

Lighting Control Technology for Digital and Dynamic Luminaires

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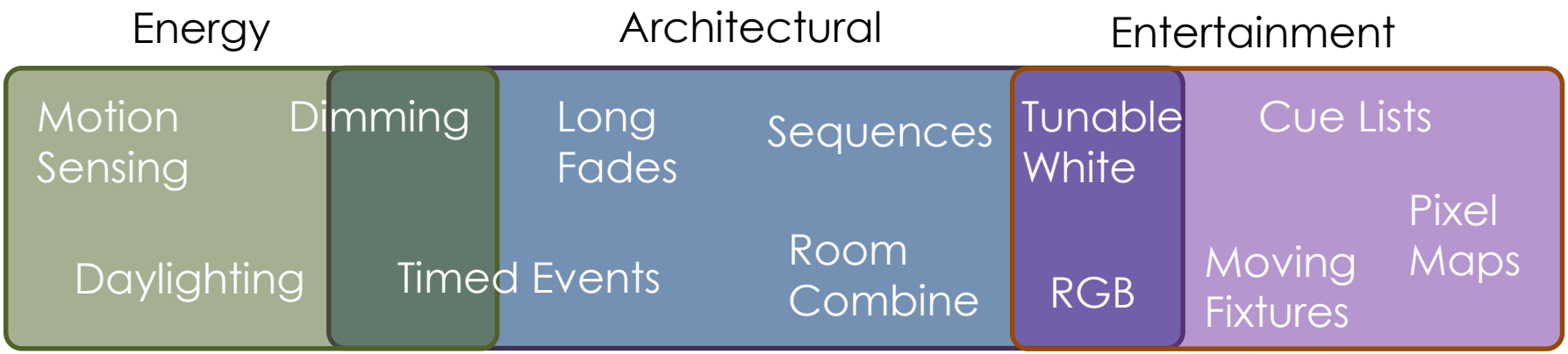
Learning Objectives:

- Appreciate the intended use for particular lighting control technologies
- Understand how to best deploy these technologies
- Learn strengths and challenges with control technologies
- Unlearn traditional thinking regarding controls design

High performance lighting controls should address the dynamic lighting requirements in architectural and entertainment spaces

The spaces

The strategies



Challenges of lighting controls (design)

- End user expectations
- Control choices
- Compatibility concerns
- Cost
- Code requirements
- Integration

Challenges of lighting controls
(installation)

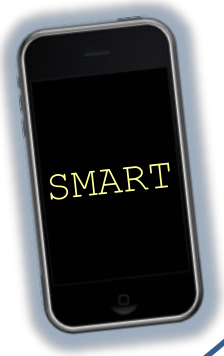
- Education
- Wiring limitations
- Cost
- Commissioning

Challenges of lighting controls
(end user)

- Education
- Training
- User interface
- Making changes
- Cost/ROI

The technology evolution

Technology meet convenience



108 YEARS

1900 ***2008***

Lighting innovation





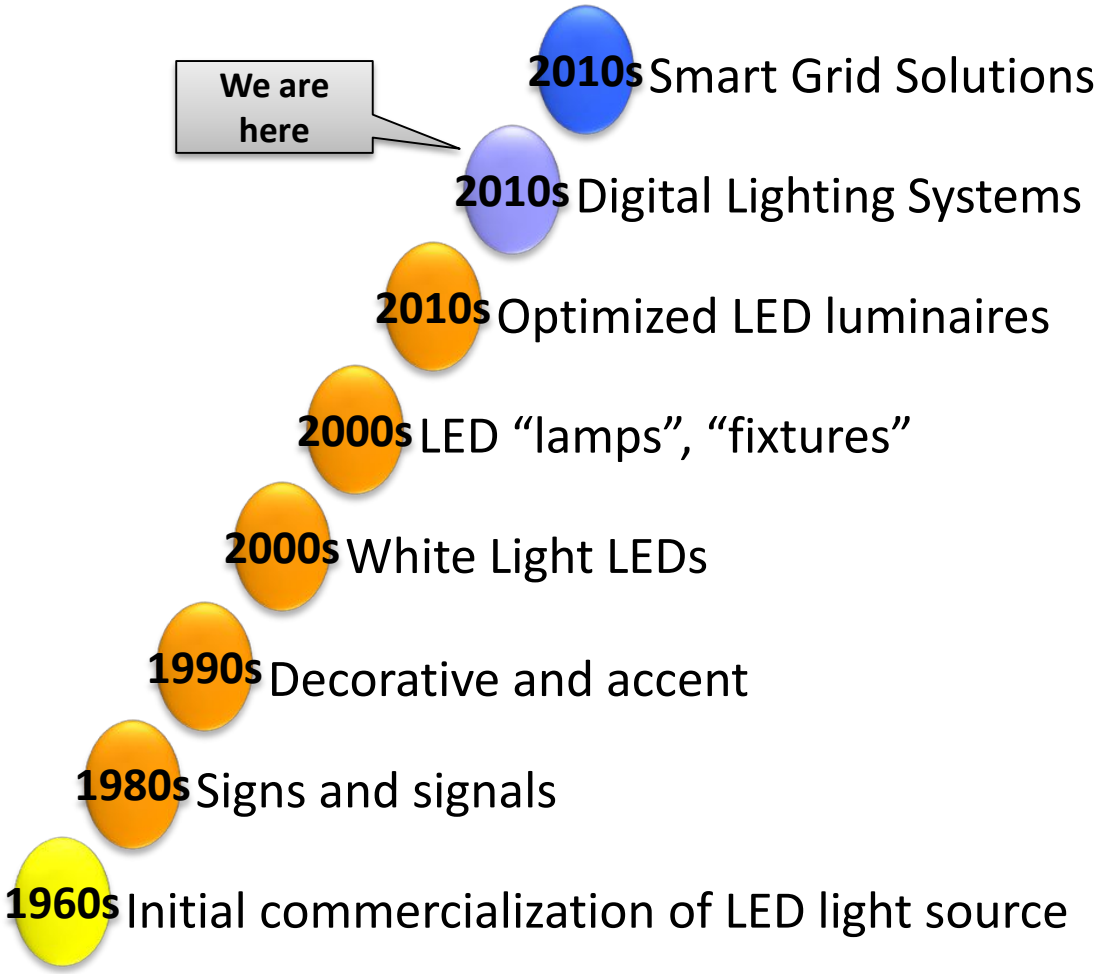



1800 1850 1900 1950 2000 2050



Multiple images courtesy of David DiLaura
"A History of Light and Lighting"

