INSIDE THE NGLS LIVING LABS

The Influence of Communication on the Complexity of Connected Lighting Systems

Pacific Northwest
NATIONAL LABORATORY

July 2021

K. Ruth Taylor
Dan L. Blitzer

CONTENTS

Connected lighting systems marketed as “easy to install and configure” rarely live up to that expectation. Installers pressed for time and who are most unfamiliar with networked controls, must rely on communications provided by the manufacturer for installation. The impact of these exchanges on installation, configuration, and system performance has been observed in the Next Generation Lighting Systems (NGLS) Living Lab at Parsons School of Design.

Since 2017, NGLS has invited manufacturers to submit connected lighting systems for assessment against a set of specifications. To date, 14 systems of wirelessly connected LED luminaires and controls have been installed in classrooms to replace existing lighting. In nine of the rooms, new LED linear pendants or recessed troffers replaced existing luminaires; in the other rooms, LED “kits” were retrofitted into the existing troffers. Eleven of the installations featured sensors integrated in the luminaires or retrofit kits; the others used ceiling-mounted sensors. All systems provided wall control devices for manual operation.

For half of the installations, all system components were furnished by single companies; for the other half, luminaires and controls were furnished by separate companies. A total of 18 different companies provided products, with four of these located outside the United States in South Korea, Poland, Germany, and the Netherlands. In addition, two different electrical contractors in New York City provided multiple installation teams totaling 10 individuals, none of whom were familiar with any of the systems.

NEXT GENERATION LIGHTING SYSTEMS

NGLS is organized by the U.S. Department of Energy in partnership with the Illuminating Engineering Society and the International Association of Lighting Designers, and managed by Pacific Northwest National Laboratory. NGLS uses “Living Labs” to conduct observational research in real-world settings—indoors at Parsons School of Design in New York City and outdoors at the Corporate Research Center adjacent to the Virginia Tech Transportation Institute in Blacksburg, Virginia. NGLS teams consist of a broad range of industry experts, including lighting designers, engineers, and utility professionals.

NGLS evaluators use detailed protocols to observe, document, and measure how systems are installed and configured, how well they perform, and how users operate them. NGLS seeks to learn from manufacturers’ varied approaches—identifying those that work, revealing needed improvements, articulating effective principles and practices, and publishing findings for the benefit of the lighting community.

The variation among manufacturers and their products was revealed through both the modes of communication and the content itself—from printed instructions to technical support. In the Living Lab, entrants submitted many different product approaches and accompanying communications in the form of printed instructions, videos, and phone-based technical support. Evaluators then observed the systems side by side, which exposed how much the documentation and instructions differed across systems, and how often installers found them to be confusing.

So far, the Living Lab has focused on connected lighting systems described by their manufacturers as "easy to install and configure." NGLS had two objectives in limiting the capabilities and stated complexity of the systems. First, maintaining consistency among the systems simplified the on-site evaluation process and facilitated comparison of the systems to each other. Second, limiting the number of variables in play enabled researchers to draw actionable conclusions rather than merely collect descriptive observations.

Notwithstanding these efforts of simplification, and the use of English as the common language, communication remained unstandardized.

The NGLS Living Lab employs several observational research methods that together provide a detailed—if complicated—picture of communication. These methods include direct observation, recorded interviews with installers, review of each installation, and set-up guides. For more information, see the report entitled "Observation as a Basis for Understanding Connected Lighting Systems."

Participants	
NGLS	Team of 12 Pacific Northwest National Laboratory employees and outside advisors and evaluators with lighting or energy experience; external communications channeled through three principal contacts (project leader, coordinator, and designer)
Building	The owner, represented by the head of facilities, and supporting staff
Owner	Director of the Parsons MFA Lighting Design Program (who is also a member of the NGLS Advisory Board), supported by other members of the NGLS team
Designers	Marketers, engineers, and technical support (engineers and others)
Installers	Ten electricians from two contracting firms selected by Parsons, working in teams of two or three headed by a senior or lead electrician and managed off site
Users	Parsons students and faculty using rooms in the Living Lab; facilities staff responsible for maintaining the systems

Conversations		
Phase	**Participants**	**Topic**
Pre-Submission	NGLS and manufacturers	Questions about NGLS Entrant Guide
Submission	NGLS, designers, and manufacturers	Issues with the submittal documents
Design	NGLS and designers[1]	Lighting performance and controls requirements
Delivery	NGLS, manufacturers, and Parsons	Logistics
Installation	Installers and manufacturers	Documentation and troubleshooting[1]
Configuration	Installers and manufacturers	Documentation and troubleshooting[1]
Handoff	NGLS and Parsons	Living Lab Status Report and manuals
Occupancy	Users and Parsons	Troubleshooting

COMMUNICATION AND THE NGLS PROCESS

The Living Lab involved six distinct participant groups representing different disciplines, educational backgrounds, and technical experience levels. The diversity of the groups posed key challenges to effective communication that involved multiple two-way and occasionally three-way conversations during the development and evaluation of the Parsons installations.

