Lighting control user interface elements are governed by few standards. This may lead to products that are unnecessarily confusing for building occupants, leading to a lost opportunity for energy savings. The problem may worsen as control capabilities rise sharply with the advent of digital and networked systems.

The Lighting Control User Interface Standards project documented existing and emerging user interfaces for lighting controls and collected input from industry leaders and policymakers on the need for a lighting control user interface standard on selected elements, and a process by which to design and create it.

The project team concluded that standardizing selected elements would be accepted by the lighting industry.

**Survey Cloud Sample**

Switches  
Color Controllers  
Scene Controllers  
Timers  
Dimmers  
Automation Controllers

**Background**

The Lighting Control User Interface Standards project is an initial investigation. Additional phases should follow that will conduct more detailed research, draw up possible content for one or more standards on the topic, and pursue adoption of those by appropriate organizations. The project was inspired by a California Energy Commission PIER project that saw final approval of an Institute for Electrical and Electronic Engineers standard.

The underlying proposition for both projects is the same: consistent user interfaces can improve usability of products and lead to energy savings. Consistency comes from standard elements of user interfaces, and the standards work best when they have the backing of a recognized standards organization. If the user perceives the room’s lighting controls as overly complex or confusing, the likelihood of energy-efficient lighting use for the space may decline.

**Technology and Research Approach**

The research team conducted a Survey of Existing Controls to collect, document, and analyze the common elements found in residential and commercial controls that the average occupant regularly comes into contact with.

The survey focused on the elements of common lighting control user interfaces, including switches, dimmers, and scene controllers found in homes and office spaces. Visual, tactile, and audio elements that serve as cues or feedback also were taken into account. The survey excluded control panels and software-based systems that are specific to facility and energy managers.

**Device Input & Mobility**

Any lighting control interface that a user does not move regularly is considered fixed, even if the controller itself is wireless or moveable under certain conditions. Any lighting control interface that the user moves on a regular basis as a part of the operation of the lighting in a space is considered mobile.
### Vertical/Horizontal Movement

**Interface**
- Touch
- Remote
- Joystick

**Movement**
- Linear (in/out)
- Rotational (up/down)
- Rotational (right/left)

**Application**
- Lighting control
- A/V control
- Temperature control

**Visual Cues**
- LED indicators
- Auditory feedback
- Tactile feedback

**Position/State**
- On
- Dimmed
- Off
- Pressed down

**Feedback for State Changes**
- Lights turn on/off

**System Indication of Activation**
- Lights turn on/off
- Auditory feedback
- Tactile feedback

### In/Out Push Movement

**Interface**
- Mechanical input
- Hybrid input
- Digital input

**Movement**
- Linear (in/out)

**Application**
- Lighting control
- A/V control
- Temperature control

**Visual Cues**
- LED indicators
- Auditory feedback
- Tactile feedback

**Position/State**
- On
- Dimmed
- Off
- Pressed down

**Feedback for State Changes**
- Lights turn on/off

**System Indication of Activation**
- Lights turn on/off
- Auditory feedback
- Tactile feedback

### Rotational Movement

**Interface**
- Mechanical input
- Hybrid input
- Digital input

**Movement**
- Rotational

**Application**
- Lighting control
- A/V control
- Temperature control

**Visual Cues**
- LED indicators
- Auditory feedback
- Tactile feedback

**Position/State**
- On
- Dimmed
- Off
- Pressed down

**Feedback for State Changes**
- Lights turn on/off

**System Indication of Activation**
- Lights turn on/off
- Auditory feedback
- Tactile feedback

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**Lighting Taxonomy**

Audit of lighting controls in today's marketplace

Product images were collected and categorized based on whether they would be encountered by an end user or a professional energy/facility manager; interface complexity; mechanical or screen input; mobility; visual cues; and dynamic feedback. Elements. The collection was used to develop a taxonomy that represents the most common features of lighting control interfaces that are used in residential and commercial environments; the majority of the items surveyed can be found in either environment. The residential products serve as a baseline as they are typically less complex and sold at lower prices. The products were selected from 44 companies, including 28 lighting, eight home automation, three home improvement, two electric, and three others.