Analog to digital lighting evolution



The digital control solution

Key Components of Smart Lighting Systems

#1: LED Luminaires & Lamps

#2: Digital Controls

+

#3: Daylight

#4: Software

#1: Solid-State Lighting Sources

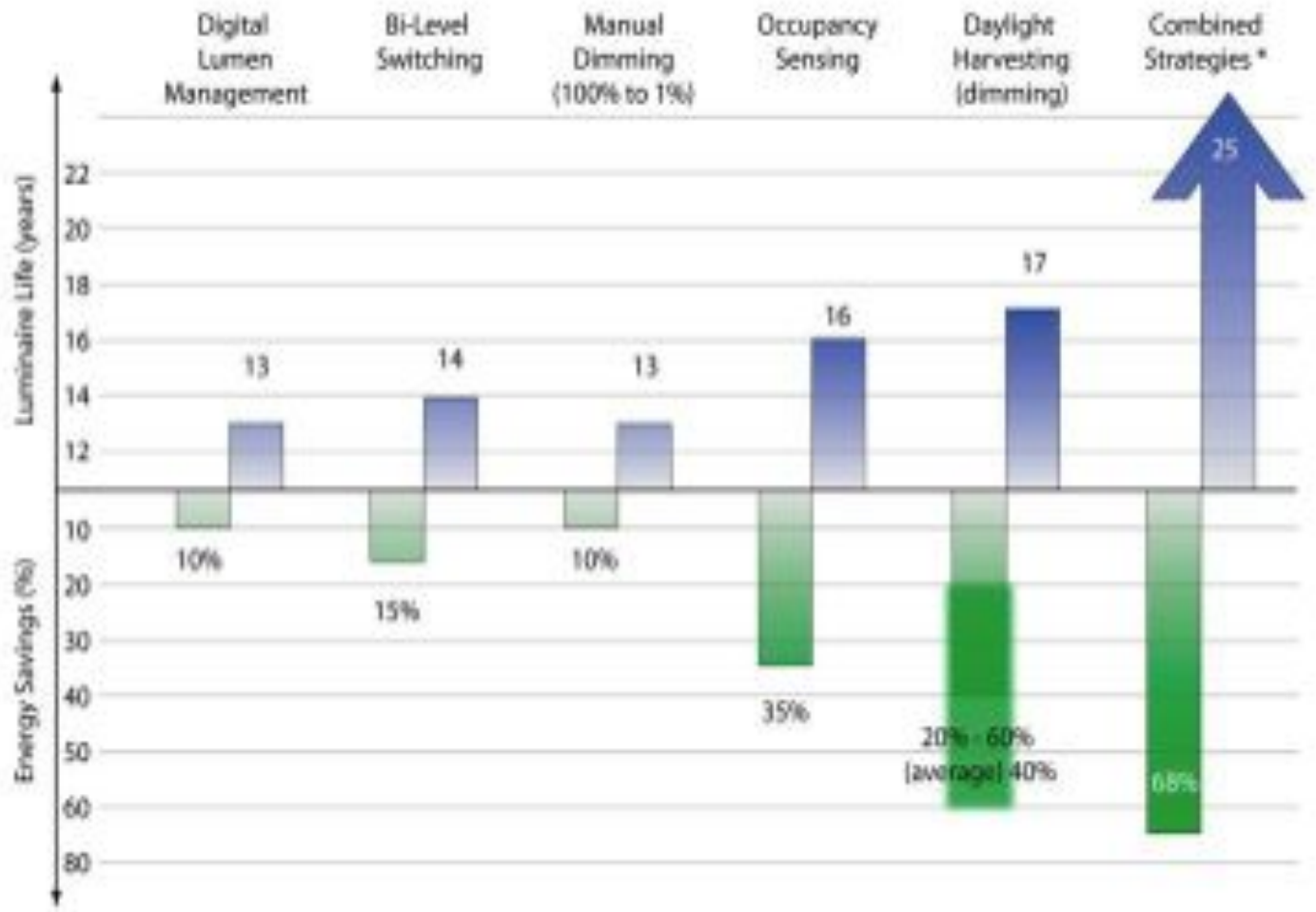
Obvious Benefits

- Low energy consumption
- Long-life (50,000+ hours)
- Dimmability
- Lower temperature
- Color-control
- Instant start

Other Benefits:

- New form factors
- Next generation (i.e., OLED)
- Redefining the meaning of a light fixture

#2. Smart and Integrated Controls



#3. Daylighting

- Dual benefit:
  - Reduce energy by 40% when daylight is harvested
  - Improves occupant well being
- Studies link daylight and views to higher levels of satisfaction and productivity
- On average, hospital patients who stay in rooms with daylight stay fewer days and required less pain medicine

#4. Useful and Usable Software

- Desktop applications
- Software to service
- Mobile apps
- BMS compatible

The static to dynamic shift

From Static Settings to Dynamic Experiences

dynamic luminaires

- LED
- RGB
- Tunable white
- Motorized

truly dynamic luminaire

dynamic control

- Phase control
- 0-10V
- DALI
- DMX/RDM
- Integrated
- Wireless

Dimming Controls – a primer

Dimming Method	Pro's	Con's
0-10V	• There is a standard • Installed base • Separate wiring makes it easier to optimize dimming performance	• Not all follow the standard, standard also not complete • Possibility of difference in performance in large installations • No networking capabilities
Forward Phase (TRIAC)	• Large installed base • Power and dimming over single set of wires	• Technology mismatch with LED sources, often problems • No networking capabilities
Reverse Phase (ELV)	• Although not optimized for LED's, less issues than forward phase	• Small installed base • Requires neutral wire • No networking capabilities

Dimming Controls – a primer

Dimming Method	Pro's	Con's
DALI	• There is a standard • Network based, offers more functionality • Simple wiring	• Not all follow the standard, implementation is fairly complex • Commissioning can be complex
DMX	• There is a standard • Network based, offers more functionality	• Complex wiring and commissioning
Wireless	• No wiring • Network based, offers more functionality	• No standards, many initiatives • Expensive

