AABC Commissioning Group

AIA Provider Number 50111116

Design for Dynamic Light: How to Create a Successful Dynamic Lighting Systems

Course Number: CXENERGY1923

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Lutron

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Learning Objectives

After this presentation you will be able to:

1. Determine the level of dynamic lighting is necessary for a project according to the needs of each space.

2. Develop a comprehensive control narrative for projects with dynamic lighting that considers all the key use case scenarios.

3. Evaluate the light quality of dynamic luminaires including spaces that utilize multiple types of dynamic tunable white or color changing luminaires.

4. Understand the implications of protocols on both the initial design and future changes to the system.

What is Dynamic Light?

Switching

Dimming

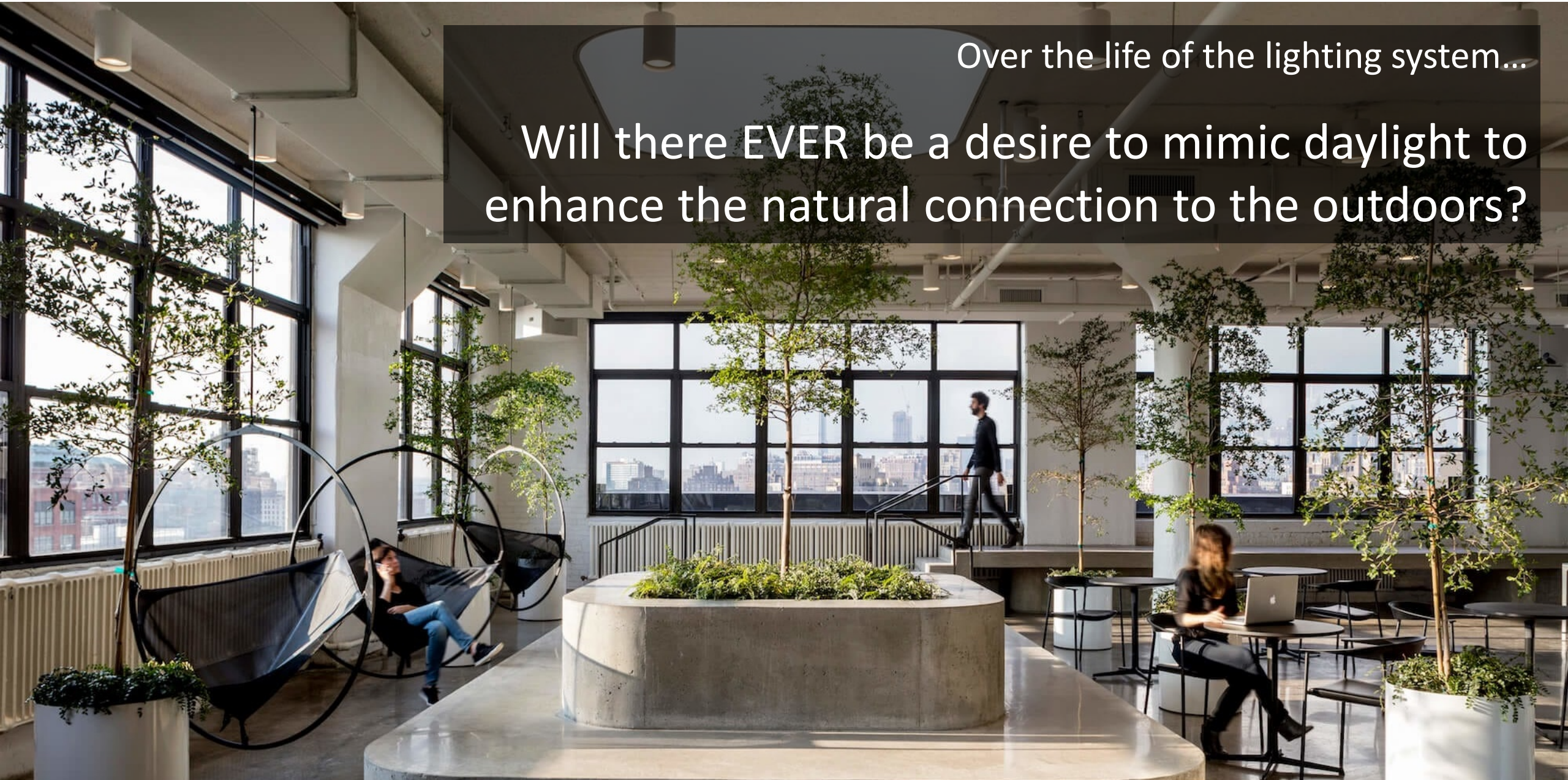
Warm Dimming

Tunable White

Color Changing

Dynamic Light

Should I include dynamic lighting in this space?

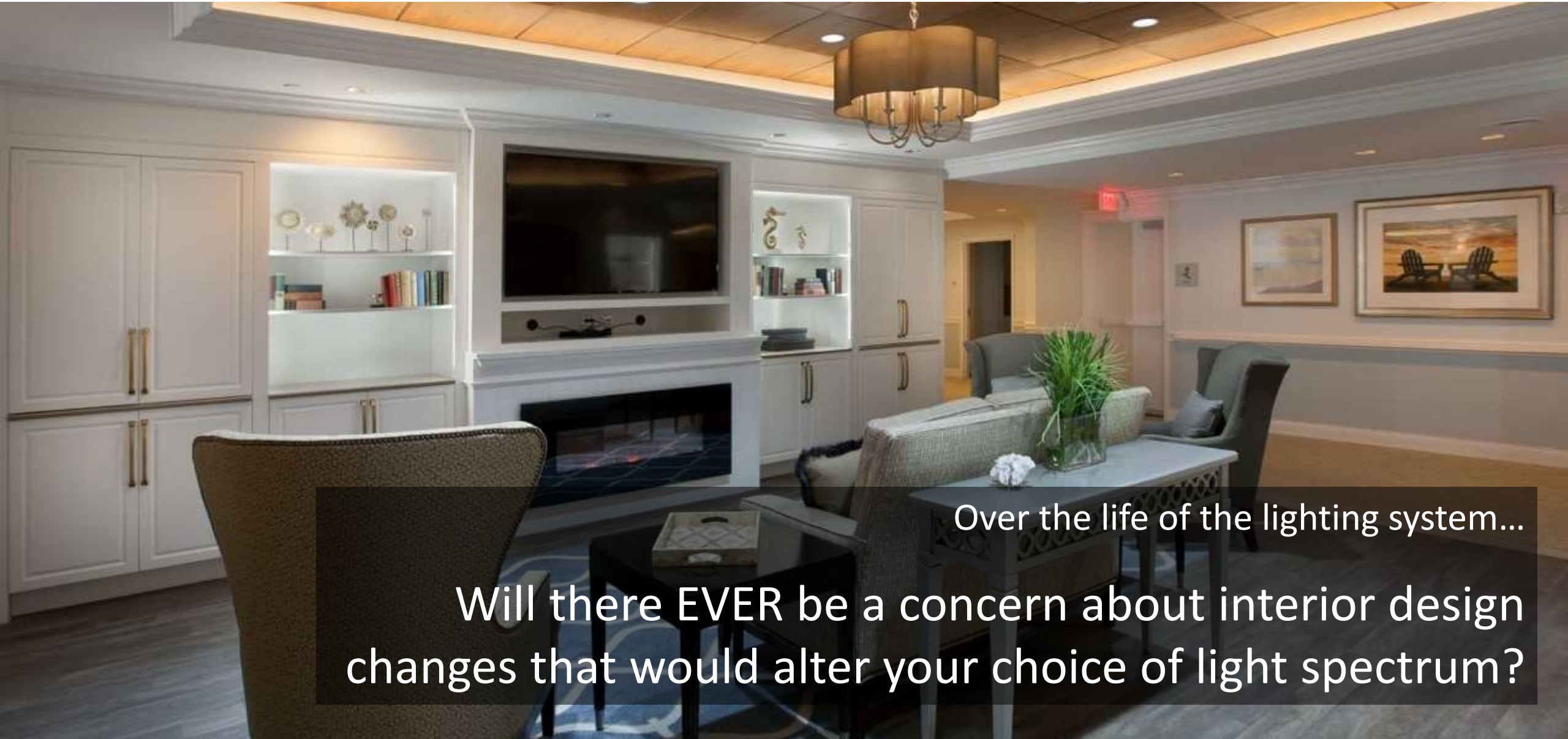


Should I include dynamic lighting in this space?

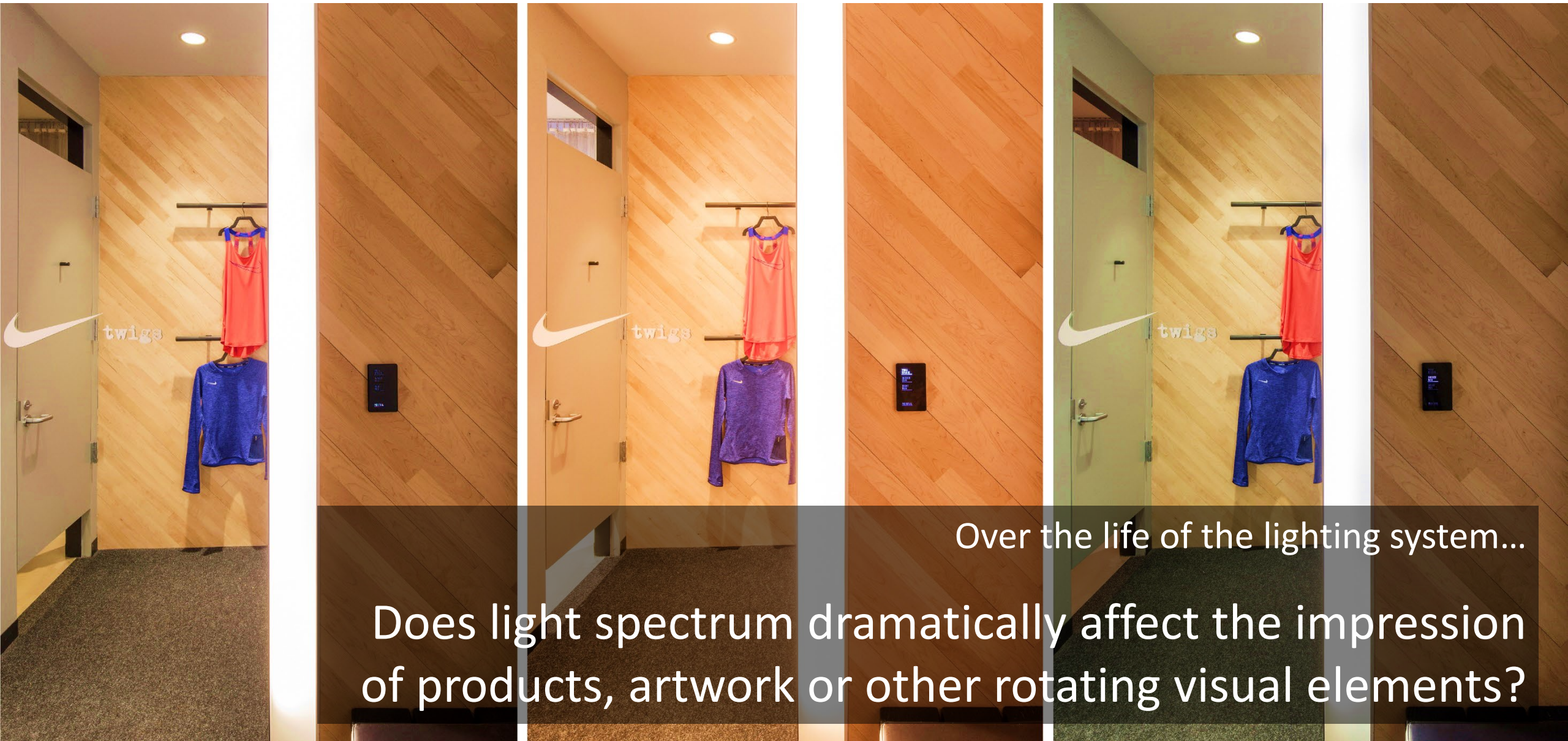
Over the life of the lighting system…

Will there EVER be a desire to use color to modify the mood of people or the impression of the environment?

Should I include dynamic lighting in this space?



Should I include dynamic lighting in this space?



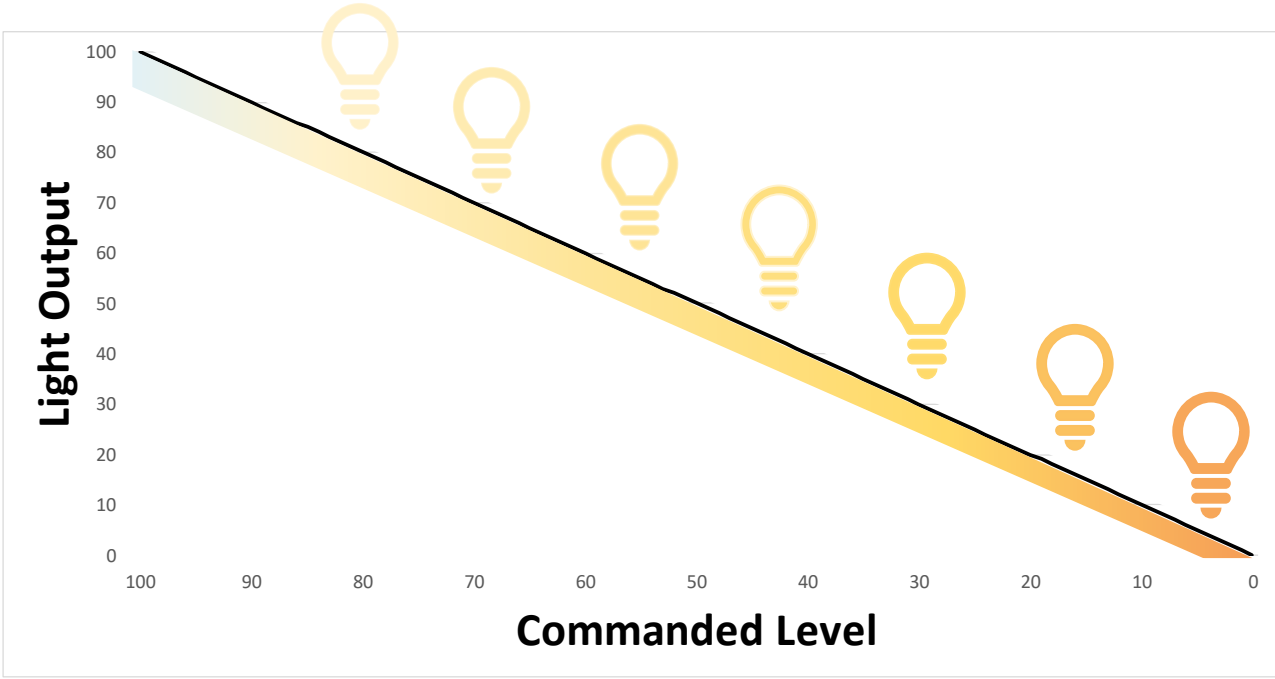
Over the life of the lighting system…

Does light spectrum dramatically affect the impression of products, artwork or other rotating visual elements?