[1] Installation and configuration conversations differ in mechanical and software documentation and troubleshooting.

COMMUNICATION TOOLS

Except for materials created by NGLS, manufacturers provided the formal communication used in the Living Lab, as shown in the following table. A general familiarity with luminaires is assumed, limiting the communication tools discussion to controls documentation. Ultimately, the successful entrants submitted all required materials, although some required repeated reminders to do so.

Entrant Documentation
Entrant Guide, including performance specifications (provided by NGLS)
Marketing brochures (optional)
Specification data sheets (required)
Design drawings (required)
Instructions (required)
Configuration app (required, system specific)
Video (optional)
Help line (optional)
Wall control labels (optional)
Interpersonal communication (as needed)

Entrant Guide

The Entrant Guide, essentially a request for proposals, described the submission process for manufacturers, functional specifications for the luminaires and controls, and required documentation. The guide also explained the evaluation process and provided general information about the installation sites.

NGLS revised the Entrant Guide for the second and third phases of the project, including new requirements for retrofit kits and clarifying aspects of the controls specification.

Marketing Brochures

Marketing brochures in the lighting industry usually show available products and highlight them with attractive application photography or renderings. Lighting professionals (as well as sales personnel and contractors) often use such marketing materials to suggest the installed appearance of design ideas to other members of a project team.

For controls, this marketing approach fails to convey the primary attributes of the product or system, apart from the appearance of various components. Instead, manufacturers typically rely on schematic diagrams describing how components relate to each other, diagrams of configuration options, and tables of system attributes. Application images often fill up the pages. Specification sheets, while important for technically knowledgeable professionals, rarely communicate clearly the capabilities and limitations to other audiences.

Overall, NGLS (including designers) did not rely on brochures to select products for the Living Lab. Installers occasionally consulted a brochure if other documents were not available or helpful.

Specification Data Sheets – Luminaires

Luminaire data sheets include most of the information important to NGLS: output, color, power, efficacy, and electrical characteristics. However, pre-printed sheets do not provide photometry for all possible models; in some cases, the data are modeled, not measured. Many do not provide details about drivers and most do not include warrantees, although separate documents are typically available and were provided.

Specification Data Sheets – Controls

Simple specification or data sheets provide some basic electrical and dimensional information about controls, but as stated above, the information by itself doesn't readily convey capabilities and limitations. Instead, most control systems in the Living Lab are supported by more comprehensive application guides that describe the system in narrative form, supplemented by detailed diagrams and illustrations. Capabilities are presented reasonably well in most cases, but limitations must often be inferred from what is not stated.

Design Drawings

NGLS assigned a unique room to each entrant with instructions to design the lighting and controls to meet NGLS specifications, which included illuminance, manual dimming in two zones, occupancy sensing, and daylight harvesting. Entrants were required to provide illuminance calculations and lighting layouts, including control locations indicated in submittal drawings. In keeping with the existing building application and the "easy to configure" systems, the involvement of a professional lighting designer was not considered realistic. Transferring the design to the manufacturers was considered a reasonable approach given that most manufacturers typically provide application engineering assistance on large projects. Without the involvement of a professional lighting designer, this configuration work is typically performed by a local lighting salesperson.

NGLS provided room drawings, either copied from building plans or redrawn for the occasion. Some drawings were clear, others were ambiguous. While the specifications supplied to entrants indicated the location within each room of ceiling-mounted projectors, this same information omitted zone designations and complicated later configuration. Most did not specify the exact location of manual controls. This ambiguity—combined with a lack of labels on the controls—led some users (and evaluators) to fumble when trying to control the lighting.

All entrants provided point-by-point computer prediction of illuminance, although a few showed illuminance values outside of the specified range or were based on inconsistent luminaire data.

NGLS contacted these manufacturers and allowed them to submit modified designs.

Although this type of iteration occurs in everyday lighting practice, lighting designers don't usually monitor products and mistakes like these. Therefore, these issues would have found their way into the finished project or at least encumbered the construction stage.

Installation Instructions – Luminaires

The troffers installed easily with barely any need for installation instructions. Linear pendants, which have more components to assemble on-site and more variation in industrial design, required installers to consult instructions. Nevertheless, installation proceeded quickly and without confusion.

Retrofit kits, on the other hand, posed more serious challenges. In part, problems with retrofit kits reflected (as did the linear pendants) the built-on-site nature of the installation; such problems also reflected the vagaries of the existing troffer into which the kits need to be installed. Without advanced information about the existing luminaire, standardized installation instructions cannot provide detailed or accurate directions.

In addition, the engineers preparing the installation instructions made what might be considered fundamental errors; for example, as reported by one experienced installer, illustrations were drawn without considering the viewpoint of the installer. It was telling when four of the five retrofit kits presented installation challenges in some fashion, leaving installers puzzled as they studied instruction sheets.