Dimming Issues

- Flicker
  - Visible
  - Stroboscopic
- Shimmer
- Steppiness
- Drop-out
- Pop-on
- Delayed turn on and response
- Mismatched light levels
- Control incompatibility and load ratings

Components of an LED System

Dimmer
input

0-10V
Forward Phase
Reverse Phase
DMX
DALI
Wireless

LED Driver
response

Current Reduction (CCR)
Pulse Width Mod. (PWM)
Hybrid

Driver "makes or breaks" the performance of the system

LED
Light source

Constant Voltage
Constant Current

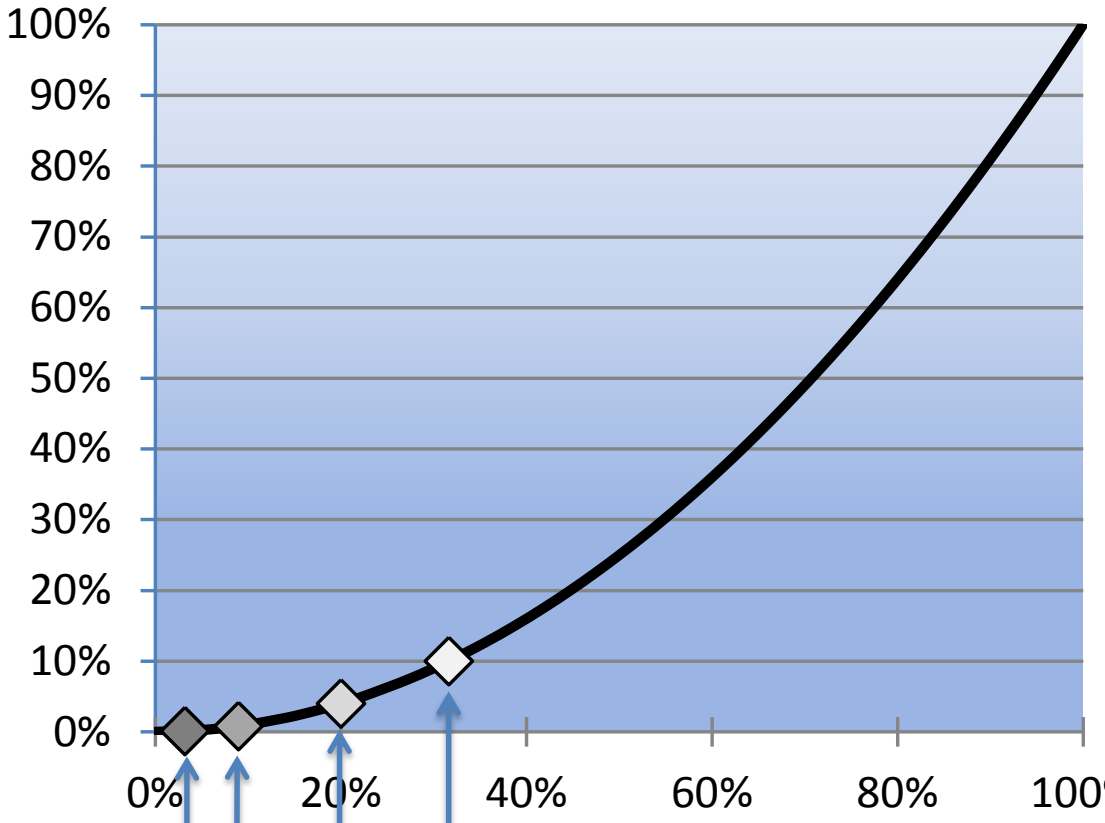
X

Human Eye Response

Perceived Brightness

Smooth Dimming

Measured Light



Perceived Light

Dim to 0.1% is 3% Perceived
Highest-Performance Spaces

Dim to 1% is 10% Perceived
Daylight & Conference Rooms

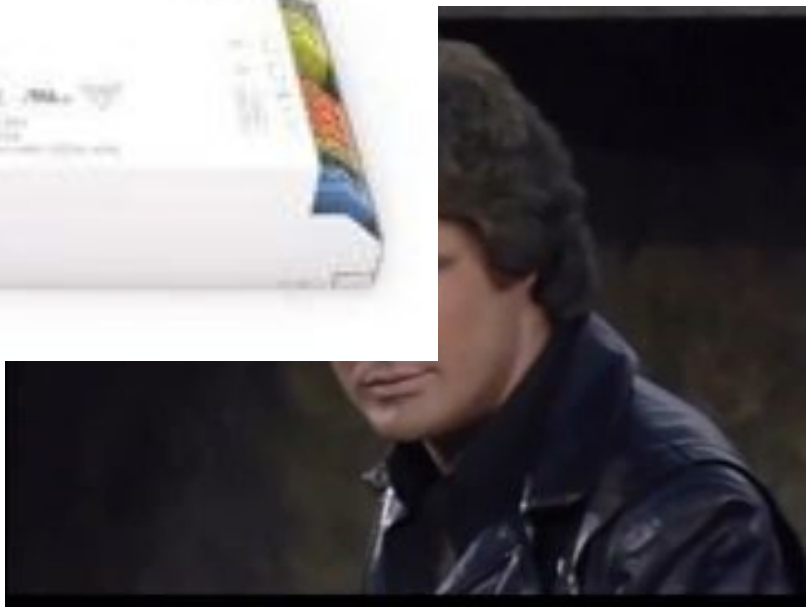
Dim to 10% is 32% Perceived
Load Shedding – High/Low