**Lighting Controls: Forms & Interactions**

Lighting controls include fixture-integrated switches/dimmers, wall-box switches, dimmers, programmable dimmers that control several scenes, and home automation systems that also control other systems (i.e., heat/air). A controller that primarily turns a light on or off is a switch. A device used to control the intensity of light emitted by a luminaire is a dimmer. A unit capable of controlling multiple lamps, light settings, and/or lighting zones is a scene controller. A residential control system that also controls other systems is home automation. A handheld mobile lighting control device that the user moves on a regular basis is a remote.

**Static Elements: Visual Cues**

Visual elements assist occupants in understanding lighting control functions before touching the controller. Visual elements commonly include words, symbols, numbers, letters, and pictographs. The following graph shows the visual cue distribution from the survey.

**Dynamic Elements: Feedback & State Changes**

Occupants receive feedback from lighting controllers via visual, tactile, haptic, and audio methods. The surveyed lighting user interfaces used a combination of these elements, although some interfaces did not employ visual cues beyond the positioning of the control on the wall in an area where a light switch commonly would be found.
**NEXT STEPS**
Standardization for industry-wide clarity

Basic power control (on/off), dimming/brightness, scheduling and timers, occupancy sensing, daylight sensing, color control, and scenes are common core concepts in lighting controls. These concepts often are communicated through user interface elements depending on whether it is an indicator or an actuator.

**MANUFACTURER FEEDBACK**

The project team continues to collect manufacturer and standards organization feedback as the next phase of the project is planned. To date, 11 companies provided feedback on UI standardization: Six companies were supportive, and five companies expressed skepticism. The majority of the doubtful comments were on the potential for proprietary design constraint and a possible decrease in unique product identification as the result of standardization.

**CONCLUSIONS**

It is important to determine the core lighting control user interface elements that cross over the myriad products in the market. While this survey is an initial map of the fundamental aspects of controls, including static elements, user interactions, and dynamic elements, further effort is needed to clarify the lighting control interface elements taxonomy.

The ultimate goal is to develop an industry standard for select lighting control user interface elements to better match lighting desired to that delivered and so save energy in residential and commercial buildings.

**POTENTIAL ELEMENTS FOR STANDARDIZATION:**

- Establish a standard language/dictionary for lighting user interfaces (controls in terms, symbols, colors, and actuation methods)
- Further investigate the possibility of dimming, occupancy, and daylighting element standardization
- Establish demand response event indicators

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**LIGHTING**
For controls that cover only lighting, the fact that lighting is involved is almost always implicit. For those that cover other energy services, the general concept of lighting comes into play. The most common symbol is the incandescent light bulb.

**DIMMING/BRIGHTNESS**
Traditional dimming is a static adjustment by the user; it seems likely that dimming by other means (e.g., daylight sensing) would be indicated by that concept. Dimming has the usual physical mappings for up, clockwise, etc., and many symbols exist for showing control.

**SWITCHING**
Although this is the most basic aspect of lighting control, it is not clear that a single word or phrase completely captures the concept. A symbol for lighting in general exists, but it is more about the light, not the control of the light.

**DYNAMIC CONTROL**
This category determines how lighting controls behave automatically in response to signals from sensors. They include occupancy/vacancy sensors, daylight sensors, and transitions, which are short-term states between relatively stable light modes.

**SCENES**
This is a set of control settings that often includes different brightness levels for multiple light sources.

**SCHEDULE/TIMES**
Schedules are most likely found on a screen interface and can reference the concepts of a calendar or clock. Mechanical clock timers have been around for decades and use a clock dial to show time dependency.

**COLOR**
Although this is a young area for lighting control, it seems likely that the word “color” and an RGB symbol will be commonly used to indicate these controls.

**COLOR CONTROL**
Tunable color, color saturation, and color temperature color technology are becoming more prevalent. New user interfaces – which use iPod-like rotary controls to adjust color – exist to accommodate this technology.

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