Background

The University of Minnesota wanted to reduce energy costs in Jones Hall since the building had fallen behind in some of the University's aggressive sustainability initiatives and needed new lighting and controls. The mixed-use building, one of many on campus, includes a combination of offices, classrooms, and public spaces, and is currently home to the University's Admissions, Language Center, and College of Liberal Arts classrooms.

Project Summary

The project provided a packaged solution for complete retrofit of the building, including site survey, design, system selection, and financial assistance with materials and labor. The University managed the lighting and controls hardware retrofit, the majority of which took about eight weeks.

The backbone of the new lighting hardware was the SmartCast platform, a luminaire-level lighting control system provided by Cree that incorporates dimming control, photosensing, and occupancy sensing onboard each individual fixture. The existing fixtures were replaced with SmartCast on a one-for-one basis. Sensors communicate wirelessly with each other to create a flexible, granular mesh sensing network throughout the building, which can be used for individual receptacle control, heating, ventilation, and air conditioning (HVAC) zone control, and of course lighting control.

In addition to the new lighting fixtures and controls, the University of Minnesota also installed wirelessly controlled plug load controls, which were a critical piece in the entire project. The lighting and plug load controls were commissioned by the vendor, Cree, as a service included with the purchase of the fixtures. The building's designated controls contractor implemented new HVAC sequences using

PROJECT QUICK FACTS

- **Location:** 27 Pleasant St. SE, Minneapolis, MN 55455
- **Building Size:** 25,000 ft^2
- **Building Sector Type:** Administrative office building (offices, classrooms, computer laboratories, lounges)
- **HVAC Unit Type:** One single duct, variable air volume (VAV) air handling unit (AHU) serving several zones. Most are hot water reheat boxes, served by district steam and chilled water
- **Building Automation System (BAS) Type:** Johnson Controls METASYS system, with controls technicians at the University making the improvements
- **Occupancy Description:** 95 occupants, operating 6 a.m.–9 p.m. CT, Monday–Friday, with variable usage on Saturday
- **Utility Incentives:** $16,100
- **Project Completion Year:** 2022

The project was funded by U.S. Department of Energy (DOE) via the Scaling Up the Next Generation of Building Efficiency Packages Funding Opportunity Announcement (FOA), which "supports high-impact real building demonstrations led by strategically structured teams who will identify and verify the cost and energy performance of multisystem energy efficiency packages." The goal of the field validation was to test the performance of plug load integration and identify potential challenges and future opportunities. Members of this project team members include Slipstream (formerly Seventhwave); Cree Lighting; Legrand/Wattstopper; Xcel Energy; and Pacific Northwest National Laboratory (PNNL).

occupancy data from the lighting network. Then, the sequences were programmed by university energy management staff. Building operators and occupants were trained on use of the lighting controls and receptacle controls.

Energy Saving Control Strategies

- Light-emitting diode (LED) with networked lighting controls (task tuned, occupancy sensors, and some daylight sensors)
- Plug load controls in office spaces
- Plug load controls on common area equipment like printers and chargers
- Thermostat setback based on occupancy
- VAV box shut off based on occupancy
- Supply Air Temperature reset
- Demand control ventilation.

Project Cost Considerations

- Project used networked lighting controls which requires a certain amount of equipment independent of space size. At 25,000 ft^2, this site is the minimum size threshold where networked lighting controls typically become more cost effective.
- At 0.89 watts per square foot, the incumbent fluorescent system was more efficient than a typical fluorescent system. Although the LEDs saved more than half the fluorescent lighting energy baseline, the relatively efficient baseline contributed in a longer payback than desired.

Potential Energy Savings		
Lighting Savings	0.88 kWh/ft^2	57%
Plug Load Savings*	Average 44 kWh/ receptacle/yr	32%
HVAC Savings	2.8 kWh/ft^2 0.06 $therms/ft^2$	36%
Total Cost Savings	$0.30/$ft^2$	
*Modeled		

Project Cost

	Material ($/ft^2$)	Labor ($/ft^2$)	Payback (years)
Lighting	$2.27	$2.37	25.3
Plug Load	$0.03	$0.01	62.2
HVAC	–	$0.37	3.2
Sub-Total	$2.30	$2.75	–
Total	$5.05/$ft^2$ I 16.9 years		

- Although the plug load controls have a long payback period, they contribute only a small amount to the overall project cost.
- Savings from mechanical integration reduced the simple payback time by one third.

Lessons Learned

Integrating lighting controls with multiple building systems is relatively new, and a number of lessons were learned during this project, including:

- **Plan for multiple commissioning visits.** Although the lighting vendor assisted through the entirety of the project which facilitated the integration, commissioning still required significant time and multiple trips.

- **Integrating the lighting controls with HVAC system may be complex.** The University of Minnesota had a novel port naming system. The lighting vendor faced some challenges when configuring both systems to communicate with each other.
- **Establish methods to determine if integration failed or stopped.** Lighting systems do not include a notification system to indicate when the connection with the HVAC system has been interrupted, therefore a mechanism for determining when the integration has stopped needs to be developed.
- **Verify wiring needs of components in design stage.** Some wall controls required a neutral wire to be fed to power the device, which required additional labor.
- **Networked lighting solutions may need internet access.** Involve the IT staff early in the project to ensure the controls system has a path to connect to the internet. Initial implementation was attempted without prior verification of this connection, which led to project delays and other challenges.
- **Label automatic receptacle controls.** Many of the automatic receptacle controls (plug load controls) were installed in quad electrical boxes with standard receptacles. This meant three of the four receptacles were constantly on. Only one receptacle was controlled to turn off when the space was unoccupied, but it looked similar to resting mode. Color-coding or some other method of identification is recommended so users know which receptacles are controlled.
- **Lighting and HVAC zones should be planned.** Mapping control points between lighting and HVAC requires coordination between multiple parties: electricians, lighting controls person, mechanical contractors, and building staff.
- **Educate building occupants about advanced or novel features.** Training occupants on the purpose and operation of lighting and receptacle controls encourages proper use and adoption.
- **Train facility operators and onsite staff during commissioning.** Once the commissioning agent is complete, it is beneficial to have competent local on-site staff to make necessary adjustments going forward.

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