Dim to 5% is 22% Perceived
Energy Management Dimming

Flicker-free Operation

Courtesy of the LRC

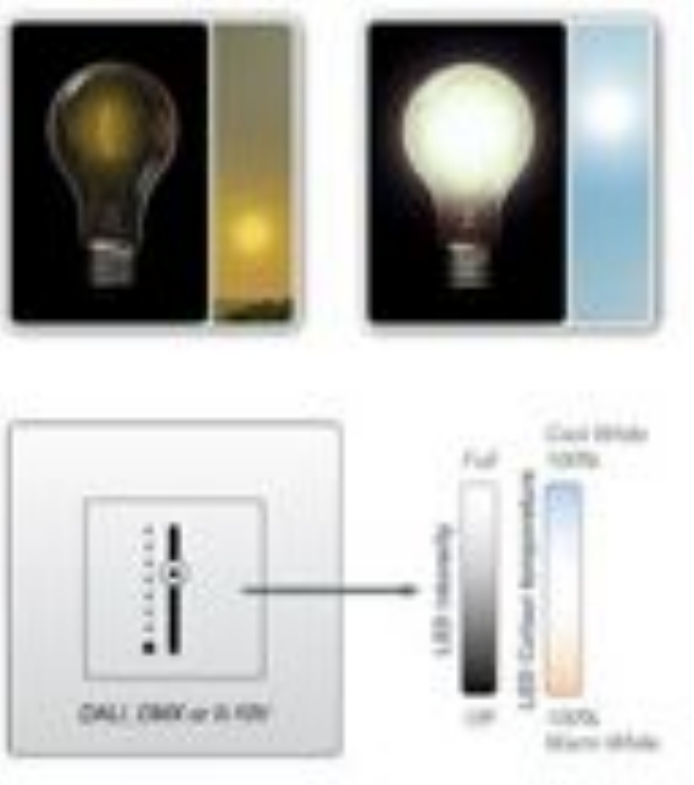
LED Drivers



Warm white dimming

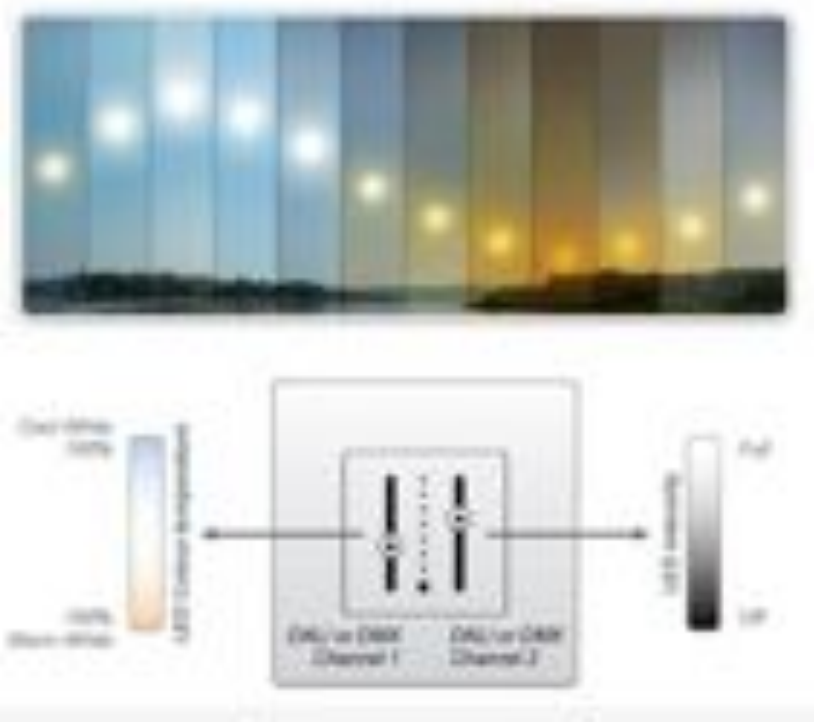
- Single control input
  (0-10V, DALI, DMX/RDM)
- Linear dimming curve white LED's
- Non-linear low-end dimming curve for amber LED's*

*when dimming down, amber content will increase before dimming to 0%



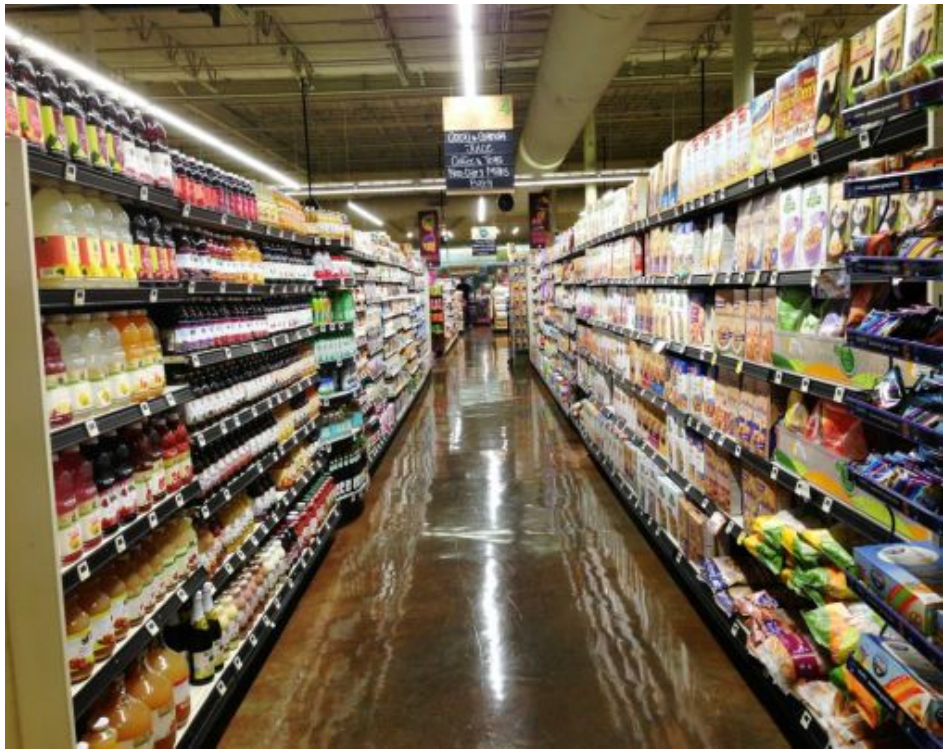
Tunable white

- Intuitive color temperature and intensity control
- Define dimming curve and input-output relation
- Works with majority of tunable white LED configurations



Delivering Enriched Experiences with Gamut Control

Tailored Optics & Task Tuning



NEMA Definition – A lighting control strategy in which the maximum light output of an individual or group of luminaires is set to provide the appropriate amount of light for a space or area.

