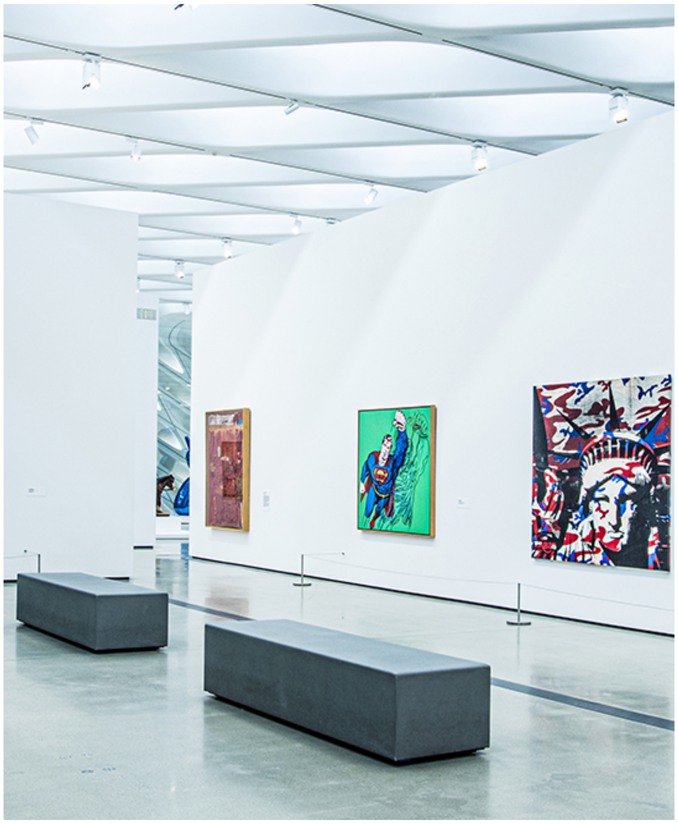
Notes on Wallwashing



Wallwashing involves providing an even layer of light along a wall from the bottom of the finished ceiling to the top of the finished floor. In museum and gallery settings, it assists with:

Adaptation: Providing uniform background illuminance eases transitions between objects that may be lit at different levels, or that may have very different contrast characteristics, assisting with adaptation and limiting eye strain.

Visual Interest: Increasing the light levels along the walls makes them a point of visual interest. In museum and gallery contexts, this helps draw the viewer into a space, and directs attention to the art. It can also help make the space feel brighter, especially in low light conditions required for conservation.

Narrative Continuity: Providing a layer of even illumination along a wall helps create narrative continuity by tying all of the works together aesthetically, rather than spot lighting, which renders each work as a discrete and highly individuated object.

Broad Museum Los Angeles: The Broad Museum has 24' tall walls, with track set at approximately 8' on center. Litelab developed a high output, 12,000 Lumen LED Wallwash fixture that can evenly wash the tall walls, and has a spacing ratio of 1:1.5.

Anatomy of a Wallwash Luminaire

Wallwash fixtures have a unique design specific to their operation. They are specialized fixtures, whose unique architecture has been developed around the parameters of providing even floor-to-ceiling illumination along a verticle plane.

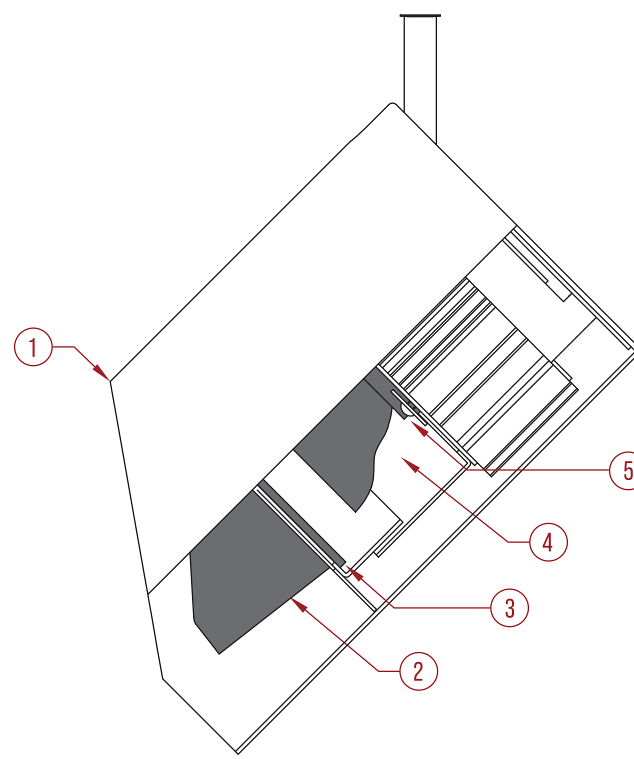
1. **Cut Off:** The cut off allows light reflected off of the kick-reflector (2) to reach the top of the wall.