What level of dynamic lighting is needed?

For **ALL** anticipated uses of the space…

Activities that need dim light are associated with a desire for a warm, relaxing environment.



Solution: Warm Dimming

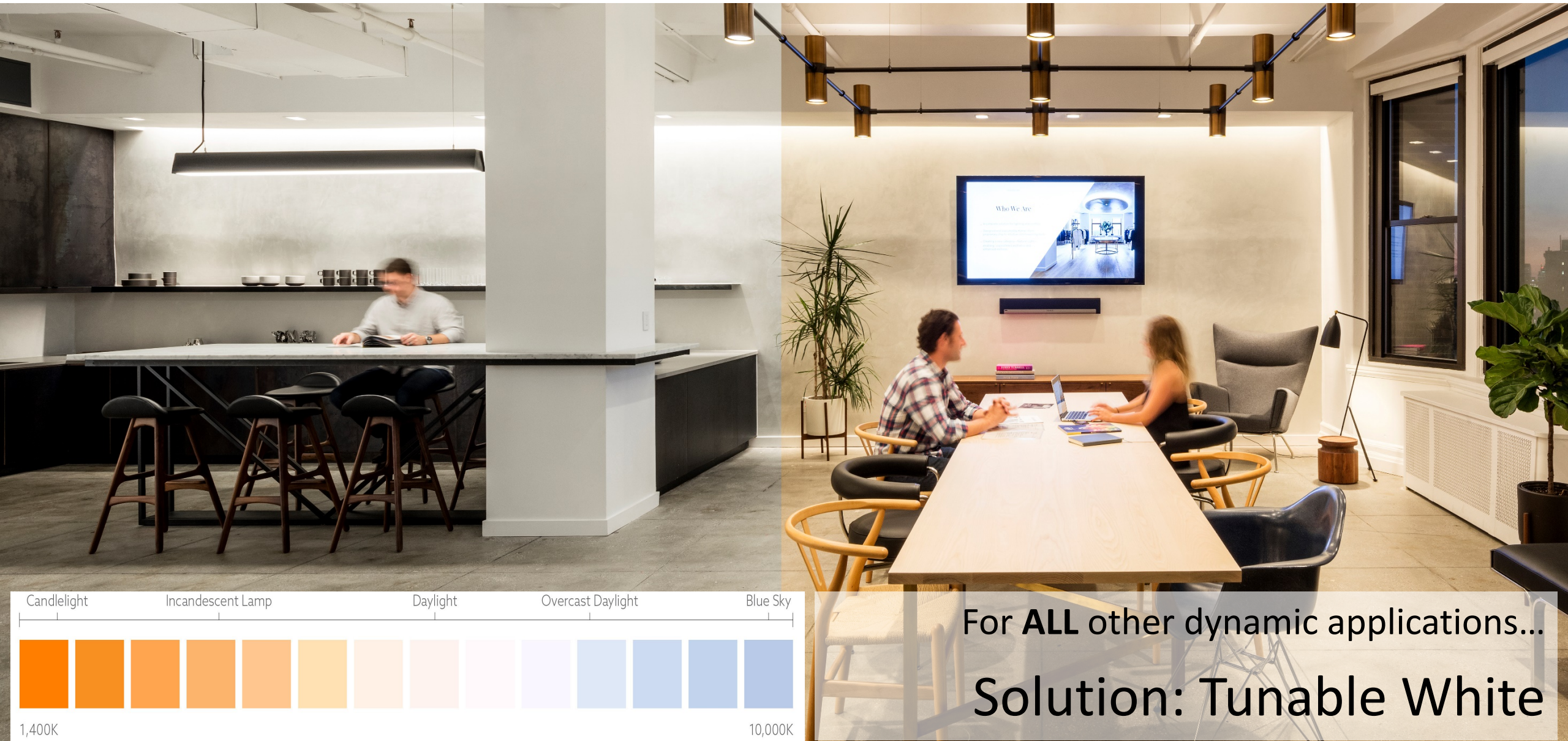
What level of dynamic lighting is needed?

For **ANY** anticipated uses of the space…

There is a desire to incorporate theatrical or dramatic color that may change based on event or seasons.

Solution: Color Changing

What level of dynamic lighting is needed?



For **ALL** other dynamic applications…

Solution: Tunable White

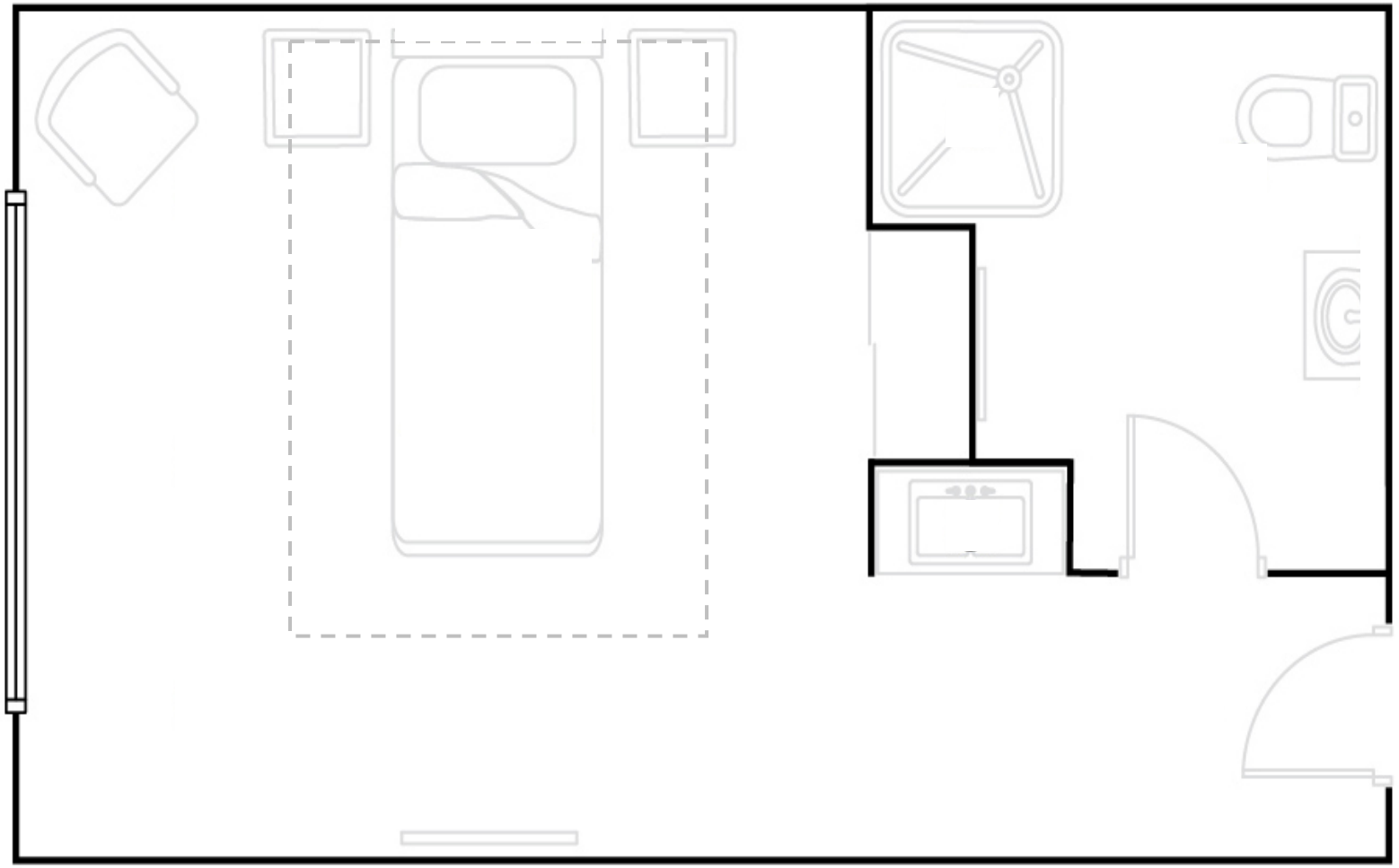
Getting the system you need

Using a patient room as an example for designing a dynamic lighting system

Brief background on the “project”

Desired Features:

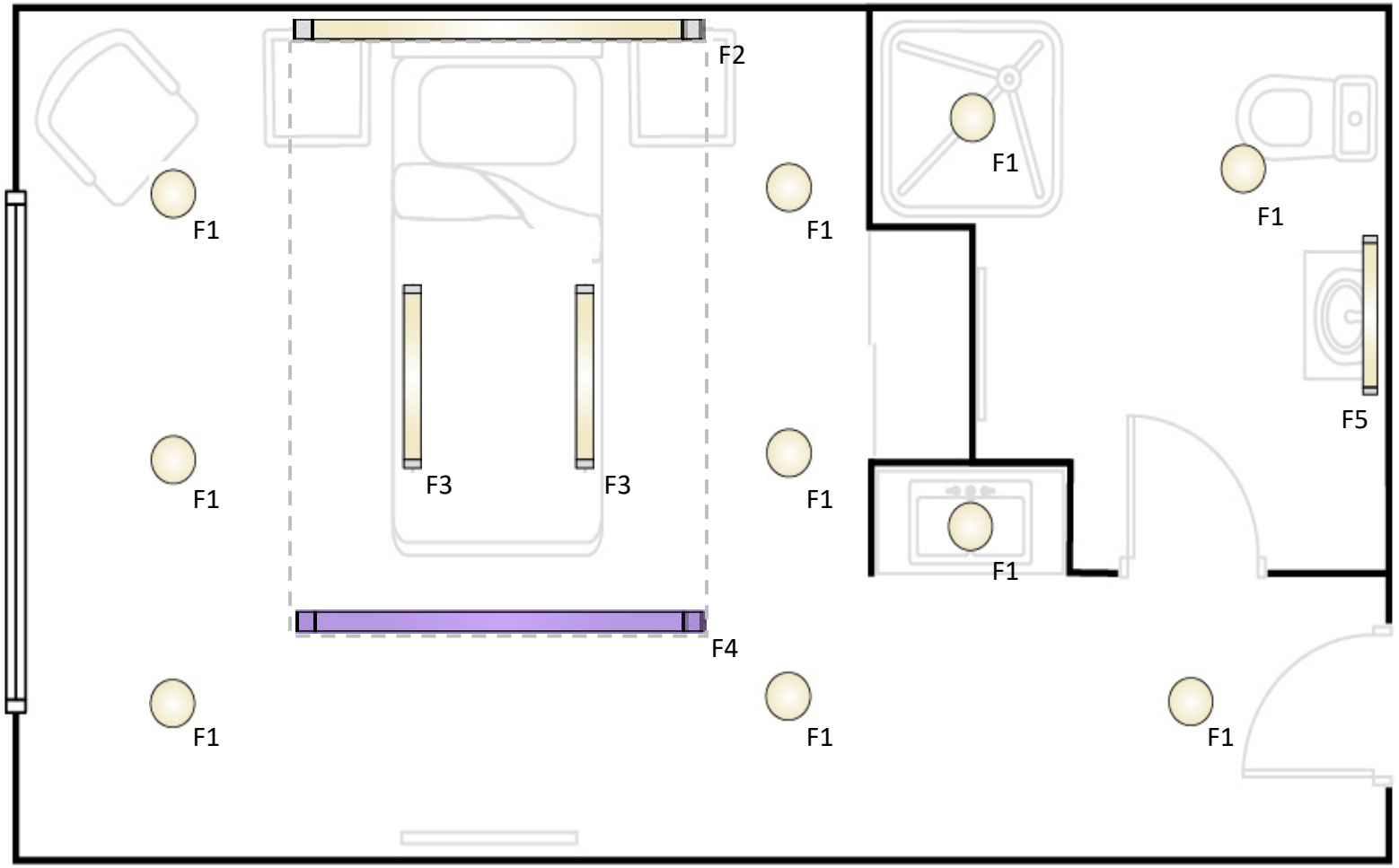
- Tunable white to mimic daylight
- Color changing light as a distraction mechanism for the child patients.



Brief background on the “project”

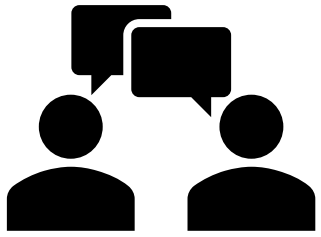
Lighting Schedule:

Label	Fixture Type	Dynamic Light Type
F1	Downlight	Tunable White
F2	Linear Patient Reading Light	Tunable White
F3	Examination Light	Tunable White
F4	Linear Patient Distraction Light	Color Changing
F5	Mirror Light	Tunable White

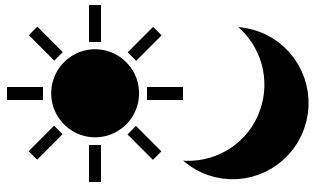


So you want to design a dynamic lighting system for a patient room, let's get back to design basics.

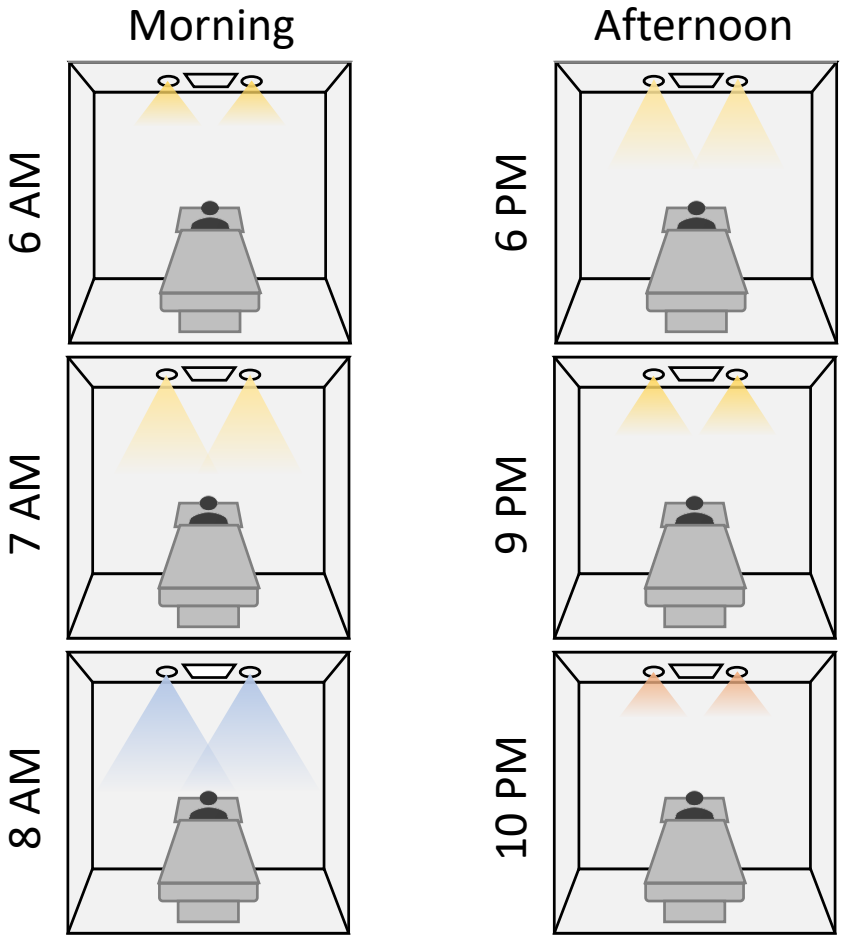
Programming	Schematic Design	Design Development	Construction Documents
Define Scenarios	Visualize Scenarios	Write Narrative	Don't Forget
• Interview end users • Understand tasks and usage for each space • Develop scenarios that define experiences • Should the scenarios change based on time-of-day	• Consider both user personas and key individual users • Consider transitions	• Review with end users	• Include detailed narrative of each scenario • Keypad Labeling



Critical Note: Customized user experience (also known as SoO) must be space and use specific



Evaluate all of the use case scenarios and document into a detailed controls narrative.