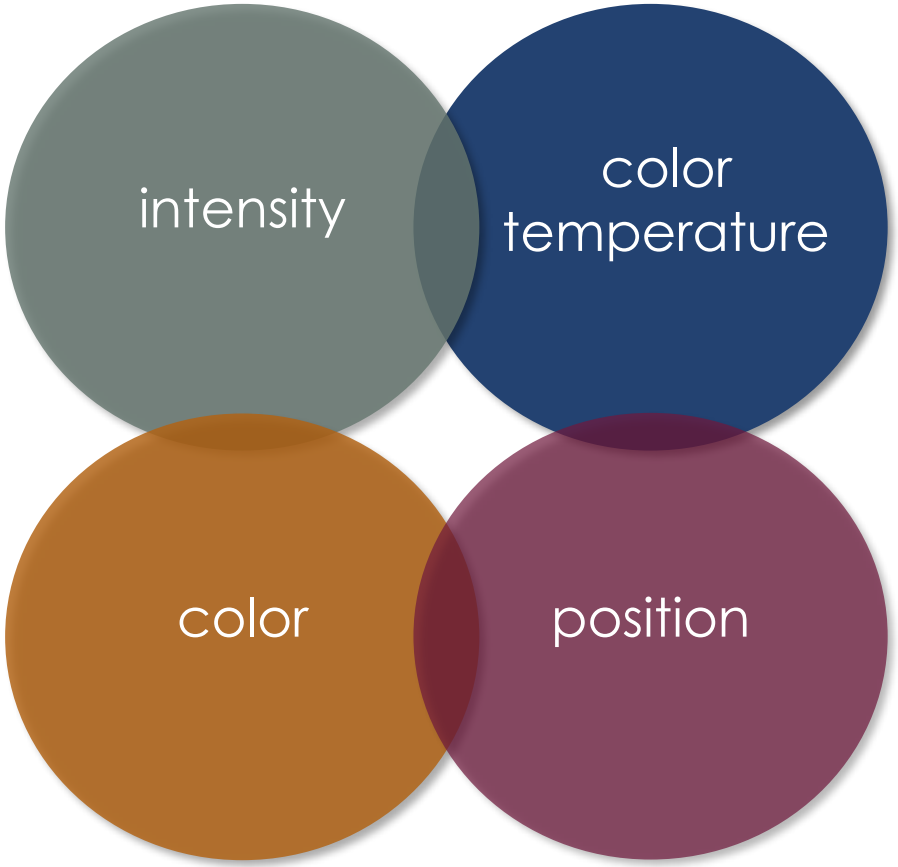
Design with color

RGB/DMX control

- Shift from theatrical to architectural spaces
- Controlled by DMX 512A protocol
- Create static and active "shows/sequences"
- Achieve 16 million colors with a basic RGB luminaire
- Control dynamic/tunable white with high resolution
- DMX controllers allow user to setup events/scenes/shows
- Greatest opportunity for growth (costs, tools, compatibility, availability, expectations0

