Centro de Tecnología en Iluminación: A Progress Report on Mexico's New Lighting R&D Center

In 2017, the Mexican Ministry of Energy awarded international funding to the Universidad Autónoma de Guadalajara (UAG) in collaboration with the University of California Davis (UCD) to establish a lighting technology and design research center known as the Centro de Tecnología en Iluminación (CTI). This is a multi-year, public-private investment focused on addressing growing climate change concerns through translational research committed to clean energy and sustainability in Mexico.

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The purpose of CTI is to accelerate the development and adoption of energy-efficient lighting and daylighting technologies, as well as to help build talent and human capital for Mexico's lighting industry. CTI's research capabilities will help meet Mexico's long-term energy-efficiency and greenhouse gas emission reduction goals.

Despite COVID-19-related delays, researchers at UAG and UCD made steady progress bringing the original concept detailed in *LD+A*'s August 2018 issue to life. In this article, readers will be updated on the progress over the first two years of the multi-year project, which were focused on establishing CTI as a third-party proving ground for emerging lighting technologies. Additionally, the project team prioritized training and education in partnership with Mexico's lighting industry to help build Mexico's technical capacity for lighting. This dual focus of R&D and education significantly shaped the final design of the new 15,000-sq ft building, which includes laboratories, technology demonstrations and training spaces (**Figures 1 and 2**).

To achieve these goals, the project team concentrated on four key activities:

1) Building a Research, Development & Demonstration Lighting Center

To help inform the design of CTI, market assessment activities were conducted with partners from industry, the public sector and professional lighting-related practitioners. Outcomes helped the project team identify CTI priorities to fully support Mexico's lighting energy saving and sustainable lighting design practices.

Industry Feedback. Lighting industry partners requested support with 1) developing new cost-effective, energy saving lighting strategies, and 2) providing the marketplace with evidence-based case studies and guides for said strategies. Specifically, industry partners were interested in collaborating on projects that focus on four areas:

- Establishing daylight harvesting energy saving potential for Mexico's market (**Figure 3**)
- Developing new sensor-based approaches
- Demonstrating smart and adaptive lighting control technologies
- Evaluating emerging LED technologies

To help address daylight research needs, a full-scale model classroom at CTI has been instrumented with sensors, while the flexible ceiling layout allows for studies of daylight harvesting and light distribution strategies.

Public Sector Feedback. Public sector partners, primarily from municipal and state agencies, expressed interest in energy-efficient lighting strategies for:

- Exterior lighting for schools
- Healthcare lighting
- Efficient lighting for low-income housing

Figures 1-2. The new 15,000-sq ft building includes laboratories and training spaces.

Additional unifying themes from CTI's public sector partners included aging infrastructure, rising energy costs and the need for sustainable design. This was particularly evident in interactions with public school partners where significant improvements in energy efficiency and lighting quality will support both student and teacher's well-being.

Lighting Designer & Specifier Feedback. Lighting designer and specifier partners expressed a need to better understand today's new construction and retrofit lighting best practices to ensure they are taking advantage of the recent advancements in technology. There was interest in developing third-party, evidence-based education materials that clearly outline the savings potential for today's lighting technologies.

2) Establishing the Photometry Laboratory

Over the first two years of the project, CTI and its partners invested in the development of a photometric testing laboratory to assist the regulatory, industry and professional communities with product testing focused on performance, longevity and quality (**Figure 4**).

In the next phase of the project, CTI will offer comprehensive photometric testing as a service to both the private and public sectors. Training and education activities will be integrated with this service, allowing students to become familiar with photometric testing procedures and methods. In the long term, CTI will offer a certificate program for photometric testing and measurements.

Figure 3. Classroom daylighting laboratory.



Figure 4.
New labs built for life testing, integrating sphere and Type-C goniophotometer.


Figure 5.
The training classroom (under construction) is the heart of CTI, supporting education through lectures and demonstrations of lighting concepts.

3) Developing Education & Training Programs

In response to the Mexican Ministry of Energy's directive for development of talent and human capital in the energy sector,[1] CTI's mission has a strong emphasis on education and training. Discussions with CTI's partners reinforced this directive by emphasizing the need for pragmatic education and training in lighting. Topic areas include a focus on professional education with offerings that range from general lighting fundamentals to more complex subject areas such as advanced lighting controls, daylighting design, testing procedures and lighting design best practices. To support this approach, CTI has established five education and training pathways:

- ***Seminar Lectures***. As standalone lecture seminars remain a popular education pathway for the lighting industry, single-day events on a variety of lighting-related topics will be hosted in CTI's training classroom. Select seminars will be taught by CTI's industry partners, further engaging students and industry.