DAILY CYCLE:

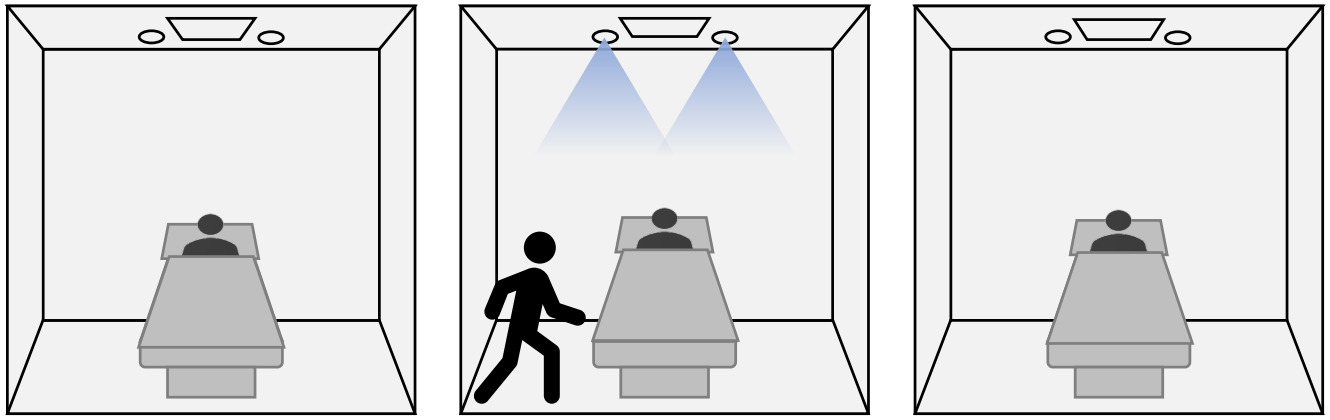
Automatic changes that occur without user interaction

- Color temperature and intensity of lights (except color changing luminaire) change in an attempt to mimic intensity and color of daylight.
- When changing, the fade time will be set to minimize distractions.
- Lights fade to the most recent active time clock event when returning to the daily cycle from an override.

Before I define my lighting narratives, how do I know what CCT values I should use?

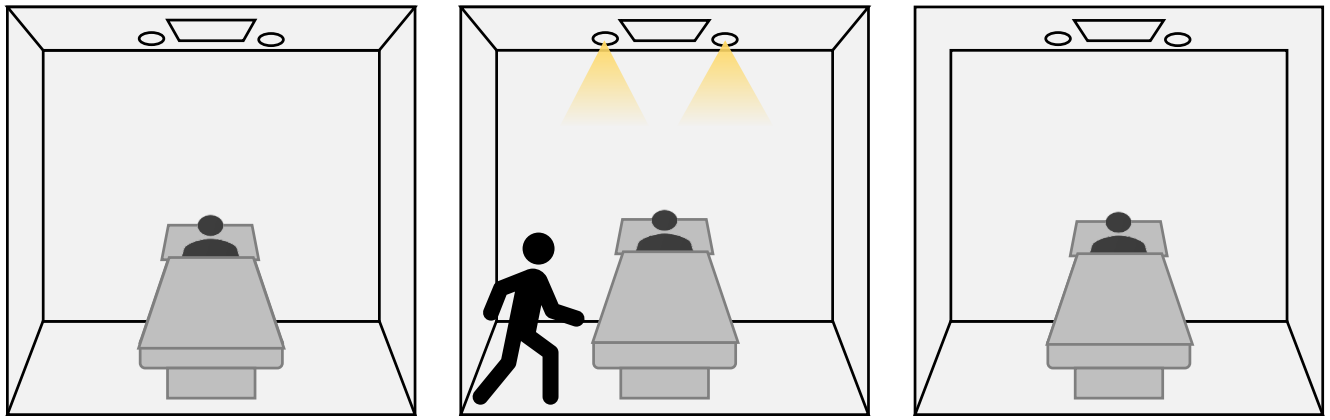
Evaluate all of the use case scenarios and document into a detailed controls narrative.

6 AM - 10 PM



15 minutes later

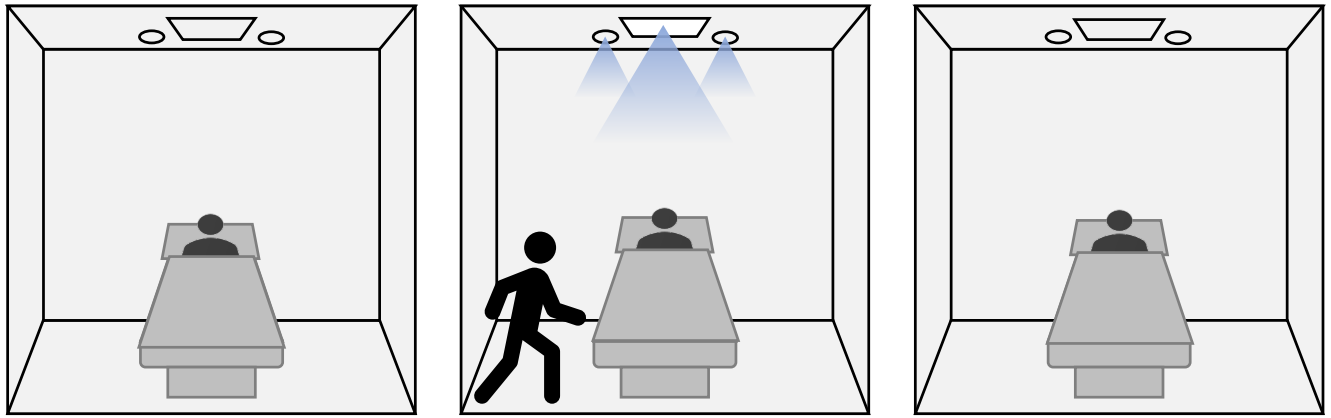
10 PM – 6 AM



CHECK ON PATIENT:
Quick check with minimal disruption

- 6am – 10pm: Patient room downlights set to “medium” light level and CCT follows daily cycle.
- 10pm – 6am: Patient room downlights are set to “low” light level and CCT follows daily cycle.
- Override lasts 15min.

Evaluate all of the use case scenarios and document into a detailed controls narrative.



1 hour later

PATIENT EXAM:
Longer, more thorough exam

- Patient room downlights are set to “medium” light level. Lights over the patient bed are set to “Bright” light level. CCT follows the daily schedule.
- Patient keypad is disabled.
- Override lasts 1hour.

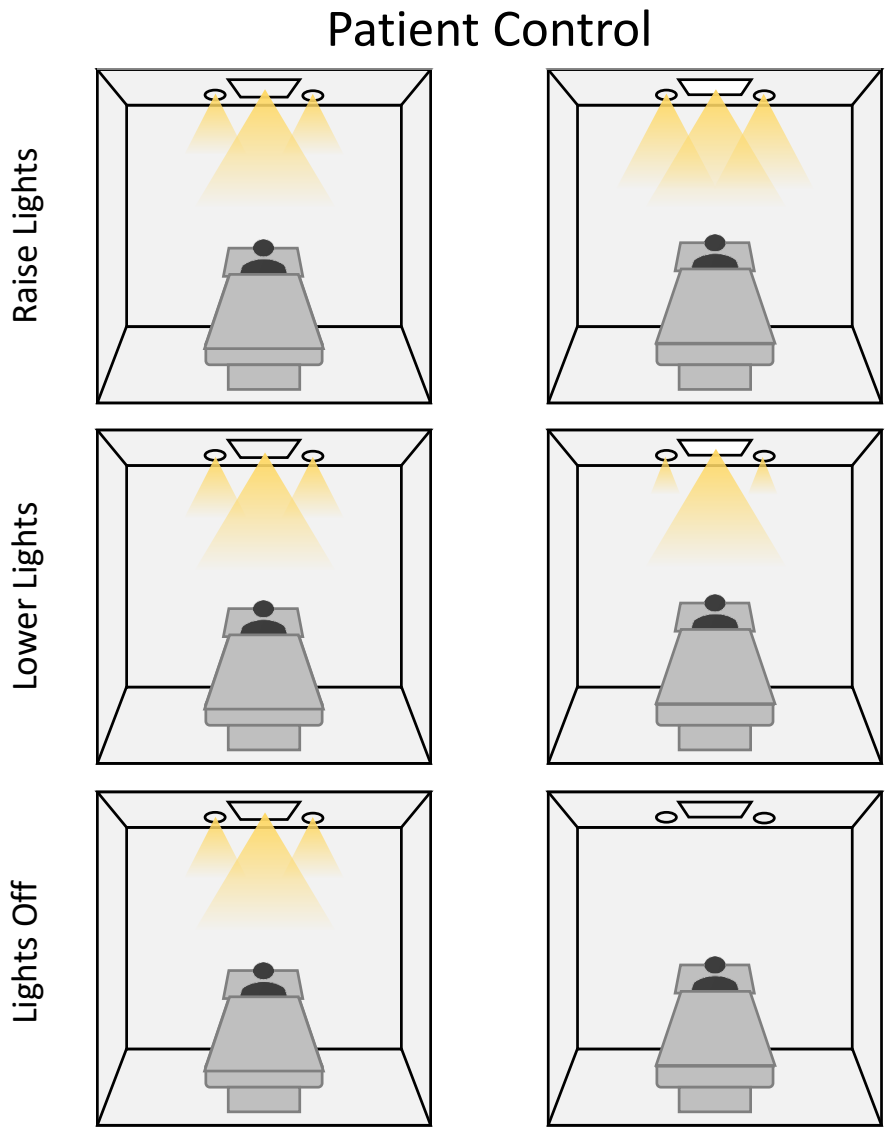
Evaluate all of the use case scenarios and document into a detailed controls narrative.

Not until staff release override

PATIENT EMERGENCY:
Bright, consistent emergency light

- All patient room and restroom lights (except color changing luminaire) are set to “Bright” at a constant 5000K CCT.
- All other keypads disabled.
- Override lasts until a specific button is pressed on that keypad.

Evaluate all of the use case scenarios and document into a detailed controls narrative.



PATIENT OVERRIDES (e.g. nap):
Temporary change in level and color

- Patient keypad 1 turns ON, raises, and lowers the headboard light.
- Patient keypad 1 turns OFF all of the lights in the room.
- Patient keypad 2 turns ON, turns OFF and changes the hue of the color changing luminaire.

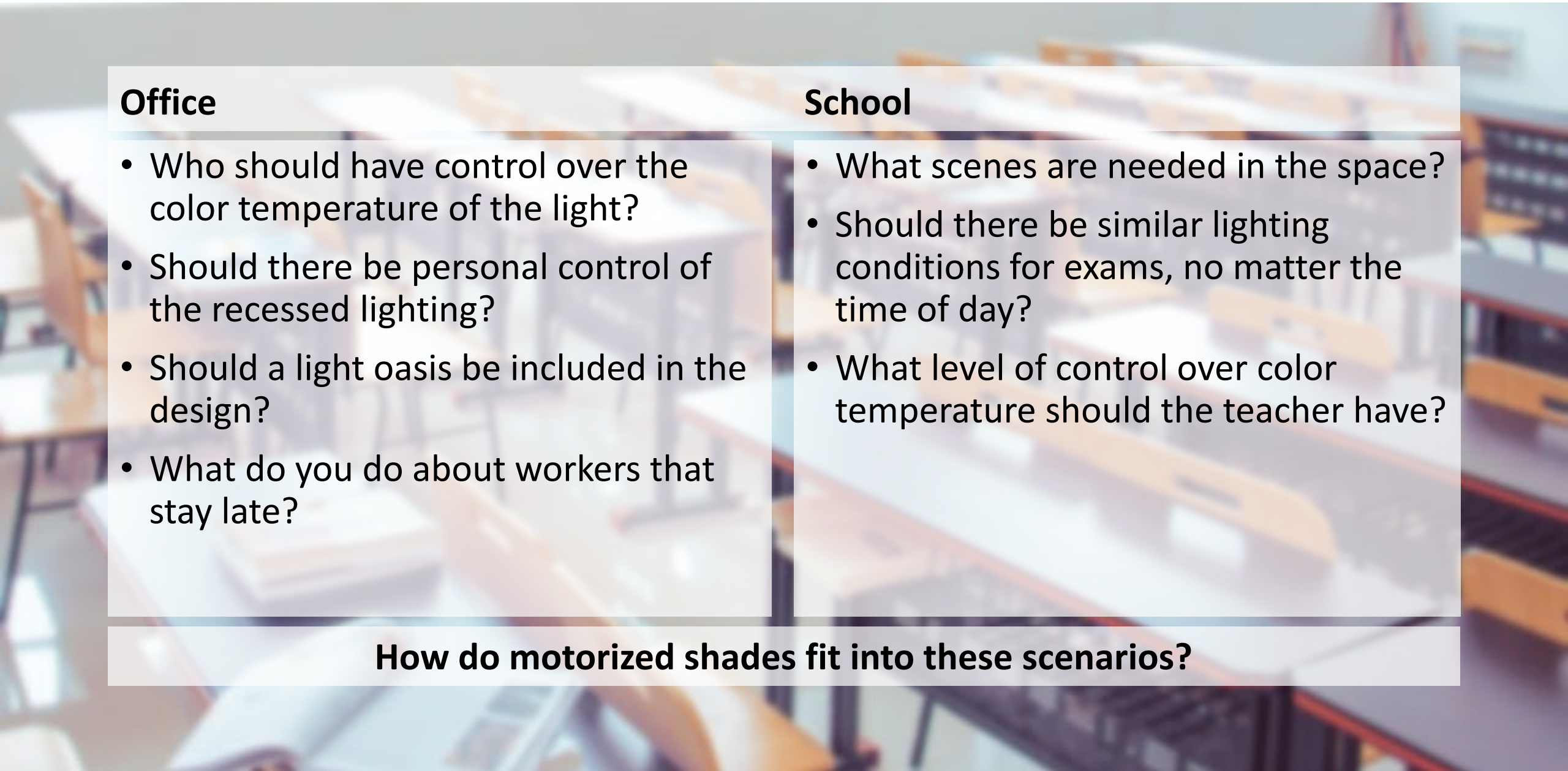
Evaluate all of the use case scenarios and document into a detailed controls narrative.