Multi-dimensional lighting

- DMX controls multiple attributes for a single luminaire



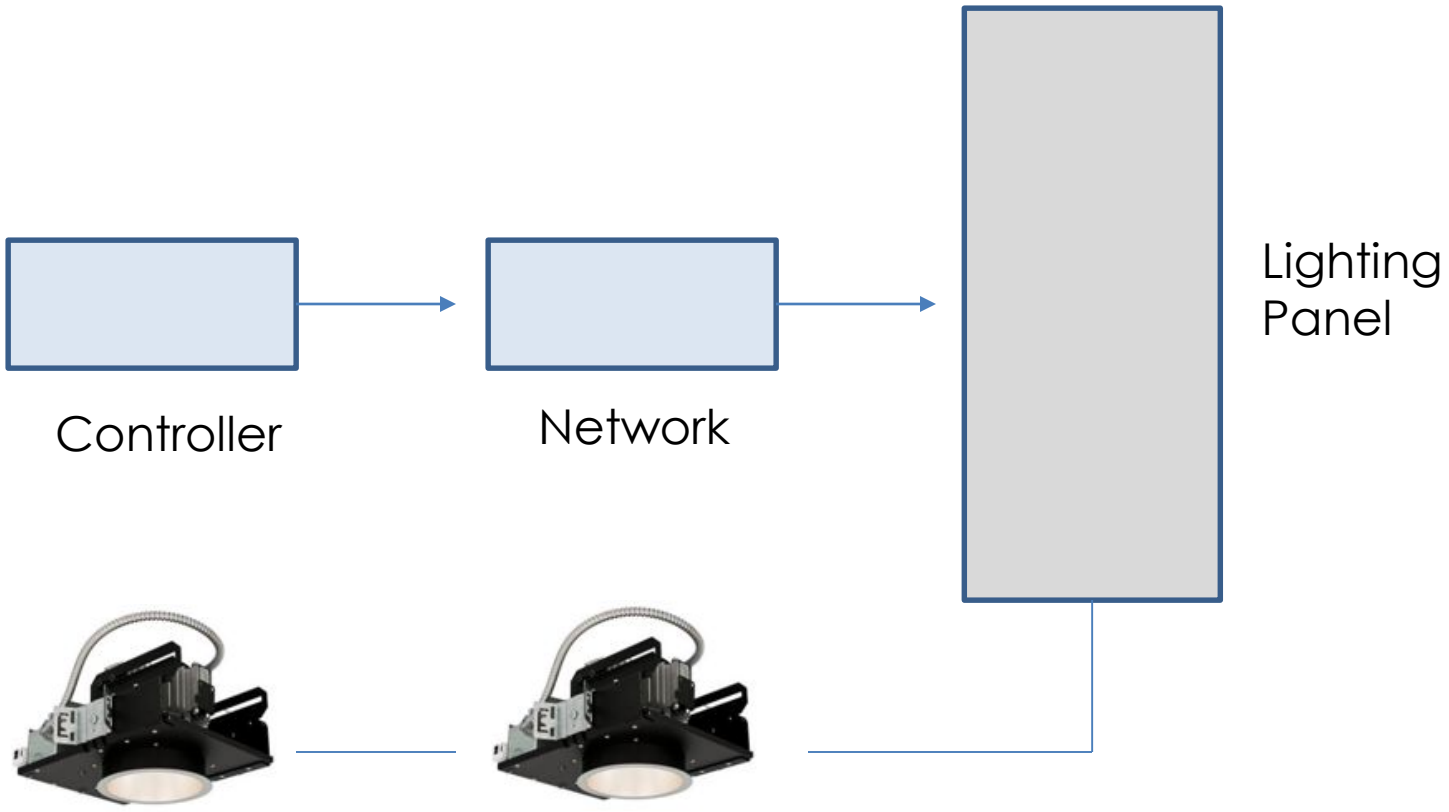
Tools to scale capabilities

Color Selection

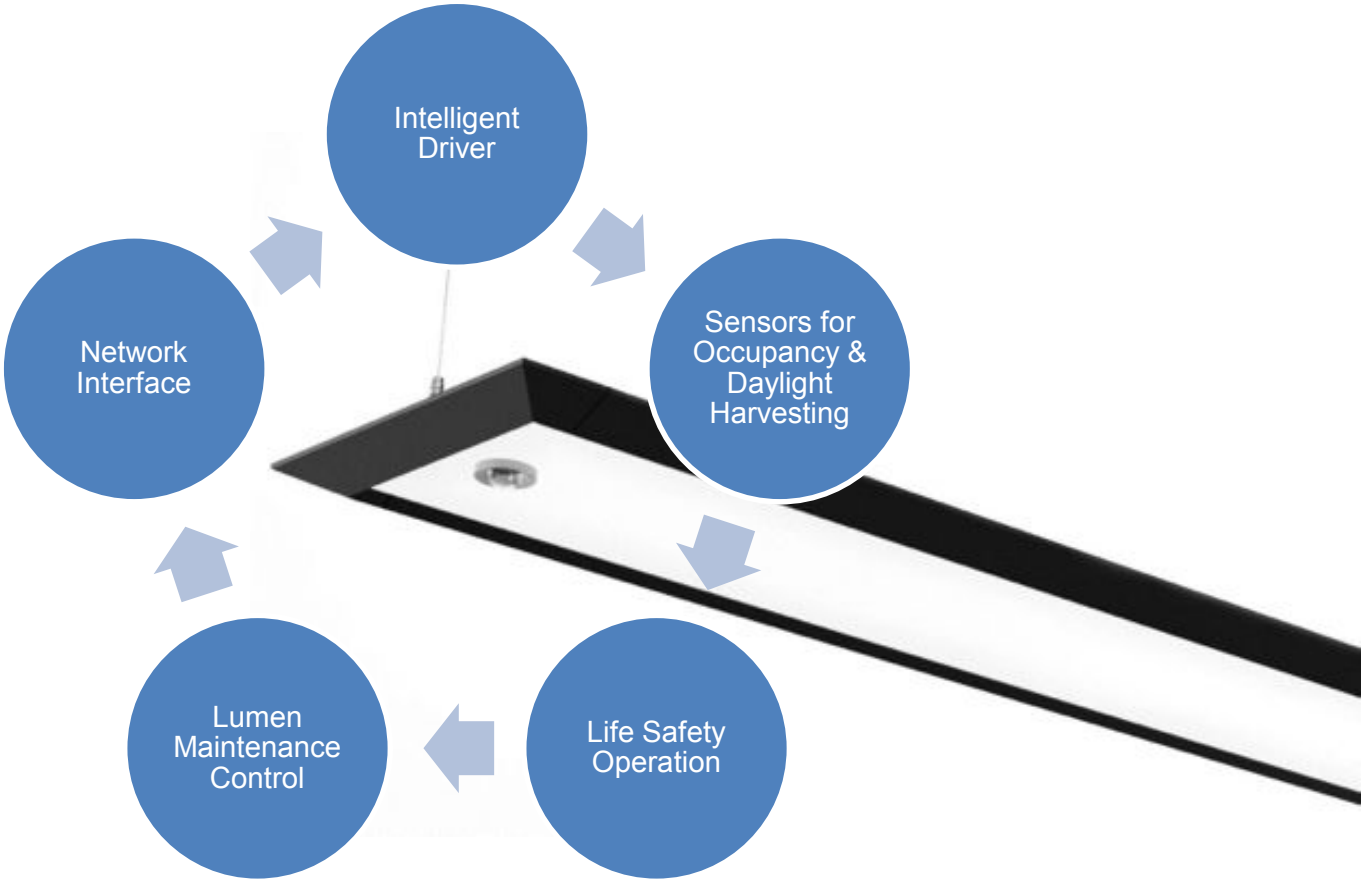
Color Temperature

Make it easy