2. **Kick Reflector:** The kick reflector redirects light towards the top of the wall.

3. **Secondary Optic (Spread Lens):** The secondary optic helps spread light along the wall, and is important in determining the on-center spacing for the wallwash luminaire.

4. **Primary Optic:** The primary optic focuses light from the source (5). It is typically a wide-distribution optic to provide maximum coverage.

5. **Source:** The source provides light and defines both output and CRI (Color Render ing). It also has a CCT (Coordinated Color Temperature), although this can be modulated through the use of gels or lenses, or in some instances, the source may be able to change CCT (as with tunable white or RGBw color tuning fixtures).



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Wallwashing Explained

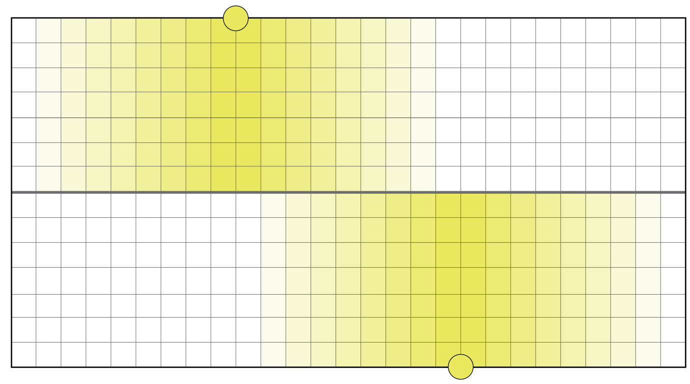
In optics, beam-angles are determined by the point at which light levels reach half of the maximum output (FWHM - Full Width Half Maximum). This concept is equally applicable to wallwashing, and ultimately determines the optimal on-center fixture spacing.

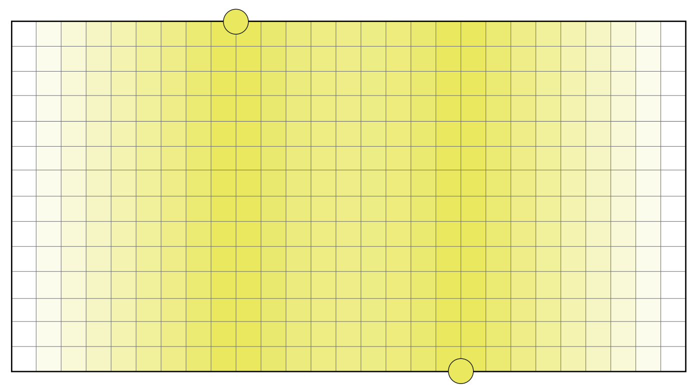
As light spreads out from the center beam, it gradually diminishes. If you were to look at light levels incrementally, you would find that at a certain distance, light had diminished to say 7/8 maximum output. Further from center beam, you would find that it had diminished to 3/4 maximum output, and so on, until there is no measurable light.