Installation Instructions – Controls

Installation requirements for the control systems varied widely among the entrants, as did the instructions. Systems with luminaire-integrated sensors mostly involved only the mounting of a few manual control devices. While installation instructions for the sensors were not needed during system installation, an explanatory document will be required when a factory-installed sensor requires replacement.

Systems with ceiling-mounted sensors required more installation and more detailed instructions. One required the installation of 10 separate components, which resulted in the incorrect installation of the system.

The more elaborate the installation, the more elaborate the instructions. Installers struggled to identify components and, amid the disarray of the installation site, even to find the correct installation sheet. Installers generally faulted the instructions for being both too long and lacking clear diagrams.

Configuration Instructions – Controls

Configuration approaches (or tools) for controls fell into three basic types: special-purpose devices, mobile apps, and computer-based programs. Nevertheless, there was widespread variation in how these tools were documented and explained.

Printed instructions, typically with screen shots, were quite common but these print documents suffered from three problems: unclear terminology, excessive detail, and awkward shifting from the instruction sheet to the app or computer. Some instructions also omitted important steps.

On-screen instructions made it easy to understand the instructions in relation to the device; for this reason they were favored by installers. Screen size also forced abridging of the information, which most installers appeared to favor.

Videos, as discussed below, helped installers visualize procedures better than written instructions[2] or diagrams—although such videos were perhaps less valuable for configuration than for installation. Additionally, videos can be too brief and fast moving, or too long and time-consuming.

Videos – Luminaires

Video instructions proved particularly valuable to installers working with retrofit kits, where descriptions and diagrams were often difficult to understand. Installers found that video instructions easily revealed the tricks of installation. However, installers needed to know where to find the video link. While most installation videos didn't require high production values and cost, they seemed less likely to be updated than printed documents (and may not have accompanied the initial product release).

Help Lines

Most entrants did not have personnel on-site during installation; those in attendance were not permitted to intervene when the installers hit a roadblock. When an installation wasn't working out and installation guides didn't solve the problem, installers tried to call the manufacturer help line directly.

In some cases, installers had difficulty connecting with a knowledgeable resource, and wait times proved to be a challenge. An installer might be willing to accept a call back or a long hold time at home, but long wait times can be costly on an installation project. Even when using smartphone images or videos, installers can have difficulty explaining the problem to remote engineers or quality control personnel. Manufacturer troubleshooters can have similar difficulties explaining the solution. Compound difficulties can lead to a particularly long troubleshooting process and installer frustration.

[2] In one instance, a video quickly clarified how to use a mobile app. Unfortunately, the installer had already struggled and wasted time before being informed of the video.

Labels

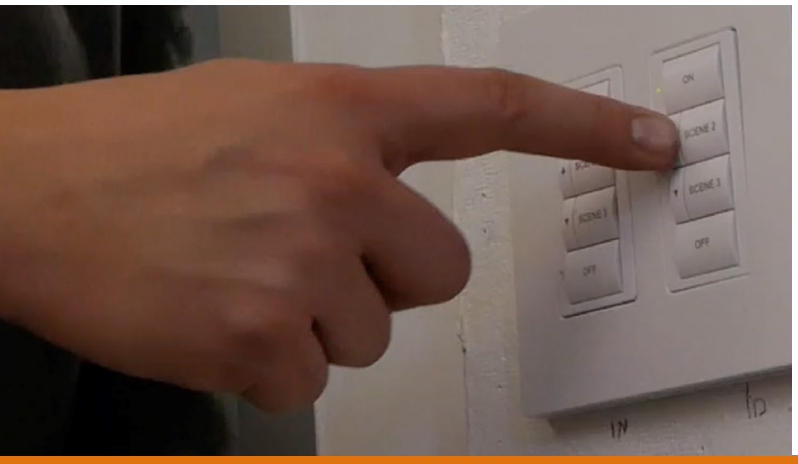
NGLS did not require labels for the manual controls, but some entrants provided them. Labels with clear, unambiguous meaning worked well, such as on/off and up/down arrows. Those that did not explain function (Zone 1, for example) or those with multiple meanings (💡) did not make usage easier. For more information, see the NGLS report entitled "Observation as a Basis for Understanding Connected Lighting Systems."

In preparation for classroom use of the Living Lab rooms, NGLS decided to create explanatory placards in lieu of labels (sample at right). Developing clear and concise language for end-user groups proved more difficult than expected.