Networked Controls-Analog

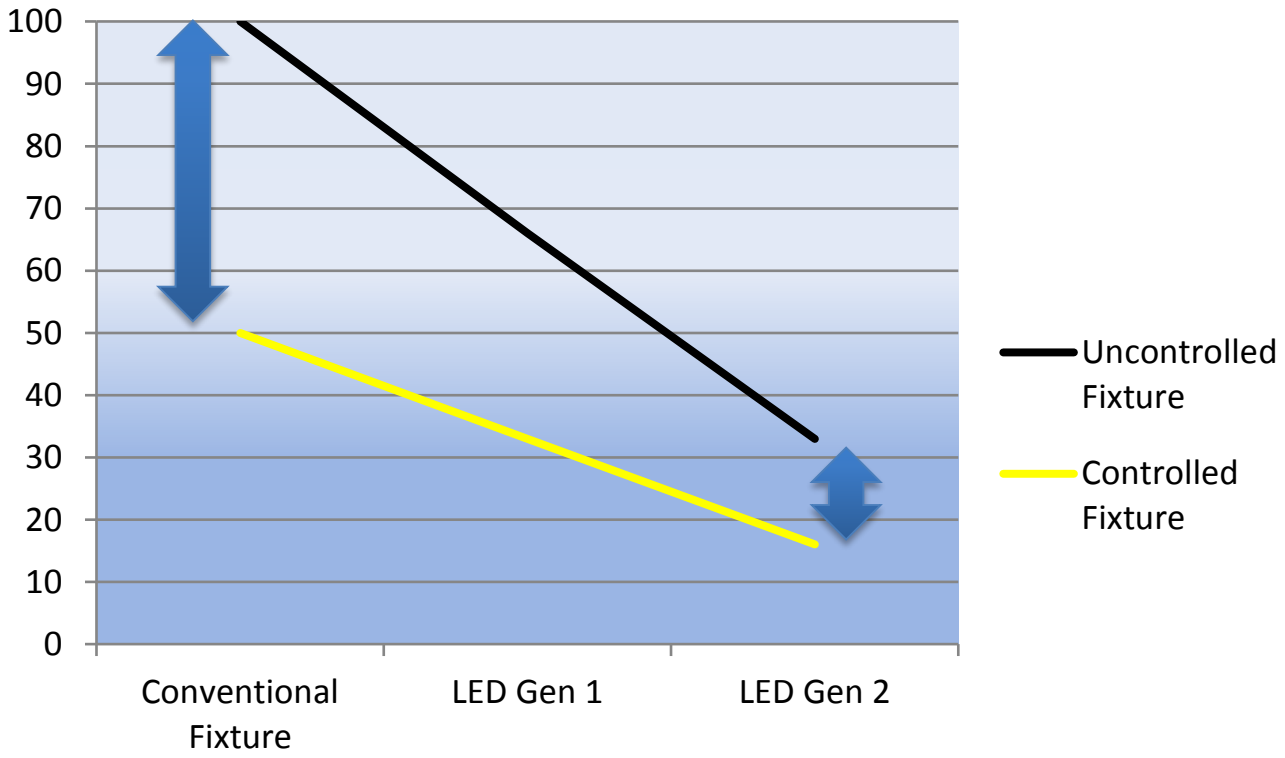


Integrated controls-Digital



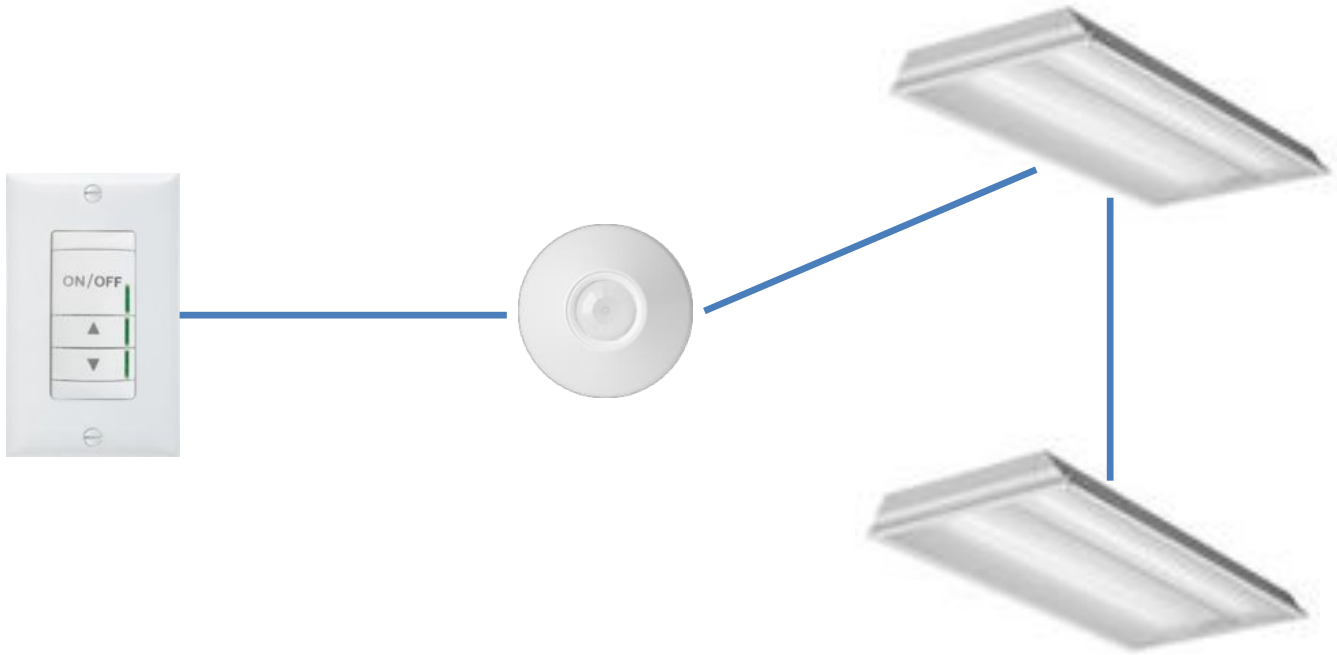
Combined control strategies of occupancy, tuning, daylighting and lumen maintenance can deliver **50% or more savings**.