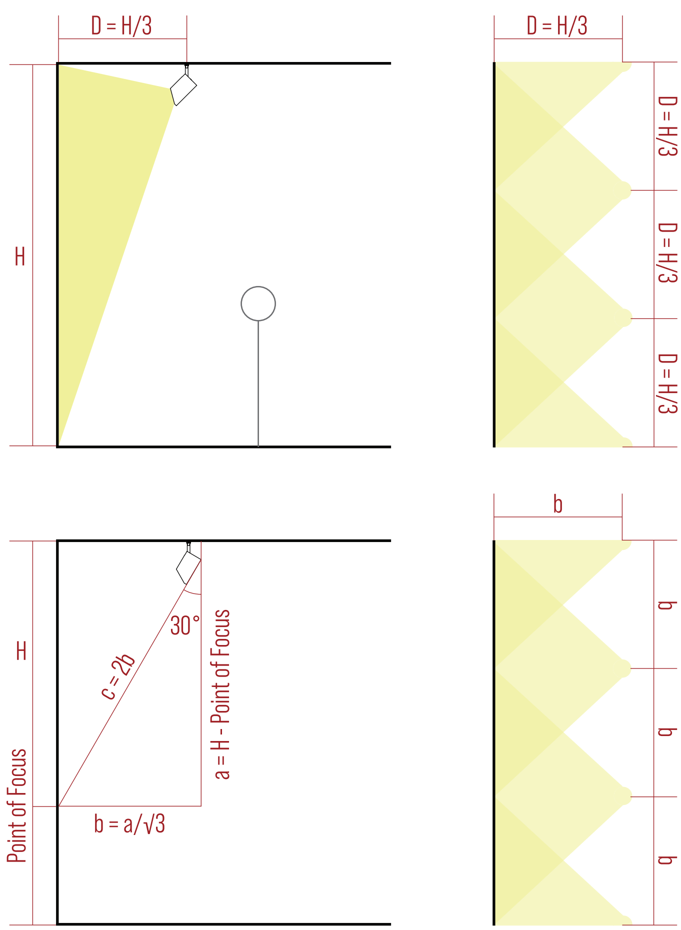
In wallwashing, spacing is determined by the 50% maximum cutoff. Once the distance to the FWHM measurement is determined, that distance is doubled to set the location of the next fixture. By placing fixtures so that they overlap at 50%, light levels across the two fixtures should remain constant. Using the 1/8 interval example above, when the fixtures overlap at 50% output:

87.5%+ 12.5% = 100%, 75%+25% = 100%, 62.5%+37.5% = 100%, 50%+50% = 100%

Illustration: In the illustration to the right, light distribution is taken at 1/8 intervals. The top diagram shows the light distribution of two wallwashers separately. The bottom illustrations shows what happens when they are combined.







Spacing

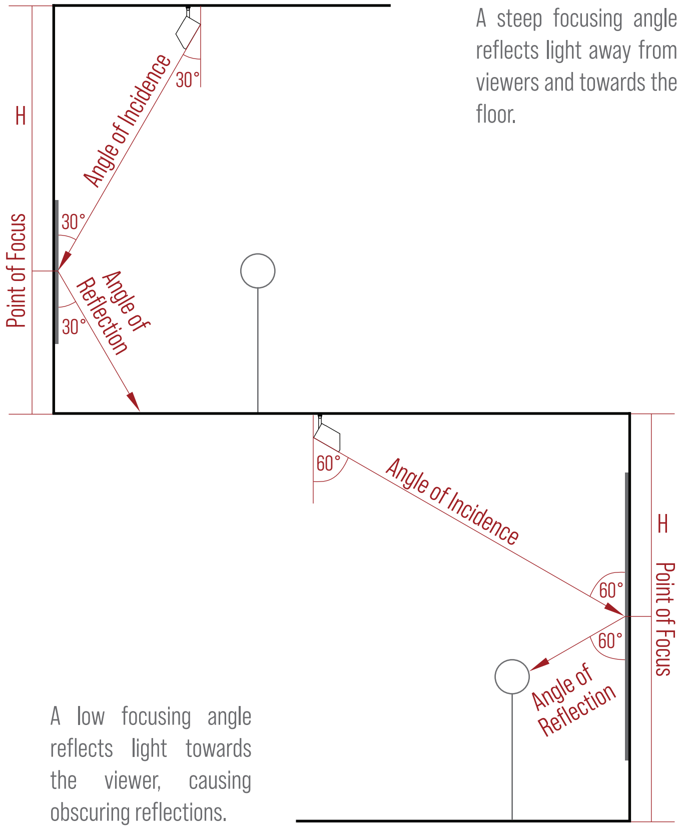
When positioning track and fixtures for wallwashing, the most common method is to use the height of the space as a reference. In 1:1 wallwash spacing, the distance off of the wall is 1/3 the height from finished ceiling to finished floor, or D = H/3. Spacing between fixtures is equal to D (S = D).

Another, somewhat more complex method, would be to start from the desired focusing angle of the fixture. In *Museum Lighting: A Guide for Conservators and Curators* David Saunders recommends a 30° aiming angle from the ceiling normal to prevent glare and reduce shadows. This would create a 30° / 60° / 90° triangle, with the long leg relating to the height, the short leg relating to the distance off of the wall, and the hypotenuse relating to the distance between the fixture and the point of focus.

In a typical wallwashing condition, the point of focus is the center of the objects being illuminated. In a museum context, this is approximately 58" above the finished floor, so the long leg of the triangle would be H (Height of space) - 58". In a 12' (144") space, the long leg of the triangle would be 144" - 58" = 86".