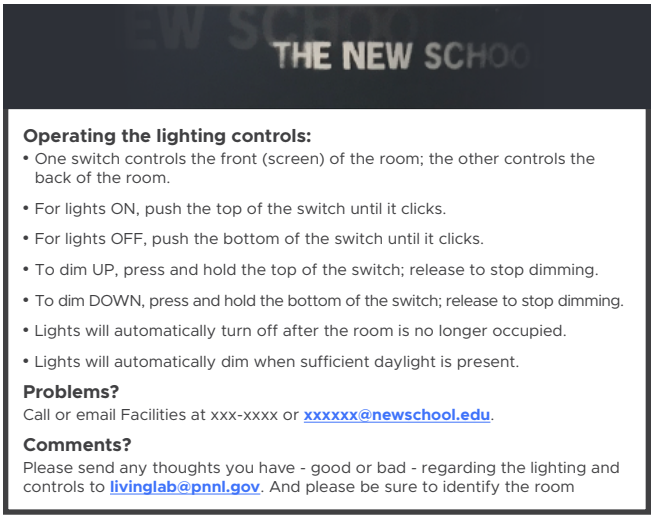
Feedback to Manufacturers

Throughout the process, NGLS provided feedback to manufacturers directly via email and phone conversations. Indirect feedback was provided via tradeshow presentations, newsletters, and magazine articles available to a larger audience consisting primarily of lighting practitioners and other interested parties, such as utility and energy-efficiency advocates and consultants.

Manufacturers were interested in the installer comments reported by NGLS, as some of these offered concrete guidance for improving products from the perspective of a key market influencer. In fact, several manufacturers asked to connect directly with installers. Manufacturers were also interested in how NGLS evaluated the systems, particularly relative to competitors' offerings. NGLS declined to share specific product evaluation results either privately or publicly.



	Entrant	Wall Control Labels
1	Lumenwerx	None
2	Signify/Selux	None
3	Crestron	Standard scene button labels
4, 10	Signify	None
5	RAB Lighting	None
6	Cree	None
7	Nextek	Custom printed labels, field applied
8	Cooper Lighting	Standard scene button labels, standard engraved icons: light bulb, up/down arrows
9	LG	Standard engraved icons: "On/Off", up/down arrows, "Dim"
11	Lutron	Standard engraved icons: light bulb, up/down arrows
12	Acuity	Standard engraved icons: "On/Off", up/down arrows
13	Avi-on/MaxLite	Standard scene button labels, standard engraved icons: power, up/down arrows
14	Silvair	Custom printed labels, field applied



Some manufacturers responded to critical evaluations by acknowledging product shortcomings and noting upcoming enhancements or revised designs. Others argued that the Living Lab process did not adequately represent real-world conditions. While this is true to some degree, the variation reflected the extent of problems more than the likelihood of occurrence.

Living Lab Status Report

NGLS prepared a status report for the Parsons facilities team explaining which controls were functioning properly and what problems were affecting the others. The report also conveyed the NGLS plan, subject to approval by Parsons, to address problem rooms by repair or replacement, as well as suggestions for further installations. Developing reasonably objective criteria for proposed actions was one of the challenges in putting the report together.

Interpersonal Communication

The Living Lab generated a myriad of interpersonal communications, mostly emails but also telephone calls and face-to-face conversations. These involved all participants in varying two-way and occasionally three-way discussions. With the exception of installer interviews and NGLS team dialogues, these discussions largely concerned problems or questions arising at different phases of the project. The topics and nature of the communications are discussed in the next section.

COMMUNICATION CONTENT AND CHARACTER

The content and character of communications varied in the different phases of the Living Lab process, sometimes reflecting real-world experience with lighting installations, other times more closely resembling a research project.

Pre-Submission

NGLS informed the manufacturing community about the project by posting the Entrant Guide on its publicly accessible website and reaching out directly by email to contacts in the lighting industry. Manufacturers responded to either seek additional information or indicate their intent to enter.

This back and forth was similar to a property owner soliciting bids for a construction process. Questions largely concerned the timing of delivery, flexibility of the NGLS specification, manufacturer collaboration, and details of the evaluation.

Submission

NGLS completed a thorough document review before accepting applicants. As part of the document review process, NGLS uncovered gaps or inconsistencies in the information and requested further documentation or clarification, generally by email. In some cases, this communication revealed ambiguities in the Entrant Guide and in the initial NGLS responses to manufacturer questions.

NGLS accepted manufacturers as entrants when their documentation met the project requirements. While repeated conversations and follow-up documentation made sure entrants satisfied NGLS at this stage, some requirements ultimately proved too flexible in practice.

Notably, one entrant was accepted despite reservations about whether its system was truly intended for the “easy to configure” market. Another was admitted despite its standard practice of providing live factory support for configuration, a practice not permitted in the Living Lab. Moreover, none of the submitted troffers or retrofit kits met the requirements for glare control, which were waived. NGLS allowed this flexibility because the primary focus of Living Lab installations is research and learning about lighting systems in real settings, making inclusion more important than strict enforcement of the specifications.

The dialogue in this phase resembled real-world pre-bid communication, although the required documentation far exceeded that for small-scale "easy to configure" projects.

Design

Attempting to simulate the experience of small-scale projects that lack professional lighting design assistance, NGLS required entrants to propose a lighting and controls design to meet the NGLS specification for an assigned room. Each space was different, some in minor details, others substantially so. The rooms occupied eight floors in three dissimilar buildings with different floor plans, ceiling heights, and fenestration.