Other scenarios you should consider:

- Patient has a late night procedure and needs to sleep late
- Family awake and reading, but the patient would like to take a nap
- Patient needs to use the restroom at night
- Patient control of the color tuning fixture
- Family enters at night and doesn't want to disturb the patient
- Patient prefers to sleep with some night light
- How do these change with a multi-patient room?

How do motorized shades fit into these scenarios?

What is important to consider for an office space? Classroom?



Office

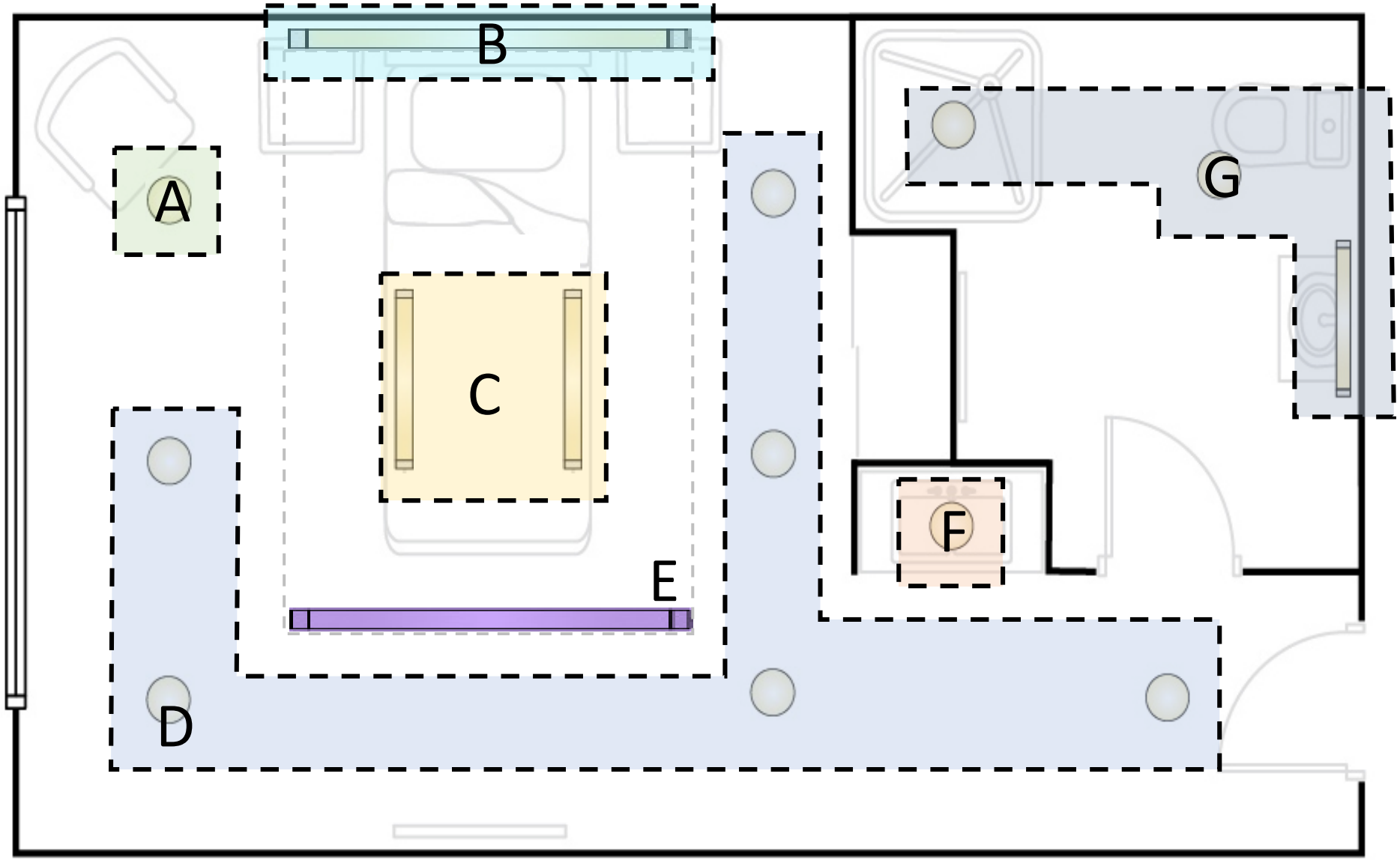
- Who should have control over the color temperature of the light?
- Should there be personal control of the recessed lighting?
- Should a light oasis be included in the design?
- What do you do about workers that stay late?

School

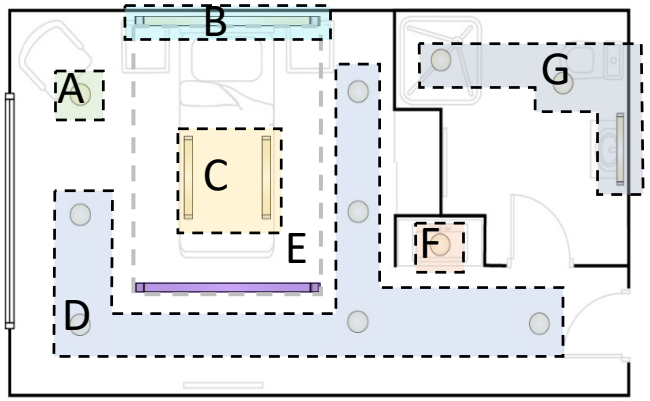
- What scenes are needed in the space?
- Should there be similar lighting conditions for exams, no matter the time of day?
- What level of control over color temperature should the teacher have?

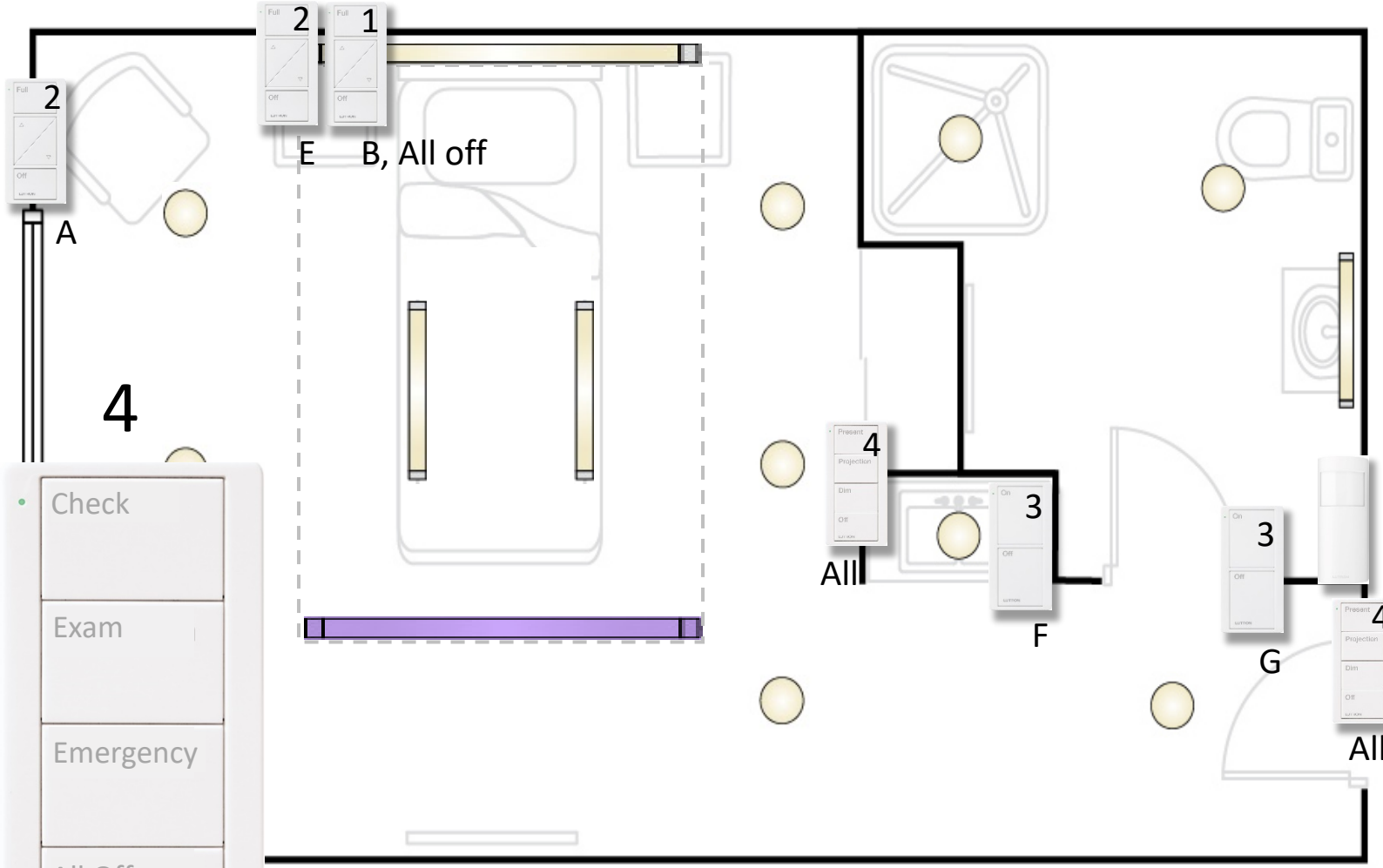
How do motorized shades fit into these scenarios?

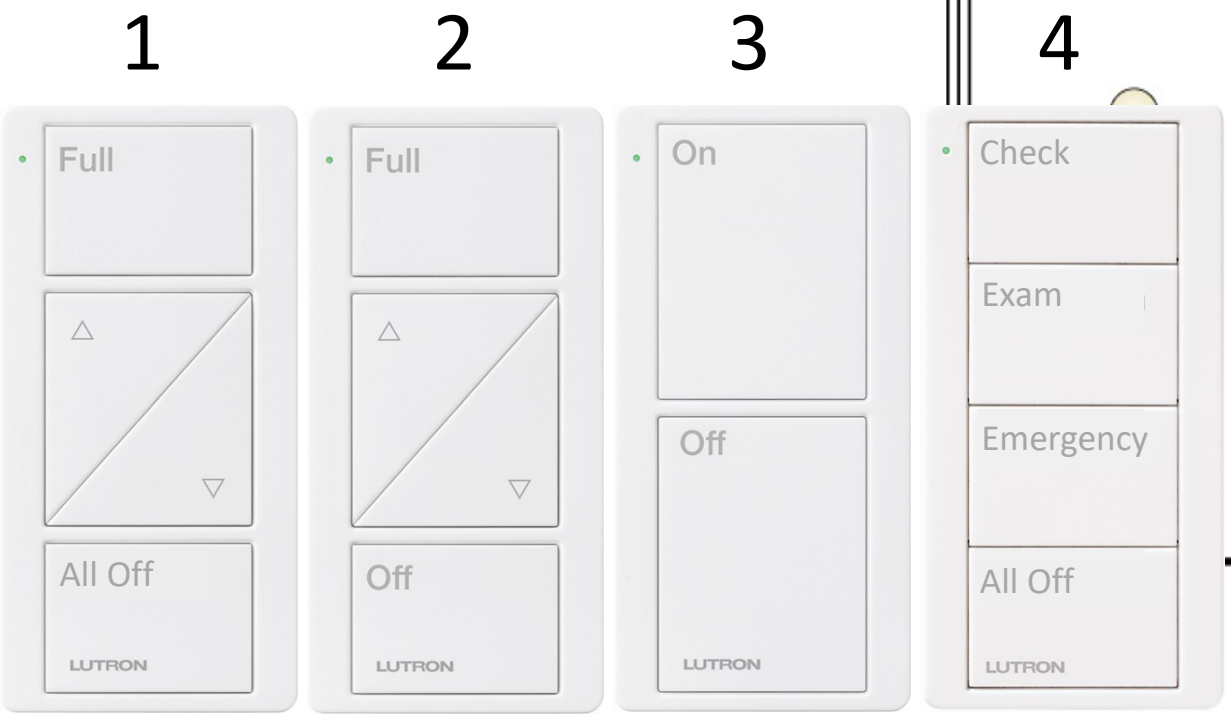
After visualizing all of the scenarios, the fixtures can be separated into their control zones.



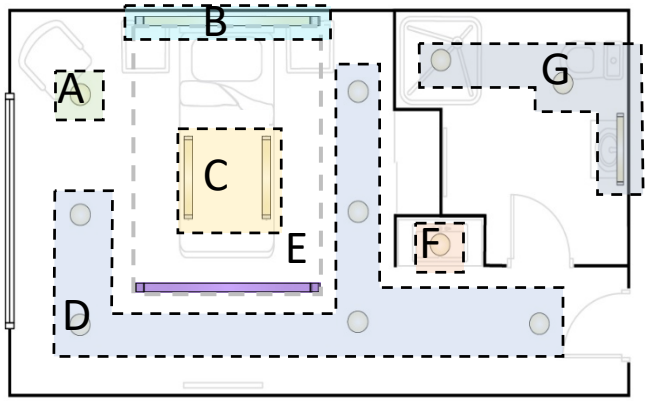
Proper controls layout and intuitive labeling are critical to a positive user experience.







Evaluate all of the use case scenarios and document into a detailed controls narrative.



Keypad	6AM-10PM*	10PM-6AM
Check	Zone D is set to 50% intensity. CCT follows the daily schedule. Override lasts 15 minutes.	Zone D is set to 10% intensity. CCT follows the daily schedule. Override lasts 15 minutes.
Exam	…	
Emergency	…	
All Off	…	
General Note: When override is over, lights shall fade back to daily cycle.		

*Keypad buttons that are not affected by time of day based control shall follow the sequence of operations written all day.