To get the shorter leg (the distance off of the wall), divide by √3. 86" / √3 = 49.65," which is very close to the 48" that would be provided using the first method. Once the distance from the wall is determined, on-center fixture spacing should be equal to the value derived for the distance off of the wall in typical 1:1 spacing conditions.

Reflections



A steep focusing angle reflects light away from viewers and towards the floor.

A low focusing angle reflects light towards the viewer, causing obscuring reflections.

In the section on Spacing, we noted that the maximum focusing angle should be around 30°, and used this principle to establish the location of fixtures off of the wall, which in turn determined the fixture spacing in a 1:1 wallwashing layout. The 30° prescription is premised on reducing reflections that can obscure the object of interest, or create a discomfort glare condition. It is derived from a number of variables, including the typical viewing angle of an individual, the height at which objects are hung, and the principles of reflection.

When a reflective object is being illuminated, it is important to place fixtures such that the reflections are directed away from the viewer. This way, the viewer can see the art, not the reflection. Since in reflection the Angle of Incidence = the Angle of Reflection, if the focusing angle is shallow enough, it is possible for reflections to be directed away from the viewer.

Increasing the Angle of Incidence, for example to get under a protruding frame that is casting shadows (see next section) will increase the angle of reflection. Based on the size and orientation of the object, and position of the lighting and the viewer, this can cause reflections that impact the viewer, either by obscuring the object or causing discomfort, or both. Although, there are some tricks to help reduce the impact of reflections.

The diagram to the left shows the prescribed 30° focusing angle in comparison to a much steeper (60°) focusing angle. You can see how all of the variables described above impact the viewer. As a result, when focusing it is important to assume a range of attributes (viewers between a set of height ranges, for example), instead of premising designs on a single, ideal condition.

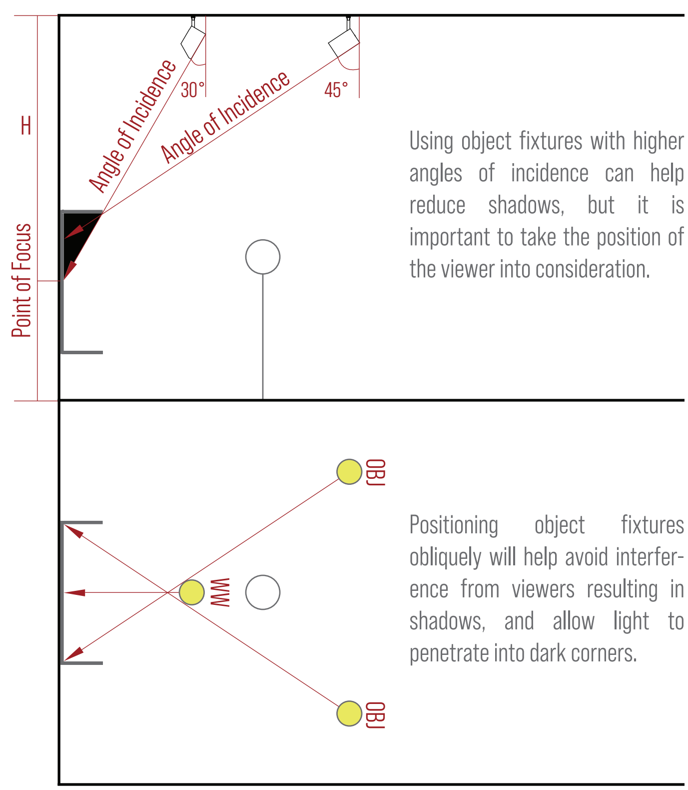
Shadows

Shadows can cast critical aspects of objects into darkness, hiding important content. Like reflections, shadows are related to the position of lighting in relation to that of the object and the viewer, although in very different ways. In fact, reducing shadows can involve taking measures that increase the potential for distracting reflections, so managing both is a bit of a balancing act.

For shadows, the shallower the Angle of Incidence, the longer the shadow that is cast. So, for a work of art has a pronounced decorative frame, a shallow (30°) Angle of Incidence can cast a deep shadow along the top of the artwork. One way to eliminate this type of shadow is to provide light at a steeper angle using object (accent) lights.

When using this strategy to reduce shadows it is important to account for the position of the viewer for two reasons. 1) If the lights are placed behind the viewer, then their shadow will be cast on the art; 2) It is important to ensure that reflections are directed away from the viewer, as per the section on Reflections above.

