsistent with widespread perceptions in a way that may cause problems (e.g. turning a machine off unexpectedly).
- The subject's responses mostly makes sense in light of what people see on current products.
- To check power status, people "poked" notebooks but observed copiers. (If future PC keyboards don't wake them up from *sleep*, some re-education will be necessary).

3.0 Cornell Test

The Cornell test (Puleio and Shanis, 2002) was conducted subsequent to the two UCB tests. It was focused specifically on computers (desktop and notebook) rather than on office equipment generally.

The reported rate of use of "sleep" features was 20% less than at UCB. Possible reasons for this include the more narrow focus on computers and the use of a specific term ("sleep") rather than the generic "energy saving" as used at UCB. More than half of respondents entered *sleep* by "allow[ing] time to pass" with use of the "start menu" capturing most of the rest of laptop users, and pressing a sleep button most of the rest of desktop users. To wake up the computer, moving an input device (e.g. the mouse) was preferred by over two-thirds of subjects. For reasons that might cause them to "increase use of sleep mode", the top two reasons were to "know how" and "easier to use".

The Cornell study asked similar questions (as the UCB studies) about indicators and produced similar results for how to indicate *off* and *on*, and for associations with green. For *sleep*, yellow and orange were both offered as options, and together over 70% of people cited it as best (the confounding blue option from UCB1 was not offered). For the meaning of blinking green, over 65% cited it as meaning a transition state or "needs attention" — less than 15% cited *sleep*. For orange (yellow was not asked about), blinking was most associated with a problem / error or "needs attention" with one fourth "don't know". For solid orange, a third associated it with *sleep*, but half didn't know what meaning to assign.

For the degree of association of various symbols with *sleep*, the ordering of the symbols was quite similar to that found at UCB (the ranking method was different so the results are not comparable other than by order). For what symbol should be used on a button to go to *sleep*, ☾ was preferred, but for all other purposes, ⏻ (and "power") was chosen. When asked which to use for going to *sleep* between ⏻ and ⏼ (with the moon not an option), only 10% chose ⏻ (with 40% undecided). For transitioning from *on* to *off*, two-thirds chose software as the mechanism and one third a button. For *off* to *on*, a button was the overwhelming choice, with twelve times as many people choosing ⏻ over ⏼.

4.0 LBNL Test

The LBNL testing was conducted in September, 2002. An earlier presentation (Nordman, 2002b) shows the results in more detail, and the actual survey instrument is available on-line which allows the animated slides to be viewed[5].

The intended procedure for this testing process was outlined in (Nordman, 2002a), based on the results of the previous tests, and needs identified by the Professional Advisory Committee (PAC). Two topics were identified for testing: power symbols (drop the ⏼ symbol from use and redefine ⏻ to mean "power") and indicator light colors and behavior[6]. The other four core principles of the standard were taken as assumed.

A set of presentation slides (with Powerpoint v.X [7]) was created and copied to a Macintosh iBook notebook computer[8]. 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[9].

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

4.1 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 (Nordman, 2002b).

4.2 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

---

[5] See [http: / / eetd.LBL.gov / Controls / publications / test6b.ppt].

[6] 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.

[7] Some of the slides required animated GIF files which need newer versions of Powerpoint (2000 or later) to function.

[8] The power button on the iBook was taped over since it uses one of the symbols in question and is just below the screen.

[9] 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.

electrical terms not power-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.

Discussion

With the wide use of the power symbols on office equipment and 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 closely examining 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 symbols presented in the text 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).

4.3 Differentiating ⏼ and ⏻

The next slide presented ⏼ 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 ⏼ 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[10] with nearly the same importance assigned for when using a product . For preference between the symbols for a power button, 42% chose ⏼ 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 <u>not important</u> to have two symbols, just over half of subjects recognized the symbols, but for those who thought it was <u>important</u>, just over two thirds did <u>not</u> recognize the symbols. This is curious and ironic.

Discussion

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

[10] For the first third of respondees, the buying vs. using differentiation was not made.

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 for the *off* mode) 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 an effective way to do this.

That almost 80% of respondees guessed that ⏼ (rather than ⏻) is the symbol to go to zero power is compelling evidence for reserving this symbol for situations in which knowing that power is zero is actually important for functional or safety reasons (⏼ 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 (e.g. medical professionals) could be trained to recognize the difference.

The respondees from the university campus (the first two sites of the LBNL test) 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.

4.4 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 is probably the 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.

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 2 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).

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, for flashing, 47% were annoyed, believed that attention was wanted, or thought an error was indicated.

Table 2. 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)

Discussion

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.

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.

4.5 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.

4.6 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.

5.0 Key Conclusions

The four tests all pointed to several key points:

- The power user interface is in many respects confusing to people.
- Many parts of the standard are confirmed by user expectations.
- When user expectations don't match the standard, they are diverse, rather than concentrated on a preferred alternate design.
- ⏻ is a preferred symbol for people to use for most power purposes.
- The meanings of color and blinking in the standard match user expectations.

A possible next step is to replicate selected portions of these tests in other countries, to see if the same results hold elsewhere.

6.0 References

Chamarbagwala, Azeen, and Phoebe Kuan-Ting Liu, Craig Rixford, Mary Trombley, and Bin Xin. 2001. "On, Off, or Asleep?: User Perceptions of Power Controls on Common Office Equipment". School of Information Management and Systems, University of California, Berkeley. October, 2001.

Chamarbagwala, Azeen, and Craig Rixford. 2001b. "Power Controls — Form and Function: Mapping the User's Mental Model". School of Information Management and Systems, University of California, Berkeley. December 2001.

Chamarbagwala, Azeen, and Craig Rixford. 2001c. "Quant. Methods Projects: Power Controls". School of Information Management and Systems, University of California, Berkeley. [http://www.sims.berkeley.edu/courses/is271/f01/projects/PowerControls/] December 2001.

Nordman, Bruce. 2002a. "Field Testing the User Interface Standard", May 19, 2002. [http://eetd.LBL.gov/Controls/publications/testing0519.pdf].

Nordman, Bruce. 2002b. "The Power Control User Interface Standard: Fall 2002 Testing Results and Conclusions", [http://eetd.LBL.gov/Controls/publications/testingoct9.pdf].

Nordman, Bruce. 2001a. "Tentative Recommendations". [http://eetd.LBL.gov/Controls/publications/July01/TentRec.7.01.pdf]. 2001.

Puleio, Jonathan, and Jenna Shanis. 2002. "User Perceptions of Power Controls, Icons and Power States". Cornell University. 2002.

ISO 2001a. Graphical symbols — Test methods for judged comprehensibility and for comprehension. ISO 9186. Second Edition, Geneva, Switzerland: International Organization for Standardization. 2001.