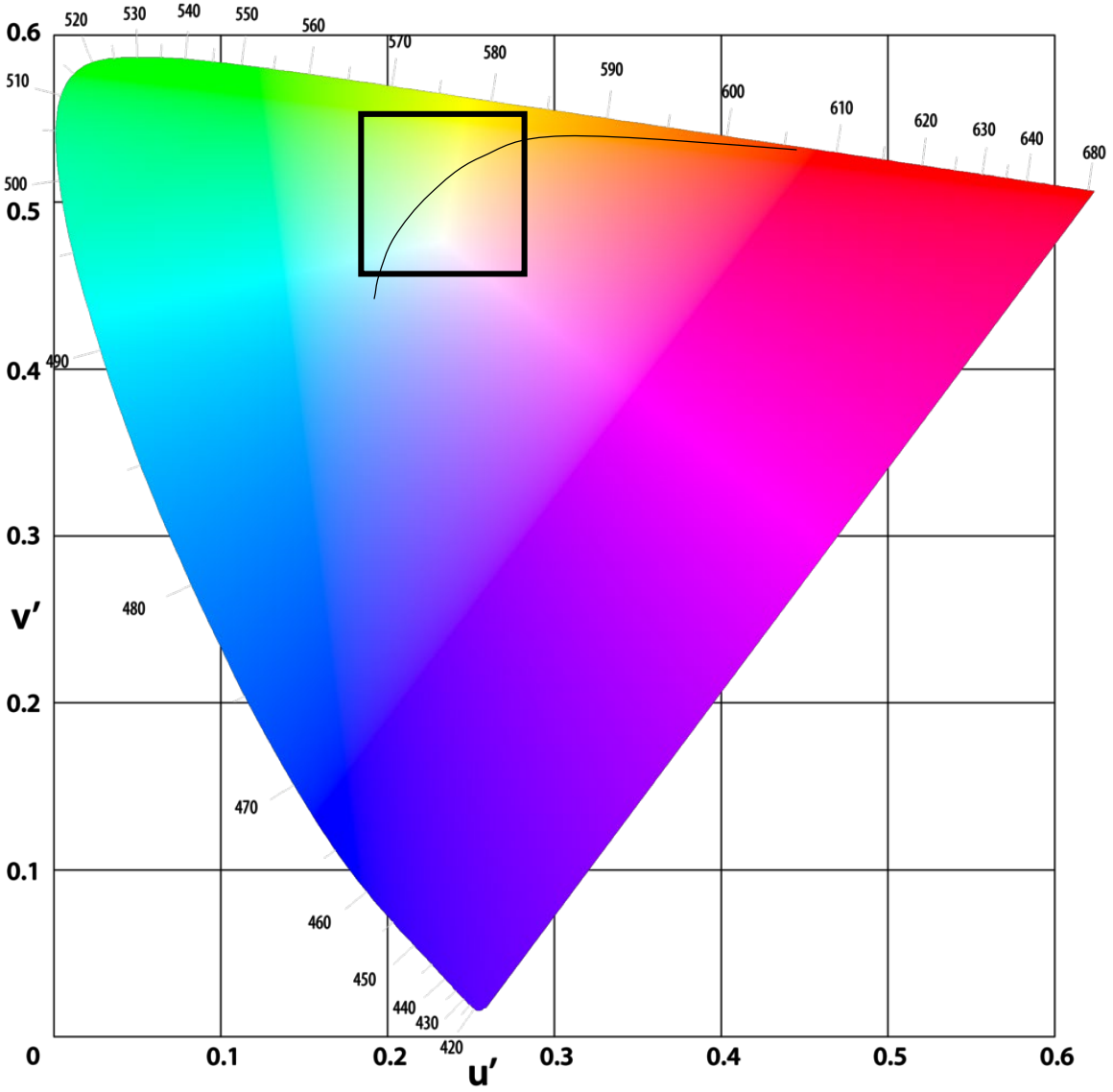
CHECK ON PATIENT:
Quick check with minimal disruption

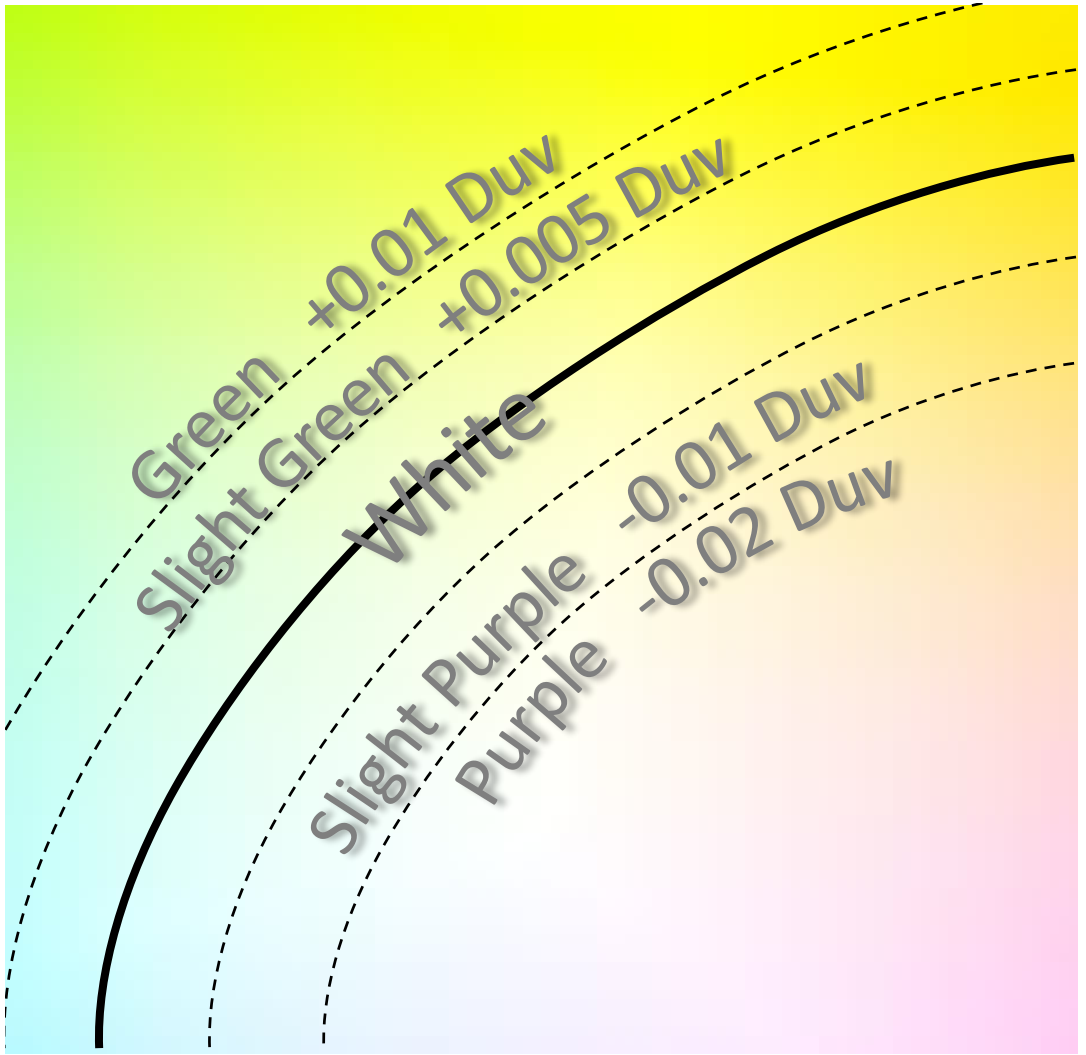
- 6am – 10pm: Patient room downlights are set to “medium” and CCT follows the daily schedule.
- 10pm – 6am: Patient room downlights are set to “low” and CCT follows the daily schedule.
- Override lasts 15min.

Quality of Tunable Light

Evaluating lighting quality between fixtures and across time.

Black Body Tuning will impact perceived lighting quality.





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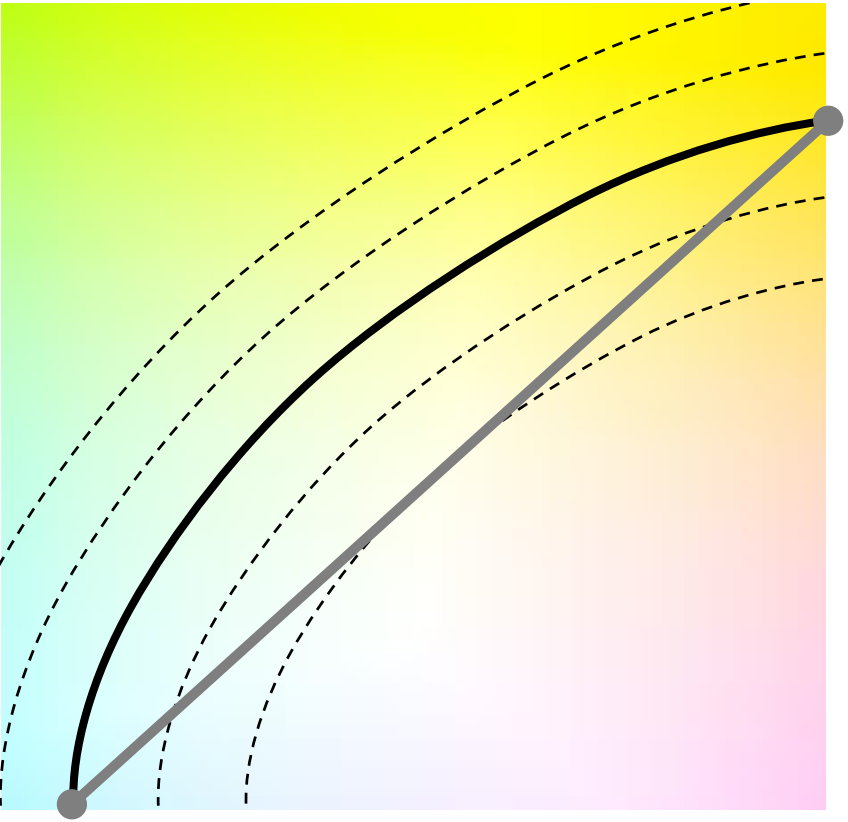
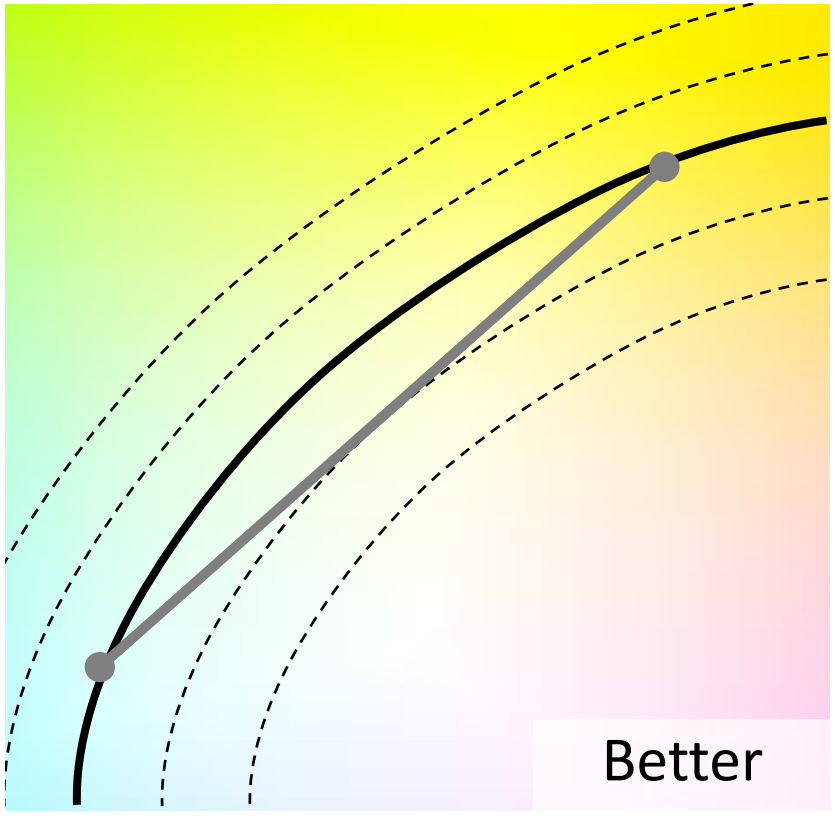
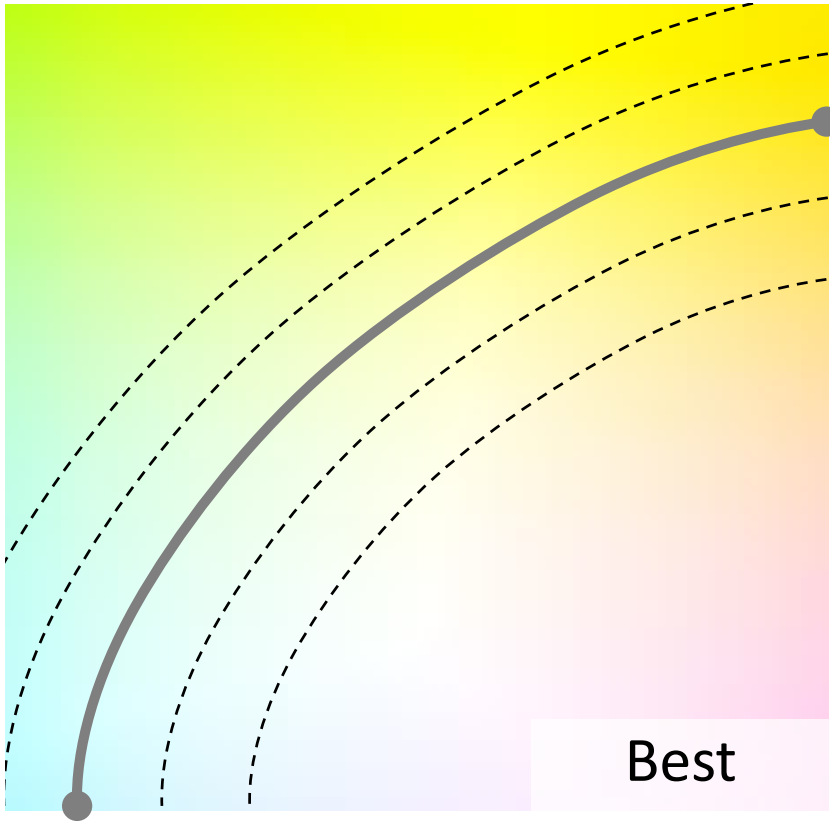
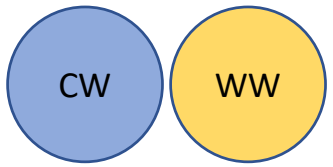
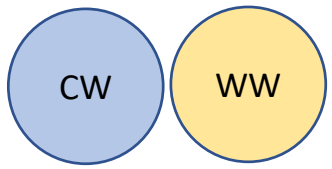
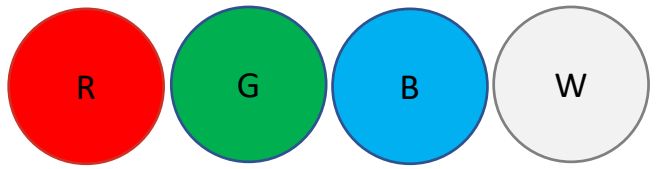