Note: If you are using a 30° aiming angle, it is possible to calculate the length of the shadow simply by multiplying the depth of the frame by √3, so a 9" frame will produce a 15" shadow. For a 45° aiming angle, the length of the shadow will equal the depth of the frame. This is because the relationships between sides in 45°, 45°, 90° and 30°, 60°, 90° triangles are consistent.



Using object fixtures with higher angles of incidence can help reduce shadows, but it is important to take the position of the viewer into consideration.

Positioning object fixtures obliquely will help avoid interference from viewers resulting in shadows, and allow light to penetrate into dark corners.

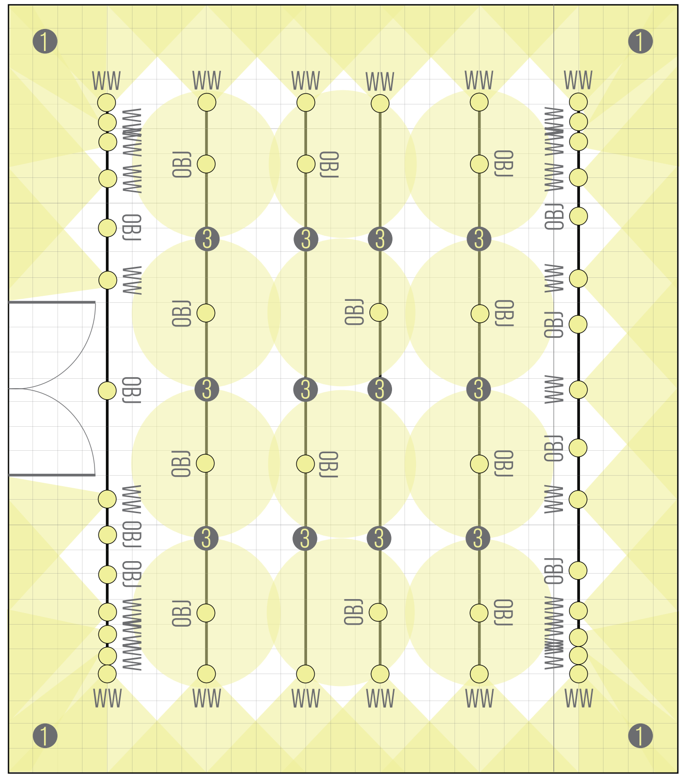
Layout

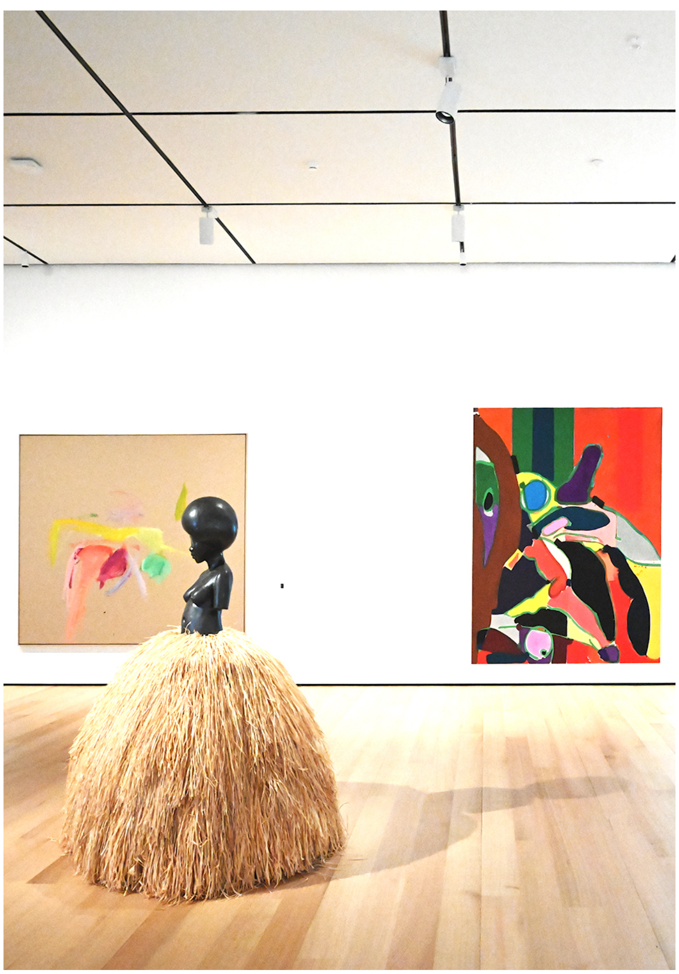
Whatever the lighting infrastructure - downlights, quick-connect canopies, track / BusRun - gallery layout is critical. It will determine the lighting capabilities of the space indefinitely. In many instances, the desire for flexibility preferences systems that are capable of change over time, like track, BusRun and Quick-Connect infrastructures.