The CTI classroom supports both in-person and online classes integrated with full-scale demonstration elements for lighting controls, daylight harvesting, optical characteristics of light sources and color quality metrics. Each demonstration has individual controls that allow the student and instructor to activate varying layers of light to communicate different concepts (**Figure 5**).

The ceiling plane of the classroom is adjustable and includes multiple demonstration layouts of different lighting approaches with both ceiling-integrated and pendant-mounted lighting

systems. Multiple track lighting systems demonstrate optical control and color.

Additionally, the training space includes a system wall for demonstrating a variety of lighting hardware components and lighting concepts (**Figure 6**).

- ***Certificate Programs.*** The Certificate Program will require students to attend a 10-week series of weekly lectures on the specific focus area to receive a certificate qualification. To help provide placement opportunities for students, classes will be co-taught by both CTI staff and industry partners. This program targets the professional who is interested in building their understanding in a specific lighting area. Certificate Program topics will include lighting basics; advanced lighting controls; daylight harvesting; horticulture lighting; exterior lighting design; and interior lighting design.

CTI was designed with these classes in mind, allowing students to engage with the hands-on demonstration and research laboratories as a complement to the lecture material. The training room supports these programs with demonstrations on color theory, lighting controls and light distribution (Figures 5 and 6), as well as the neighboring daylighting labs.

- ***Traditional Lighting Programs.*** The market assessment identified a need for the entry-level workforce to have a deeper understanding of both lighting technology and lighting design issues. To address this, the UAG School of Architecture & Engineering and CTI are exploring establishing both undergraduate and graduate lighting programs. Initially, lighting will be offered as a minor concentration option for UAG's master's degrees in engineering and/or architecture. Over the next five years, CTI will support the development of a stand-alone master's degree in lighting within UAG's School of Architecture & Engineering.
- ***Graduate Program for Professionals.*** CTI identified an opportunity for a targeted graduate program that spans one to two years specifically for professionals. The Professional Graduate Program will combine education material from the seminar lectures and certificate programs, as well as adding field work and additional targeted research with CTI faculty advisors. Once launched, this program will provide professionals an opportunity to obtain their master's degree in lighting from UAG.
- ***Online Learning.*** The need for online learning opportunities is high, especially now as students emerge from COVID-19 shutdowns worldwide. To address this, CTI has established an online learning component for each of the seminar lectures and certificate programs. All lectures and demonstrations will be live streamed, as well as recorded for online viewing. The video streaming will be complemented by readily accessible lecture and research materials.

Figure 6. Lighting system wall (under construction) for education and training.

4) Conducting Research Projects

To date, CTI has established two research and testing efforts with industry partners on 1) daylight harvesting and 2) vacancy-occupancy controls for common

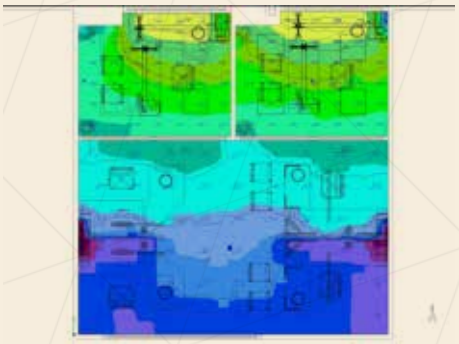

Figure 7. Side-by-side daylighting laboratory.

Figure 8. CTI experimental corridor to test occupancy-based bi-level lighting strategies.

spaces. An early focused effort has been directed at daylight harvesting opportunities using side-by-side labs (**Figure 7**), as well as the full-scale classroom for controlled studies.

CTI's side-by-side office configuration allows for continuous, comparative measurements for daylight harvesting approaches. The iso-lux photograph (left of Figure 7) shows ongoing calibration work with near-identical distribution characteristics between the two test rooms. One of the spaces has daylight harvesting controls, while the other does not and serves as the control for performance and energy use comparison.

Control strategies for Mexico's common spaces, such as the corridor pictured in **Figure 8**, are also being evaluated by CTI researchers, with an emphasis on implementation barriers unique to Mexico. Preliminary research focused on fixture integrated sensors vs. zonal sensing strategies to reduce light levels up to 50% during periods of detected vacancy.

As the project team emerges from COVID-19 shutdowns, CTI will host two high-visibility industry-sponsored symposiums on horticultural lighting and municipal lighting. CTI will also launch its first formal testing and measurement efforts as an industry service activity. Additionally, several demonstration projects associated with early research endeavors on daylight harvesting in education facilities; smart exterior lighting; and bi-level occupancy controls in public spaces (i.e., corridors, lobbies, etc.) will be initiated. ◎

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