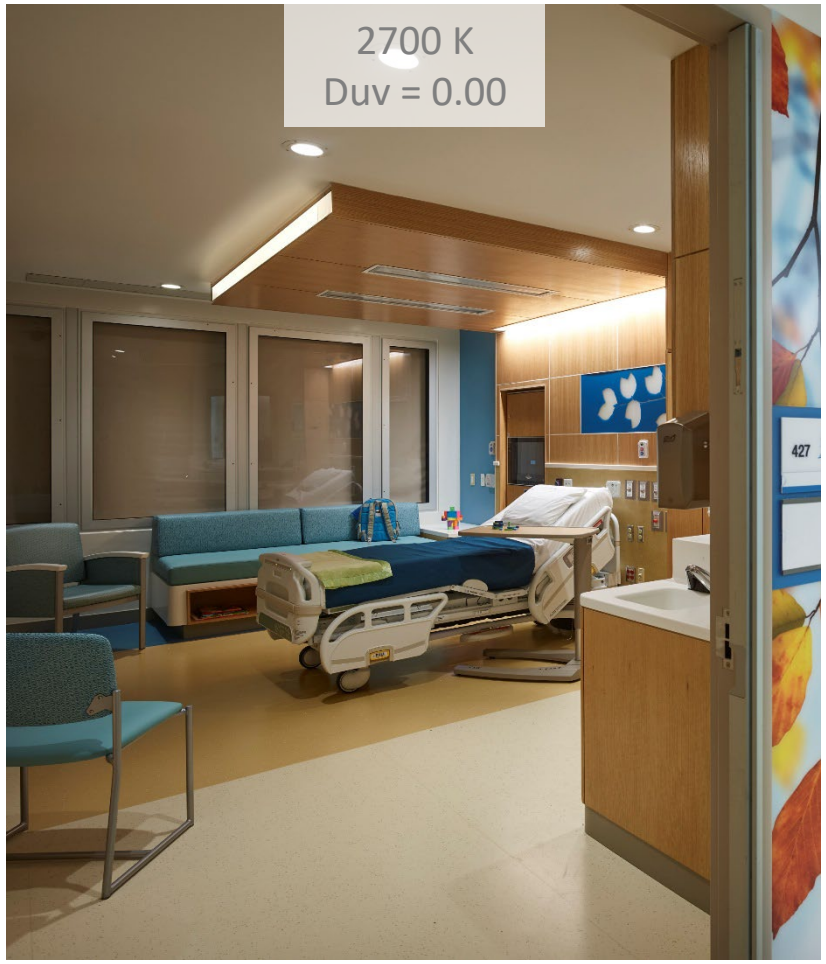


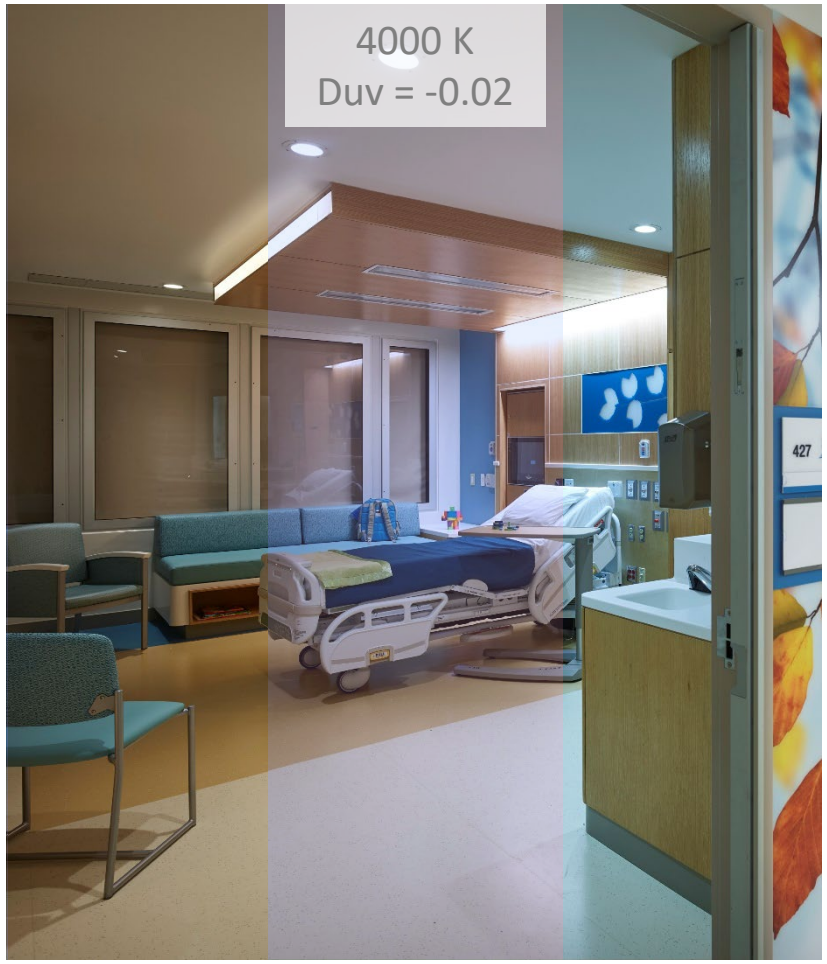


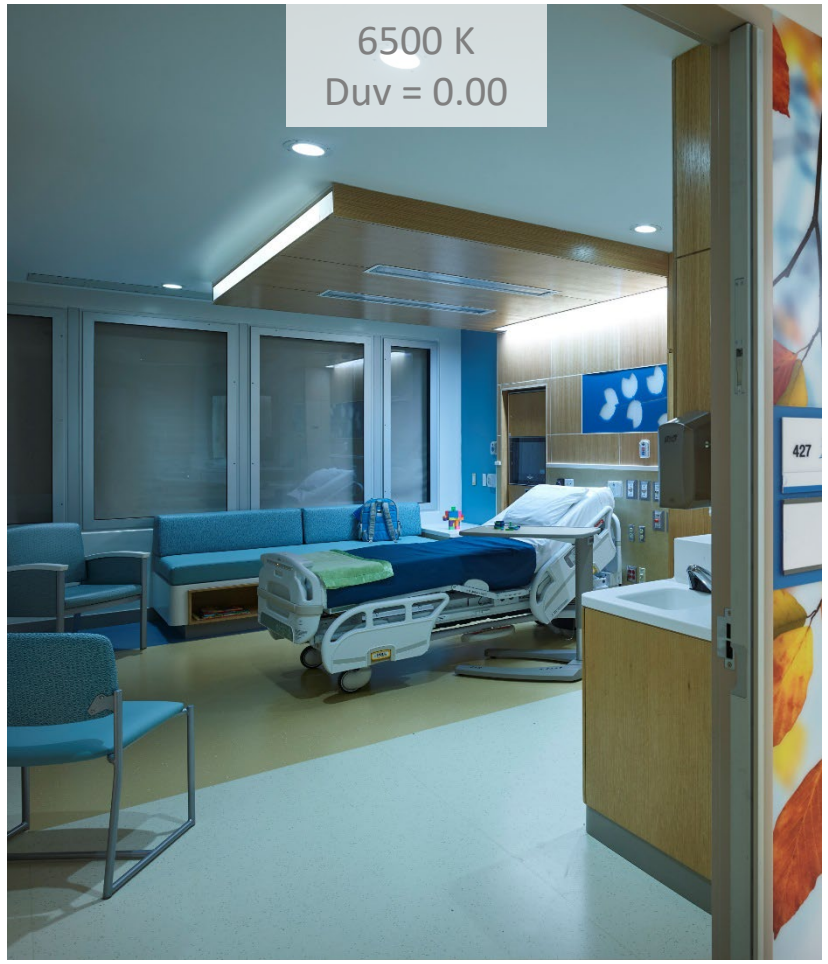




Evaluate the color appearance across the color temperature range of your source.







Summary of lighting quality recommendations (evaluated across all desired CCT values)

Eliminate Poor Performance

- Validate the source color matches across all fixture types within the same space
- Color fidelity capability: $R_f > 80$
- Color vibrancy capability: Minimal desaturation, none in red hues
- Flicker:
  - $P_{st} < 1.0$
  - SVM < 1.6

Recommended Performance

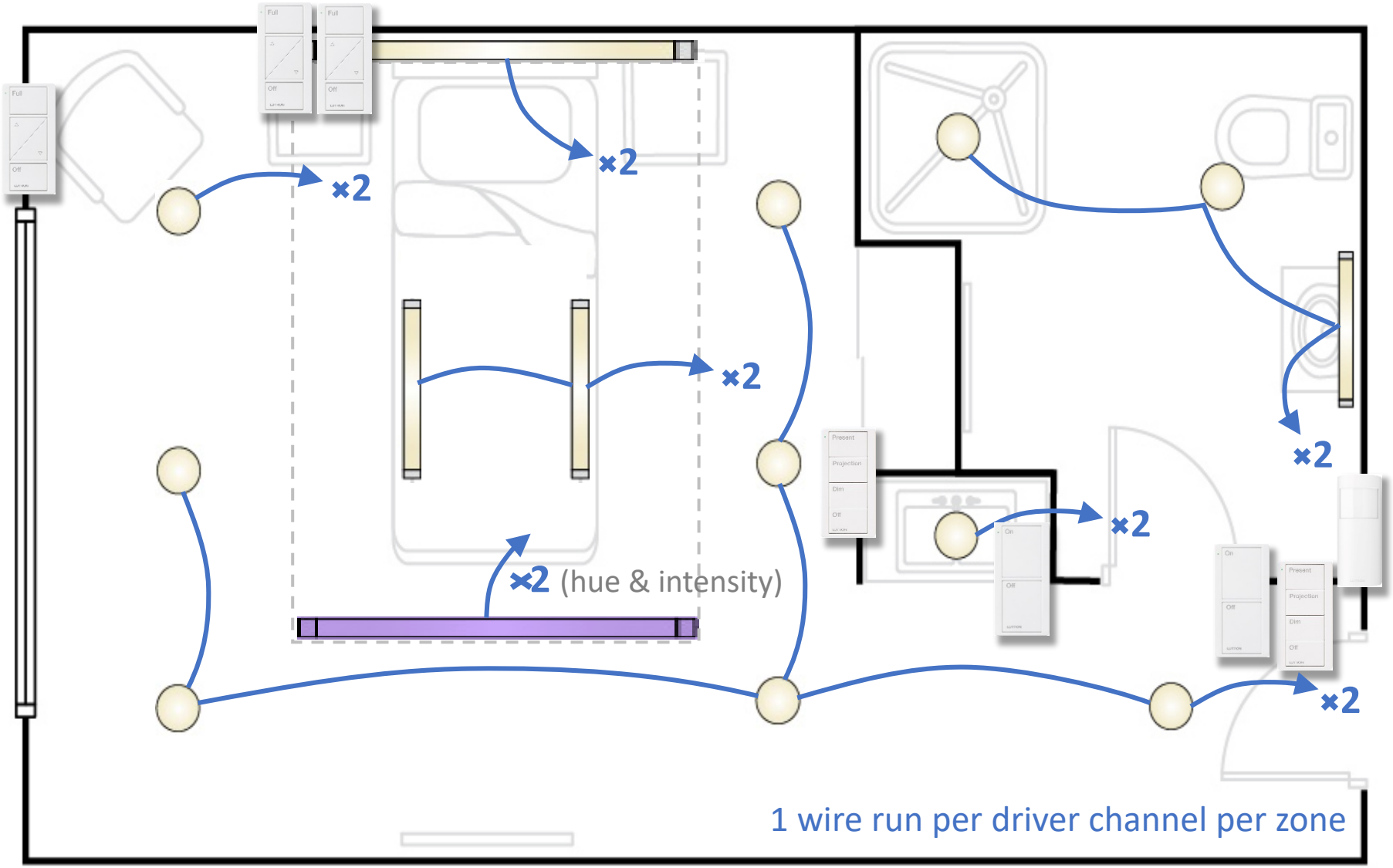
- If possible, use similar LED modules when using multiple fixture types in the same space
- Consider modules that use feedback to maintain color consistency
- Color fidelity capability: $R_f > 85$
- Color vibrancy capability: Saturate red
- Flicker:
  - $P_{st} < 0.7$

Critical Note: Get this information from your fixture OEM.

Other Design Considerations

How to avoid common mistakes to simplify design and setup.

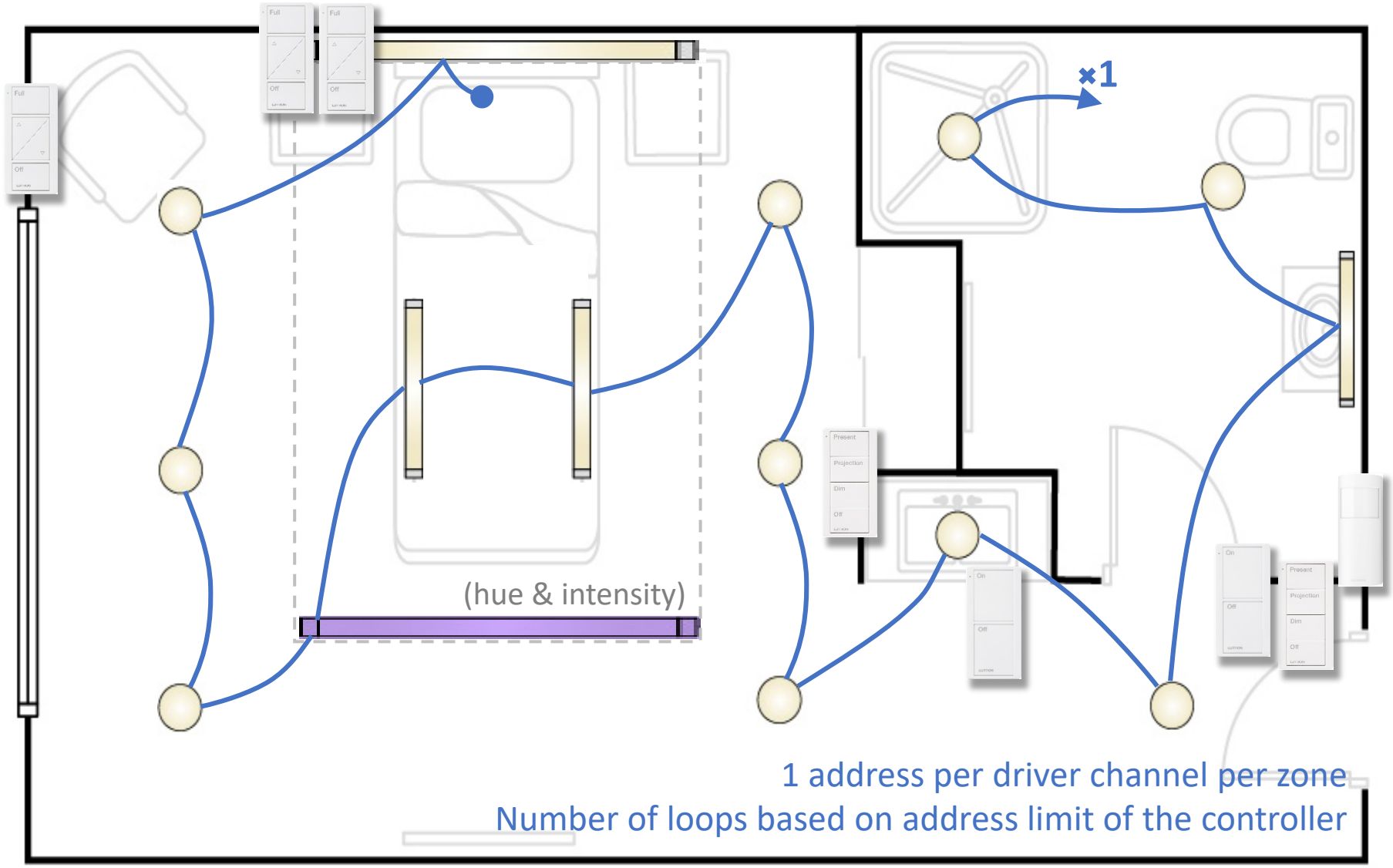
Using 0-10V allows no future re-zoning or the ability to control future driver channels (e.g. new features).