Manufacturers responded to NGLS-provided room drawings with equipment layouts and standard photometric calculations, which varied in detail, thoroughness, and presentation. Some entrants provided ambiguous instructions for sensor or manual control placement, resulting in confusion during installation. For example, two entrants used the same sensors but provided contradictory instructions for placement.

Although the NGLS process left each entrant with considerable flexibility to select and lay out its system, several entrants either misunderstood the specified requirements or substituted their own judgment as to what would be appropriate for the application.[3] Failing to provide the correct control zones was the chief example of this type of missed communication. When such entrant errors were not uncovered and corrected early, systems failed to perform to specification—a disappointing result.

As before, NGLS initiated back-and-forth communication with entrants to adjust the designs. The presence of lighting designers on the NGLS team able to intervene and correct misunderstandings rendered this phase less realistic than the previous two.

Delivery

Entrants delivered their products directly to Parsons, where they were stored and later transferred to the designated rooms for installation. As is common in real-world construction and despite standard shipping documents, delivery of all components was not fully confirmed until all cartons were opened—that is, until installers were on-site and about to begin their work. This approach naturally resulted in delays and a spate of calls to find and replace missing components.

Some information wound up with installers' project managers, who were not on-site in some cases. As a result, installers doing the work lacked some drawings or other instructions. Obviously, this problem is not unique to lighting controls or the NGLS process.

In addition, neither the installers nor the NGLS team representing the facility owner were on site consistently; this made communication and coordination during delivery more cumbersome compared to a typical project.

Installation

NGLS asked installers to rely entirely on the standard installation instructions provided with the products, together with the design drawings. As described earlier, the quality of the instructions varied. Instructions installers did not fully understand held up the work and, in some cases, stalled it altogether. Missing or incorrect components added further delays and frustration.

Information sent to one project manager was not relayed to the installation and configuration team. This oversight was not discovered immediately, creating mistakes, delays, and frustration.

For the most part, carton identifications were fairly—but not entirely—clear. Installers with experience handling multipart luminaires generally worked through the process of finding and arranging the components, whether for pendants or controls.

[3] In one instance, the mistake could not be undone in the field despite the requirement that systems be capable.

Installers consistently favored drawings over written instructions—even instructions with added diagrams. When drawings did not completely detail the installation, problems arose. Installers often struggled to reorganize their efforts around less familiar documentation.

Installers worked in teams of two, dividing tasks according to experience. As a result, they often worked on different tasks with limited exchange of on-the-job learning. On the other hand, installers did consult each other (and members of other teams) when instructions were unclear.

If work had to stop because of a problem, NGLS instructed installers to "do what you would normally do," which invariably involved making a phone call. As noted earlier, videos produced by manufacturers helped solve some of the problems encountered during retrofit kit installation—if installers could find web links to these videos.

Generally, communications proved easier for luminaires than for controls, largely due to the latter's unfamiliar terminology. For systems from a single manufacturer, finding the right point of contact was more difficult compared to systems where one organization provided luminaires and another provided controls.

Configuration

Communication during the configuration phase was similar to the installation phase, with one important distinction: While mechanical experience was common among the installer teams, practical experience with wireless systems was limited to a handful of knowledgeable installers. Two teams relied on consulting a younger installer with electronics know-how. The variation in configuration ability among the teams was much greater than with installation.

Lengthy installation manuals, combined with unfamiliar terminology and inexperienced installers, also made configuration quite challenging. Several installers admitted they did not read longer, technically dense material carefully or fully—a level of candor that reflects the open and cooperative atmosphere in the Living Lab project. Out-of-date software compounded the installation manual problem, and on some occasions it took several calls for a factory engineer to recognize the fact that a problem originated in the software or the manual itself, rather than in the installer's technique.

With a knowledgeable installer on hand, the technical terminology of controls posed less of a challenge. Nevertheless, inconsistent terminology (discussed in the vocabulary section) limited the usefulness of prior experience with controls.

When problems proved intractable, installers resorted to help lines—often with the same problem noted earlier of finding a knowledgeable person. In some cases, factory engineers were able to diagnose and resolve problems. In others, the confluence of multiple problems made troubleshooting an iterative and time-consuming process.[4] Occasionally, factory personnel provided conflicting information, compling the problem and delaying a solution.

[4] For example, one problem during configuration initially appeared to be a mistake in assembling a wall control (after repeated configuration attempts); however, after further calls to factory engineers, it turned out to be a defective component.