Control Savings – Law of Diminishing Returns

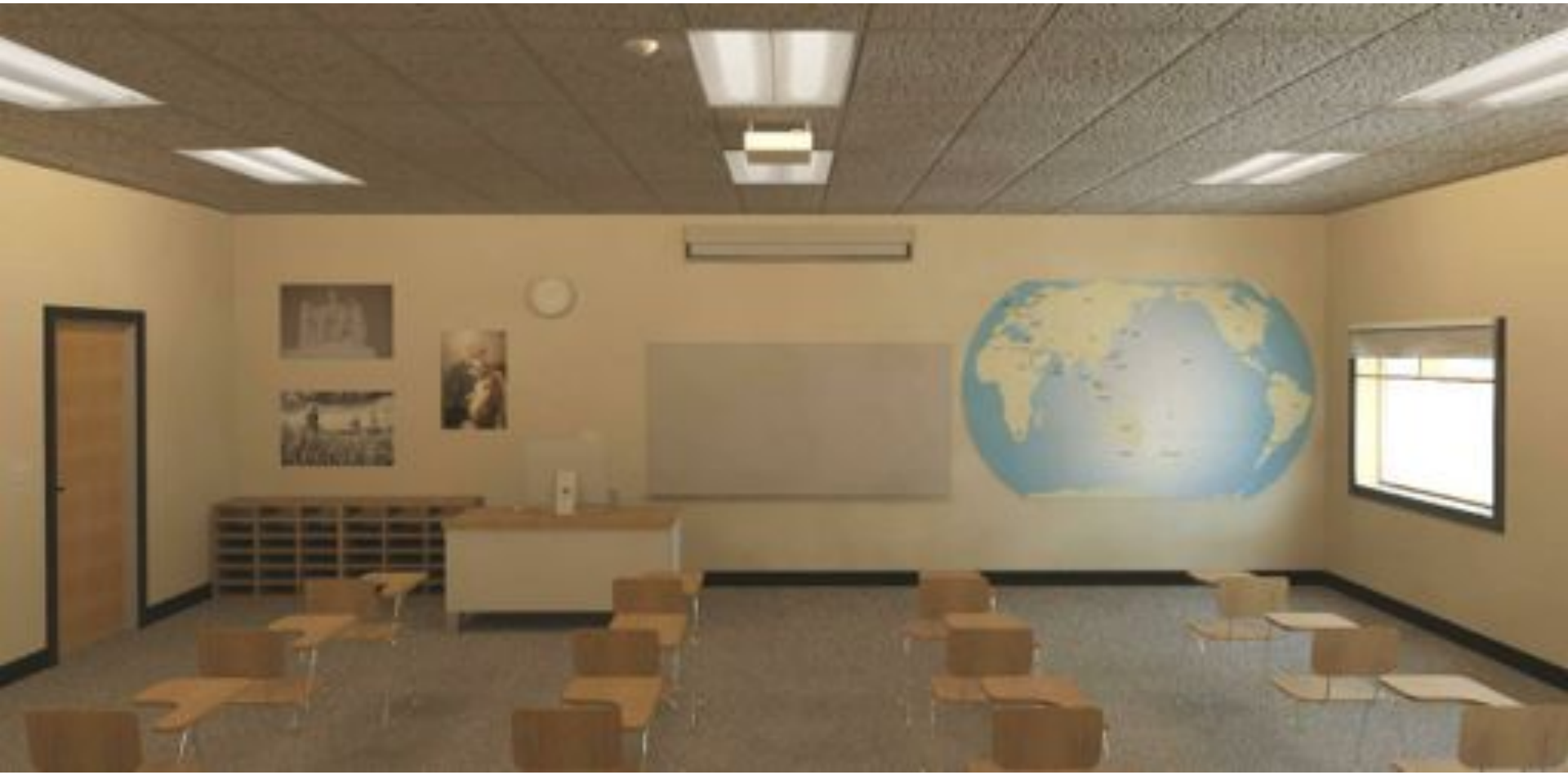


- As fixtures get more efficient, the magnitude of savings from controls is reduced
- Savings from multiple strategies are multiplicative, costs historically are additive
  – Lumen Maintenance, Occupancy Sensing and Task Tuning, each saving 15%, deliver a combined savings of $.85^3$ or 39% … **not** 45% (15% x 3)

Networked Controls



Classroom Wired Networks



Controls that allow multiple zones delivering scenes for enhanced quality of light to optimize the functions taking place

Classroom Wired Networks

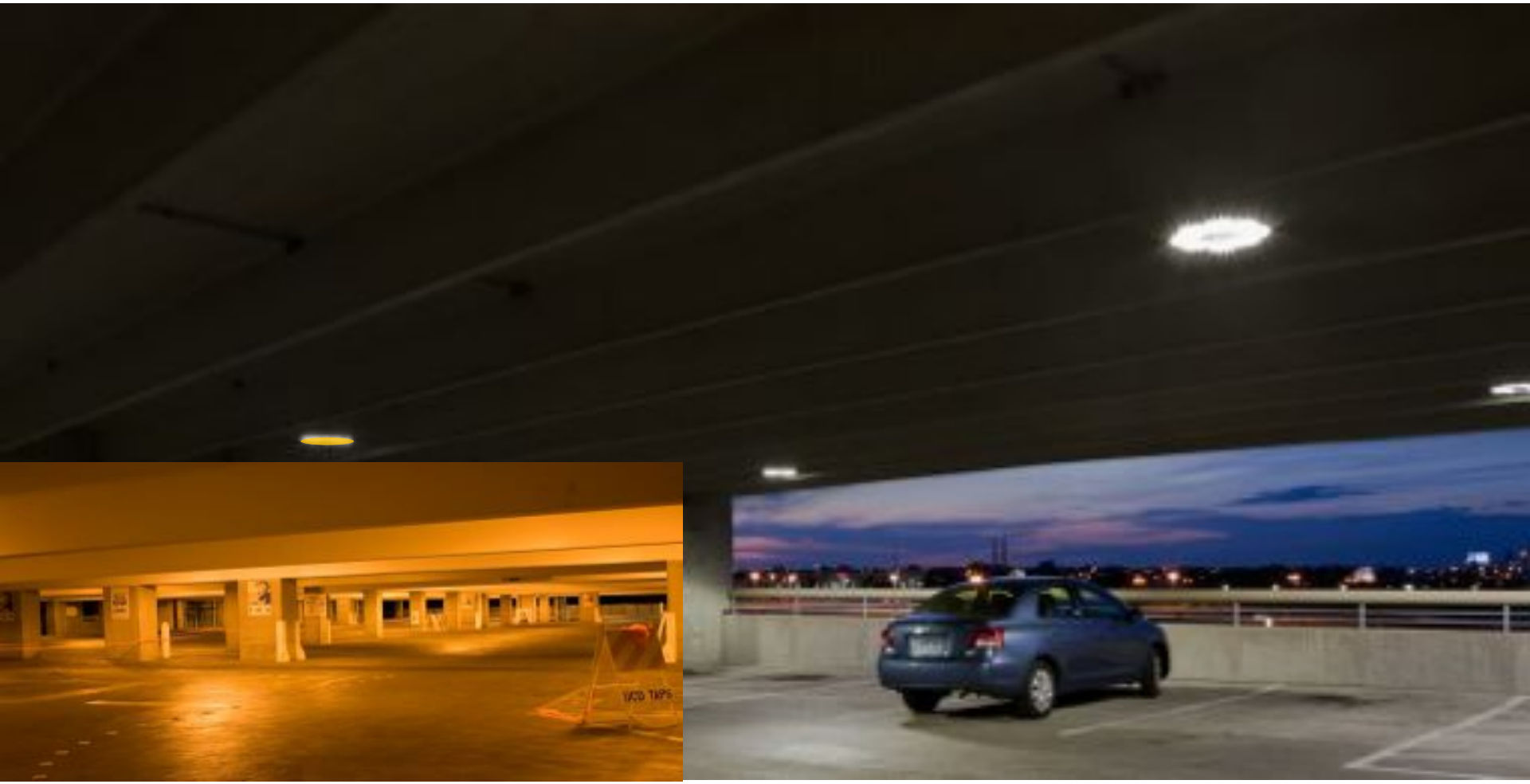
…for focused attention

Classroom Wired Networks

…for challenging visual tasks requiring contrast control.

Cut the wires

Covered Parking Wireless Networks



Enriched full-spectrum color

Covered Parking Wireless Networks

…with responsive integral sensors

Covered Parking Wireless Networks

…that wirelessly network to light the entire field of view
and deliver safe and secure visual setting.

Evolving Better Lighting Solutions

Enhanced…


Enriched…


Enabled…


While Using Fewer Resources.

Thank You!

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AcuityBrands.
Expanding the boundaries of lighting™