0-10V:

Wire runs: 14

If the controller address limit is met, future re-zoning or the ability to control future driver channels is not possible.

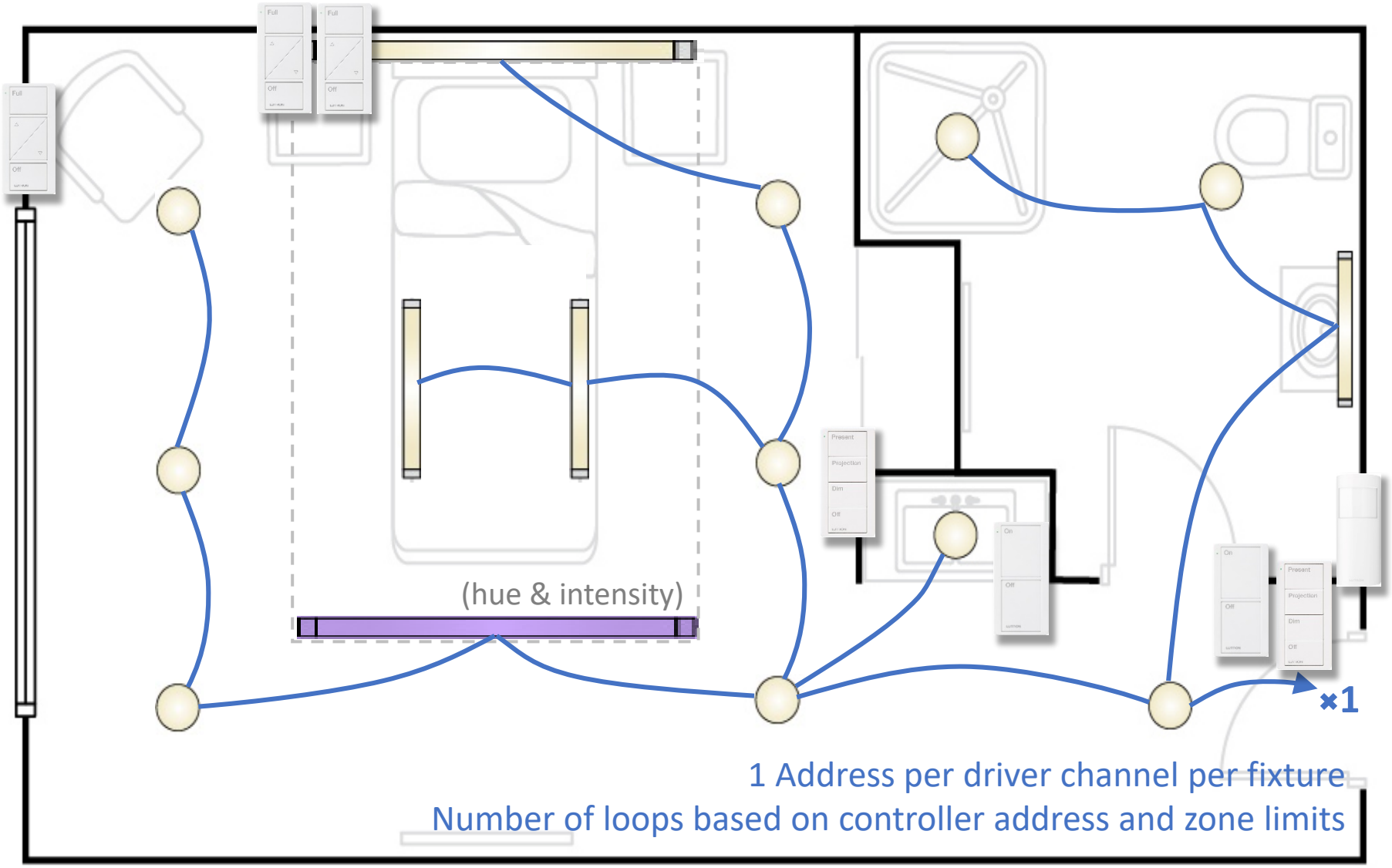


DMX:

Loops: 1

Addresses: 14

If the controller address limit is met, the ability to control future driver channels is not possible.



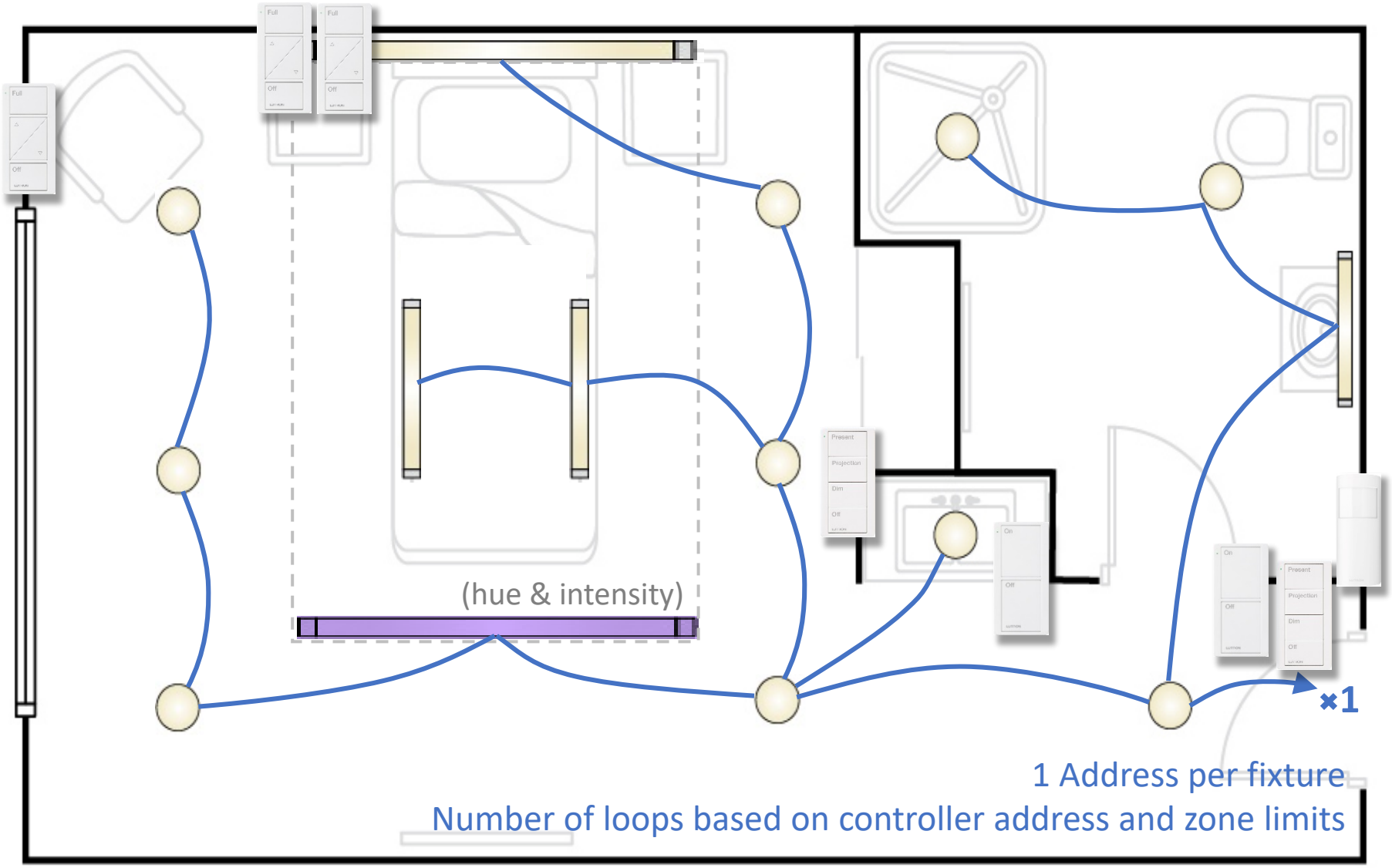
DALI Type 6:

(or other proprietary protocols based on DALI Type 6)

Loops: 1

Addresses: 30

Many manufactures add proprietary commands, which will affect compatibility of custom features.



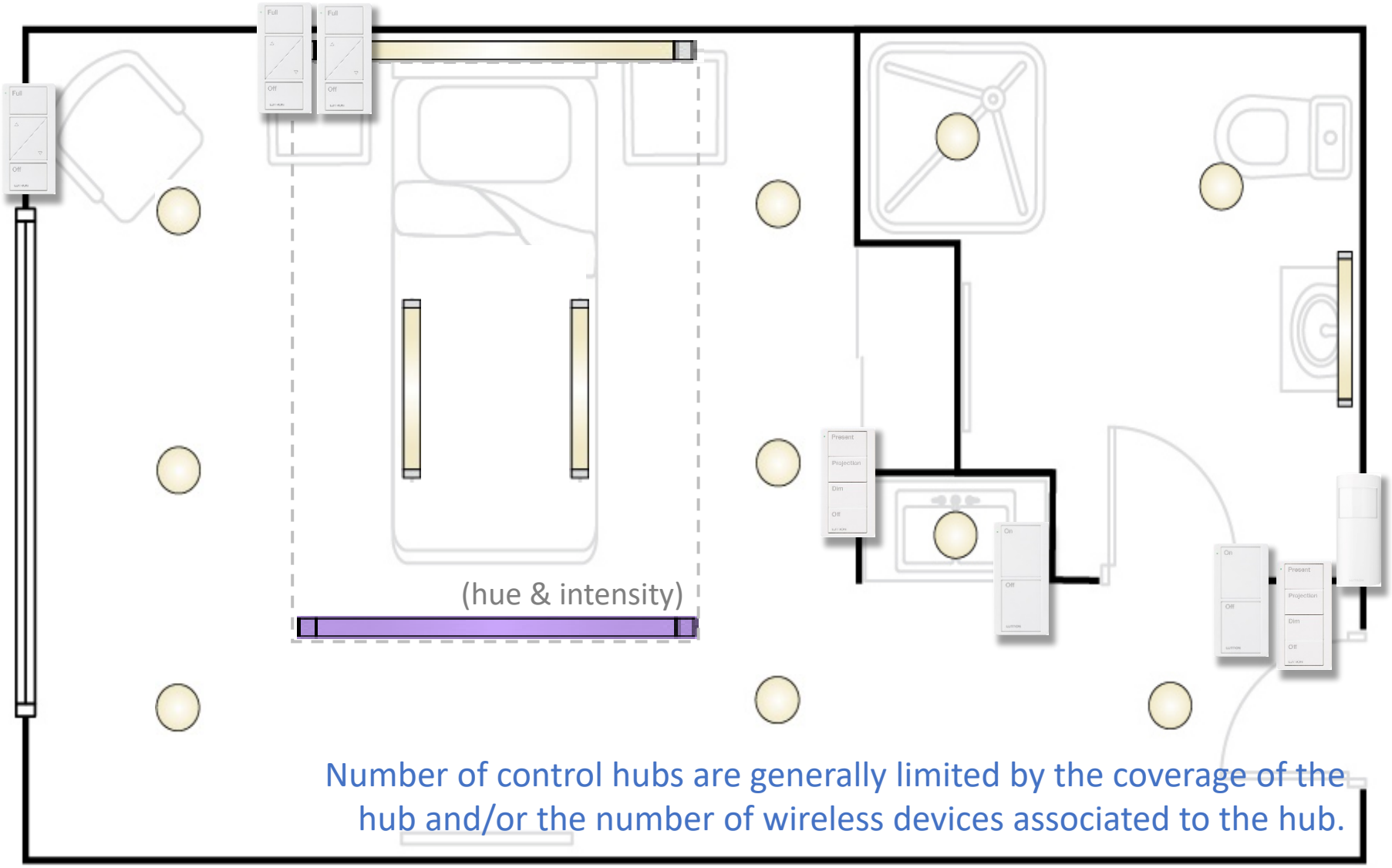
DALI Type 8:

(or other proprietary protocols based on DALI Type 8)

Loops: 1

Addresses: 15

Currently, there are no open protocols for wireless color control, which limits compatibility options.

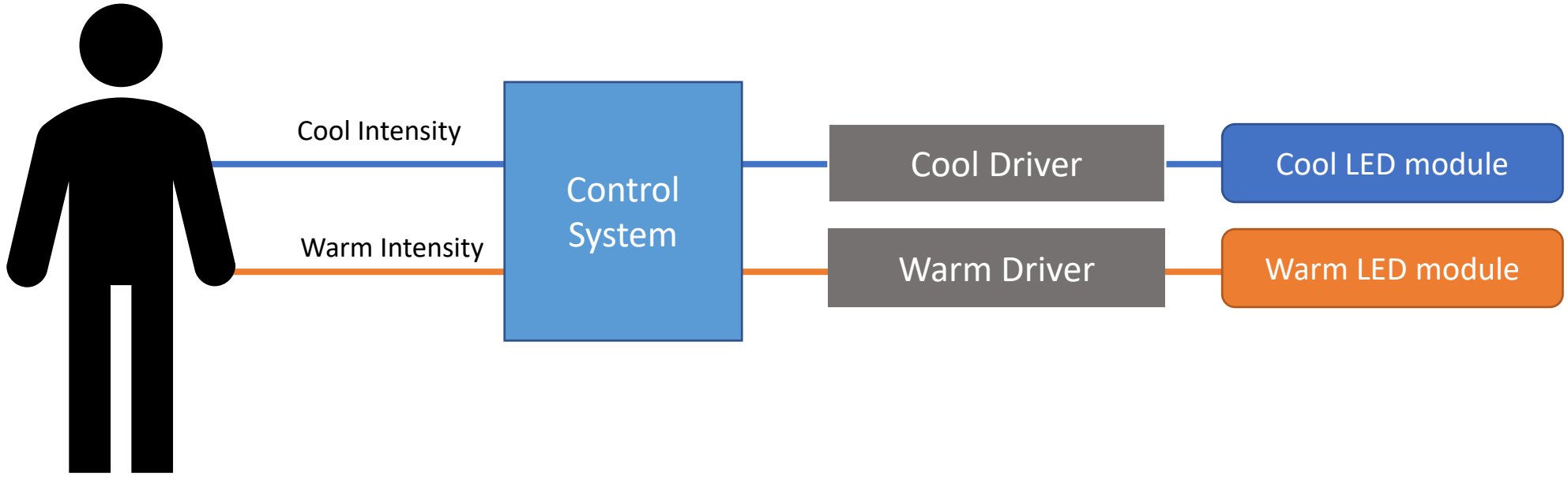


Wireless:

Devices: 23

Number of control hubs are generally limited by the coverage of the hub and/or the number of wireless devices associated to the hub.