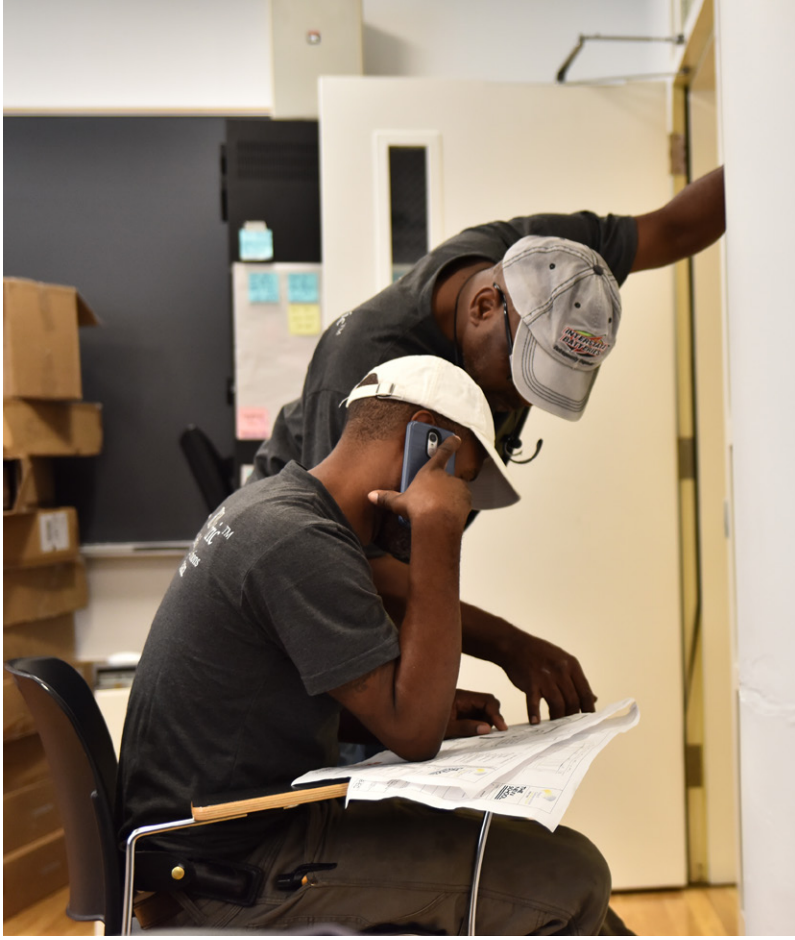
Handoff and Occupancy

Transition of the Living Lab to the Parsons facilities staff began in the fall of 2019 (but was interrupted by the outbreak of COVID-19). Of the 14 systems installed, nine met the NGLS specification. One system had been replaced over the previous summer; four others were targeted for repair or replacement. Communication during this period included complaints from users to the Parsons facilities team, Parsons and NGLS responses, and the "Living Lab Status Report."

Following the return to classes, the facilities staff received complaints from faculty members by phone and email. Lights did not turn on. Lights did not turn off. Lights did not dim properly. Every complaint required on-site inspection for correct diagnosis of the problem. Often, the facilities team, lacking time or requisite knowledge, involved the Director of the Parsons Lighting Design program, who serves on the NGLS Advisory Board. Broken or missing components required communication with factories and follow-up to ensure delivery. Replacement parts turned out to be a nagging problem because connected lighting system controls are not available (yet) from local distribution; all required special orders outside of normal supply channels from the manufacturer.

The Parsons facilities team logged all complaints, providing the NGLS team with a useful record of symptoms. Unfortunately, no similar recording was made of the diagnoses or solutions. Some experiences were noted in the "Living Lab Status Report."

Even a fully functional wall control can fail to deliver intended benefits if users don't understand how to operate it. While an on/off rocker switch is well understood, a user may not recognize that pressing the rocker on a similar device dims the lighting. For controls with buttons that users find unfamiliar, or those requiring multiple actions, the problems are worse.



The "Living Lab Status Report" recapped the Living Lab process, assessed the condition of the installed systems at handoff, and provided recommendations for next steps. The assessment, in tabular form, considered five parameters:

- Wall control operation
- Operation to specification
- Occupancy: failure to stay on when occupied
- Occupancy: failure to turn off when unoccupied
- Continuity and support

System status for each parameter was assessed as "OK" or characterized by the general type of failure.

Recommendations regarding the installed systems reflected the need to make sure all rooms could meet the lighting and control needs of the users and the facilities team's desire to consolidate the Living Lab to a limited number of systems well regarded by NGLS. To that end, NGLS recommended seven systems be retained, and the balance repaired or replaced.

The “Living Lab Status Report” also included proposals for continuing development of the Living Lab. This approach reflected a long-term plan by the Parsons facilities team to winnow the choice of systems so that the most effective could establish a “building standard” for future construction and renovation.

NGLS intended to deliver the “Living Lab Status Report” in person and in writing, and to follow up with tutorials on system operation for facilities staff. While the written report was delivered, staff training was postponed due to lack of availability during the pandemic.