Design decisions can greatly affect the system capabilities and cost to install and commission.



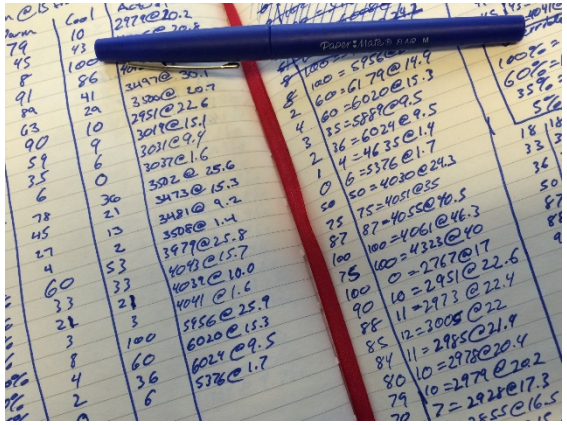
Design decisions can greatly affect the system capabilities and cost to install and commission.

- × User Experience limited to scenes

- × Daylight Dimming is not practical

- × Timeclock control is difficult

- × Setup is custom and time consuming



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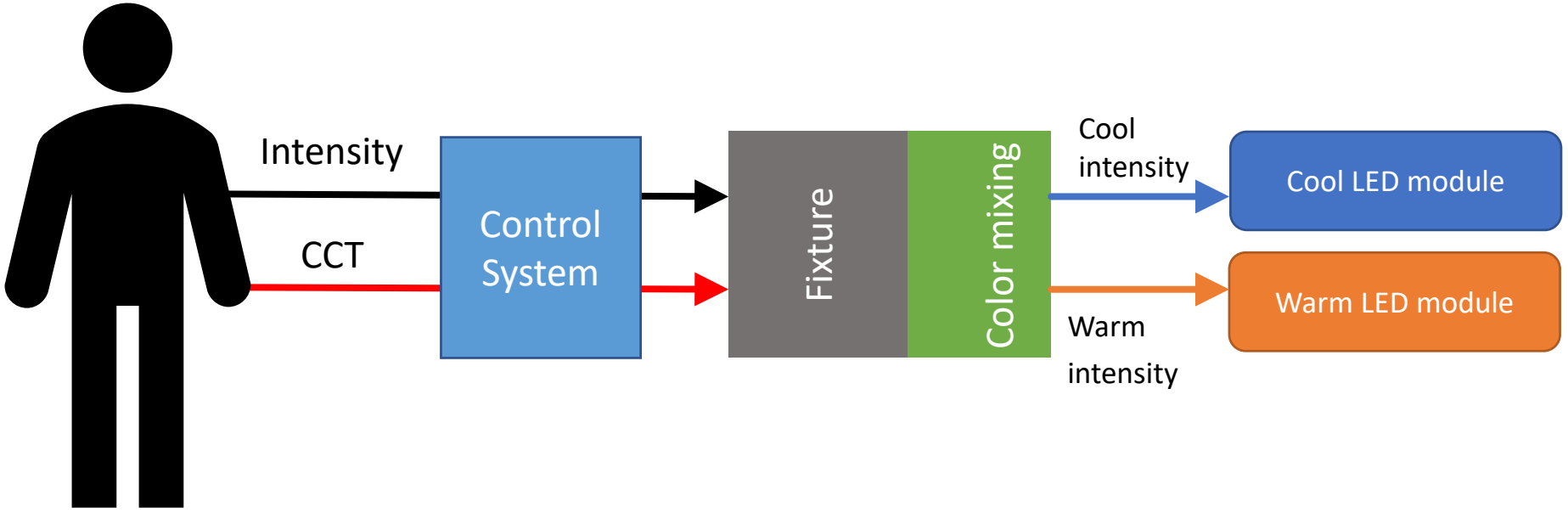


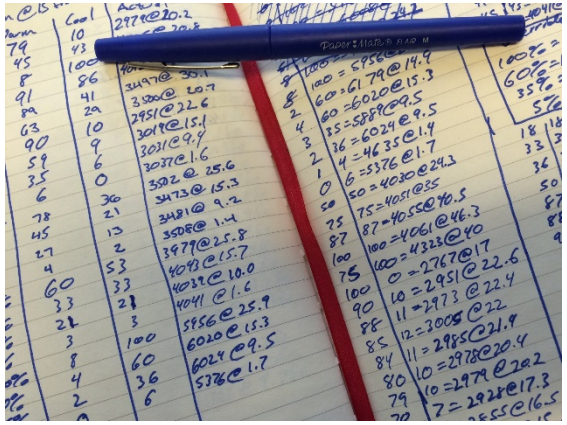
Design decisions can greatly affect the system capabilities and cost to install and commission.

- Independent Control of Intensity/CCT

- Daylight Dimming is easy

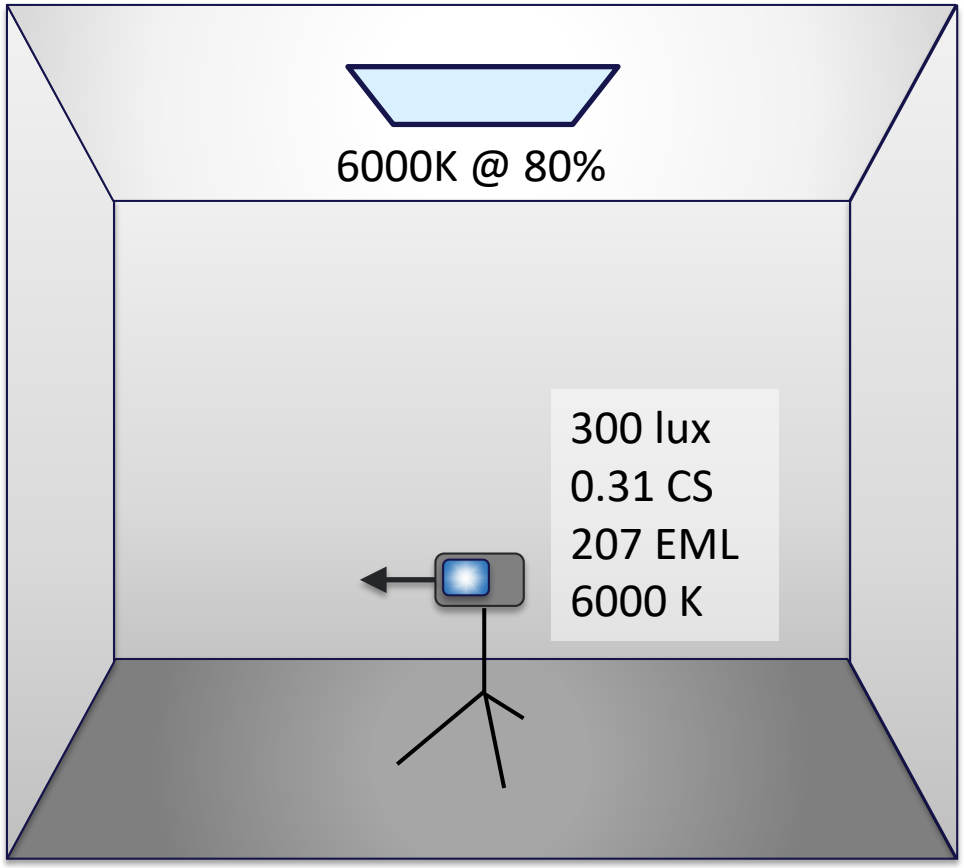
- Timeclock is easy

- Setup time is greatly reduced and allows for greater flexibility

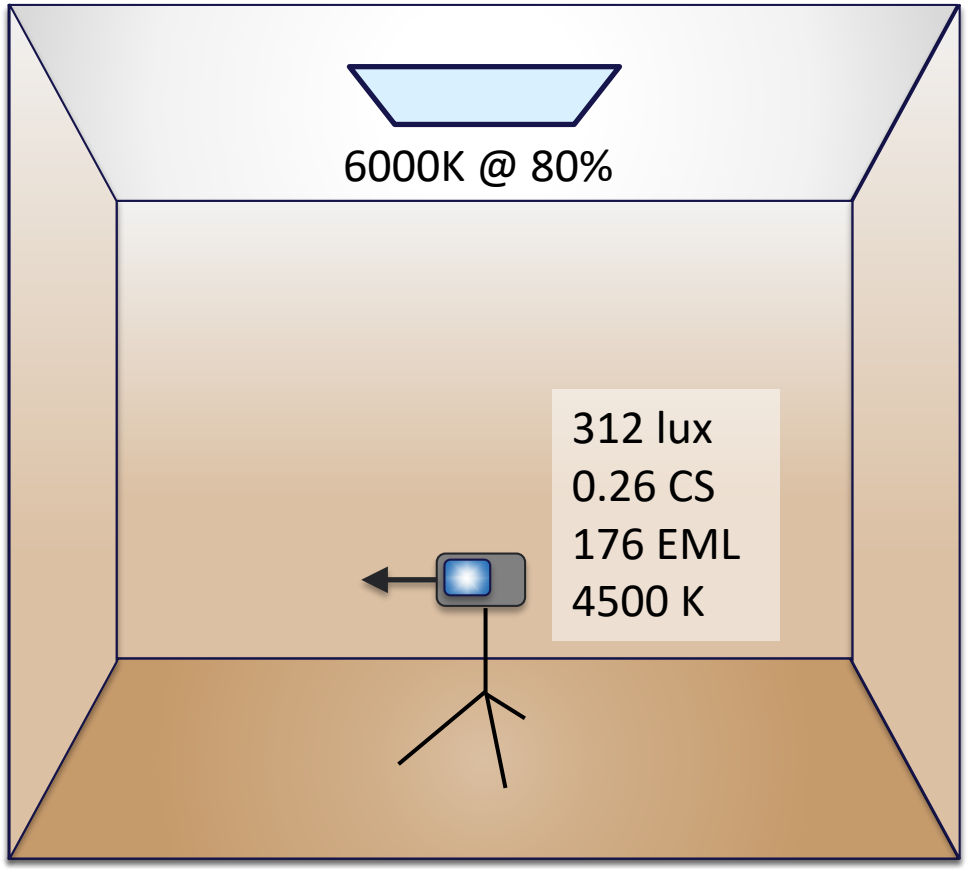


Critical Note: Designers need to hold the specification. It isn't just important to specify this once, it is important to make sure this is what ends up on the job.

How to meet the requirements of a circadian light metric. [e.g. Circadian Stimulus (CS) or Equivalent Melanopic Lux]



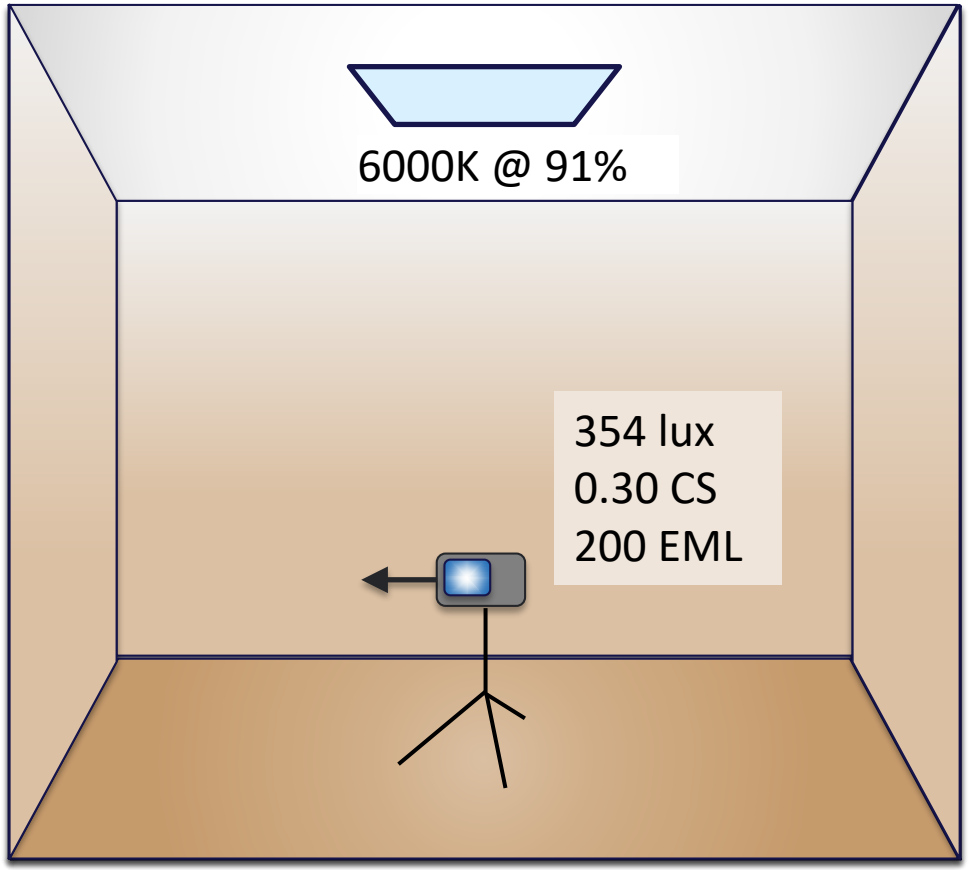
Computed/Simulated Metrics



Measured Metrics

How to meet the requirements of a circadian light metric [e.g. Circadian Stimulus (CS) or Equivalent Melanopic Lux].

1. Calculate/simulate the desired circadian metric in the space based on CCT and intensity settings (give a small intensity buffer)
2. After installation, measure the circadian metrics in the space
3. Keeping the CCT of the light sources constant, modify the intensity until the desired metrics are achieved



Summary of design & setup recommendations

1

Use digital protocols

- Design simplicity
- Future proofing
- Make sure you include enough fixture addresses in control devices

2

Use drivers with intensity and CCT inputs

- Greater flexibility for users
- Easier connection to automation including daylight sensors and timeclocks
- Simpler installation and setup

3

Provide an intensity buffer when designing for circadian metrics

- Objects and paints usually disproportionately reduce blue content (and CCT) from the luminaire to the eye level

Reminder of where to watch out for potential pitfalls

PROGRAMMING	SCHEMATIC DESIGN + DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	INSTALLATION + COMMISSIONING
Consider all stakeholders and use scenarios to define tunable light needs	**Minimize changes to system layouts with digital protocols**	**Understand how protocols effect control wiring and number of addresses needed**	**Use drivers with separate channels that control intensity and CCT**
Don't forget to evaluate and define transitions in and out of scenarios	**Evaluate color accuracy, consistency, and quality at all desired CCTs**	**Include detailed controls narratives**	**Expect CCT to be different at eye level than at luminaire level**

Critical Note: Designers need to hold the specification. It isn't just important to specify this once, it is important to make sure this is what ends up on the job.


Questions?

This concludes The American Institute of Architects
Continuing Education Systems Course

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