VOCABULARY

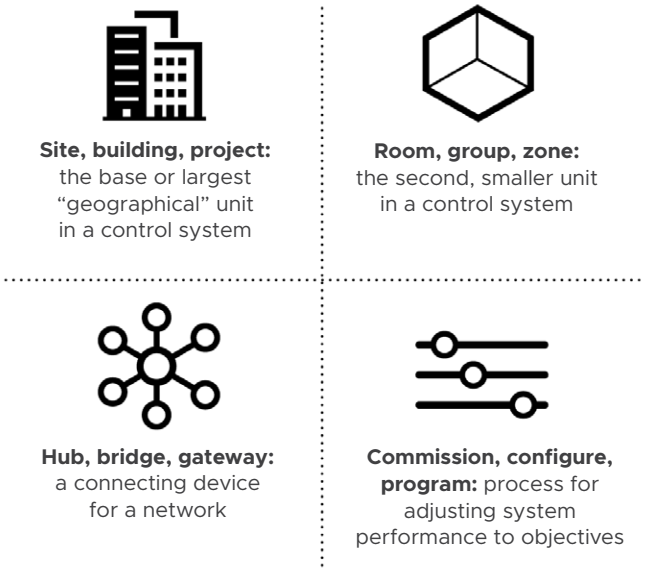
Technical vocabulary challenged all participants in the Living Lab process. For some, it was the widespread use of unfamiliar terminology in the controls documentation. For others, it was language inconsistency among manufacturers.

As noted earlier, the experience of installers with wireless, networked controls varied considerably. Early-career installers generally demonstrated better understanding and facility than more senior installers.

The designers who were participating as evaluators (and brought substantial experience) often found it difficult to understand instructions using different vocabulary for otherwise familiar functions or actions. The list in the right column includes some controls terms that puzzled installers and some designers. The descriptions are as used by documentation from the Living Lab and are not necessarily accepted definitions.

The graphic at right lists some terms used by different manufacturers to signify a largely similar component; that is, terms that a “typical” practitioner would likely consider interchangeable.

Behavior (used to describe what a control does)
Device (used to describe a switch, sensor, or node)
Discover (used to describe how a network recognizes components)
Group (used to describe components within a network, including multiple zones)
Hold time (initial portion of a two-part, timeout period)
Node (used to describe a sensor with radio frequency (RF) capabilities)
Profile (stored record of control behaviors)
Prolong time (second portion of a two-part, time-out period)
Push to (save)
Read to (save a file)
Save to (read to a file)



Confusion in controls terminology is not new—for example: zone, channel, and scene; dimming percentage, light output, power, or perceived brightness; and zones and circuits can all be interchangeable. However, the confusion over terminology is expanding rapidly as systems become more elaborate and manufacturers proliferate.

CONCLUSIONS

Getting control systems to perform as expected is not a simple process, even for control systems marketed as “easy to install and configure.” This complexity can make owners and specifiers uncertain whether a connected system is right for their installation. Communication can reduce configuration complexity, but experience in the Living Lab reveals that this objective is not yet being achieved. To date, the NGLS team has learned the following:

It’s Complicated

The process of installing and configuring systems of luminaires and wireless controls includes numerous participants and a wide variety of communication modes, which contributes to confusion and misunderstandings. Different participants and types of communication at every stage of the process multiply the opportunities for errors and crossed signals.

Experience Is Limited

Based on NGLS observation with the Living Lab project, most lighting practitioners lack experience with wireless, networked controls. The limited number of knowledgeable practitioners (from installer, to specifier, to facility maintenance) comprise an extremely valuable resource. Moreover, controls education—while growing—is still spotty.[5]

Communication Is Critical

With limited first-hand experience, most installers of connected systems must rely on installation and configuration guides to a much a greater extent than they do when installing luminaires. Facilities personnel lack relevant experience, documentation to troubleshoot problems, and the time to learn. Users find controls unfamiliar and therefore do not take advantage of how controls can enhance the visual environment or reduce energy consumption.

Communications Can Be Better

Data sheets for controls, similar to those for luminaires, do not easily convey capabilities and limitations; marketing brochures tend to be superficial. As a result, specifiers often struggle to select the most appropriate system for the application.

Installation manuals are typically too long, inviting installers to skim or skip altogether. Technical language is unfamiliar and inconsistent from manufacturer to manufacturer. Installers favor information integrated into configuration mobile apps, but this communication method has not yet been widely provided. And, as noted earlier, installers found drawings to be critical to a successful installation.

Users often find the labels on manual controls—when provided—do not clearly denote the function.

Manufacturer help lines work, provided installers can reach them in a timely fashion and the personnel on the phones are knowledgeable.

[5] The California Advanced Lighting Controls Training Program is an important exception. A lead installer on the Living Lab project observed that his European electrical training was more thorough and rigorous than what he has seen here.

RECOMMENDATIONS

NGLS lists several recommendations below for improving communications based on the Living Lab experience.

For Manufacturers

- Provide both a quick guide and detailed installation and configuration instructions, as is common for computer setup.
- Provide images clearly reflecting what installers will see during the process and include more of them.
- Include a glossary of controls terms in the instructions, as terminology varies from manufacturer to manufacturer.
- Integrate the instructions described above for mobile apps.
- Make sure help lines are available to installers across multiple time zones.
- Support the development of consistent controls terminology across the lighting industry.

For Specifiers

- Provide a detailed description of the intended performance of the control system.
- Clearly designate control zones and control locations (including sensors and manual devices) on drawings.
- Support the development of consistent controls terminology industrywide.

For Installers

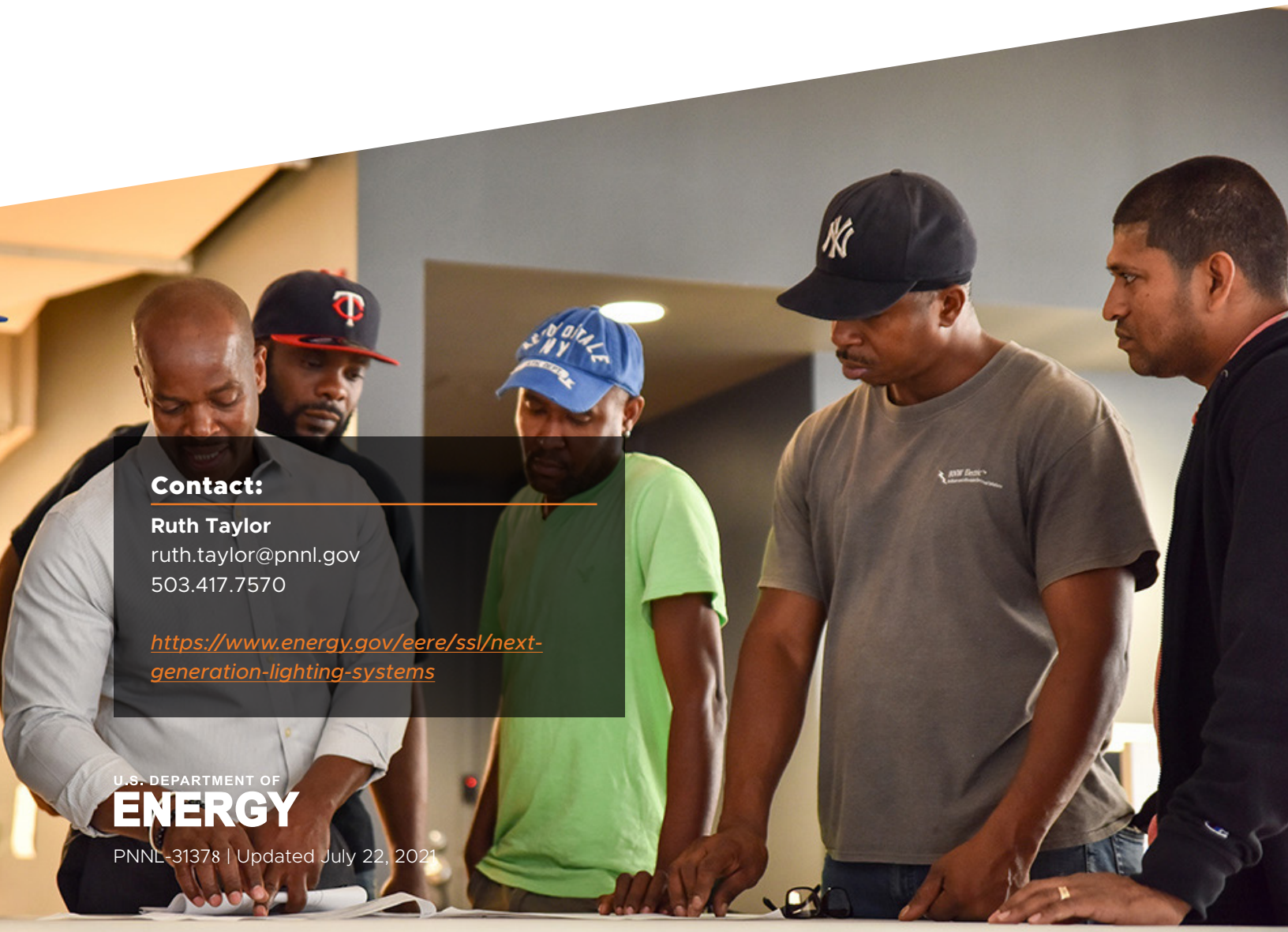
- Team leaders and project managers should review materials in advance.
- Team leaders should make sure their installers read installation materials fully.
- Support installers with industry and manufacturer education on controls.

For Owners

- Require clear labeling or function identification on manual controls.
- Provide mandatory control systems training for facilities personnel.
- Maintain a detailed complaint log, including specific remedies, to share with system manufacturers as appropriate.

Pacific Northwest
NATIONAL LABORATORY

Next Generation
LIGHTING SYSTEMS



Contact:

Ruth Taylor
ruth.taylor@pnnl.gov
503.417.7570

https://www.energy.gov/eere/ssl/next-generation-lighting-systems

U.S. DEPARTMENT OF
ENERGY

PNNL-31378 | Updated July 22, 2021