Using the principles articulated in the previous sections, it is possible to generate general guidelines for museum / gallery lighting layout. From the Spacing section, it is possible to determine the distance off of any wall required for even wallwashing based on the height of the gallery. From the sections on Reflections and Shadows, it is possible to determine the position of supporting fixtures, like Object or Accent lights, and Framing Projectors.

The goal of Layout is to provide an intelligent infrastructure that speaks to the needs of the institution. This will typically mean ensuring that both wall-mounted and three dimensional artifacts can be illuminated, and may include requirements for emergency and general lighting. Conservation-based illumination values may also play a role in Layout, since they can vary greatly based on media. As a result, the layout may have to address both the needs for illumination, as well as those for differences in illumination levels (this may impact decisions around dimming systems and fixture infrastructure as well).

The simple scheme to the right provides a template for gallery layout. It assumes a gallery height of 12' (144"), with a grid unit of 1' x 1'. This layout does not address egress, but does take into consideration the requirements of general illumination.





Design

General:

Track or BusRun is oriented along the long axis at a distance H/3 from the wall, where H = the height of the space. Additional track/BusRun is set in equal intervals across the center of the space, so that the ends of the track can be used to wallwash the walls in the short axis. The ends are aligned H/3 in the short axis for optimal lighting.

Lighting Notes:

1. Additional wallwash fixtures are used in the corners for even distribution.

2. Avoid placing fixtures in areas where they can create glare conditions, and use Crosshair Baffles or Hexcell Louvers to reduce potential glare from spot fixtures.

3. Use available track space for Object / Accent lights, including Zoom fixtures, Fixed-focus luminaires, Very Narrow Spots and Framing Projectors. These fixtures can be used to accentuate points of visual interest, or to light 3-dimensional objects in the space. Fill light can be provided by wide-angle object luminaires, or other track / BusRun mountable fixtures, like Linear LEDs.

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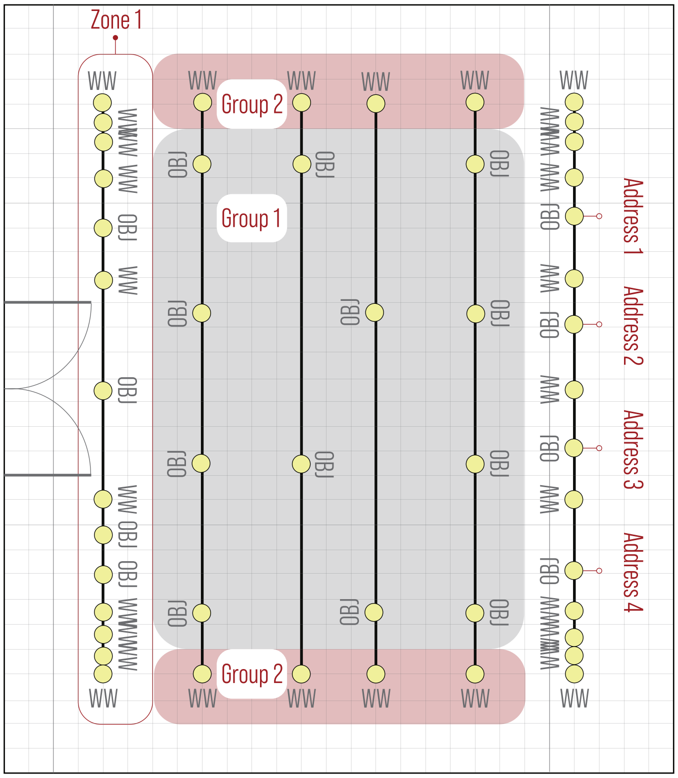
Controls



There are numerous control options available to museums - from analog ELV (Electronic Low Voltage) and 0-10v dimming protocols, to advanced digital protocols, like DMX, Dali and Wireless (BLE). Before deciding on a controls strategy, it is important to engage with all stakeholders (curators, facilities teams, conservators and exhibit designers) to understand the controls narrative and ensure that the system not only fulfills narrative requirements, but also fits user experience.

Choosing the best controls system will be based on considerations of sources (replacement LED, LED, Static or Tunable white), context (new build or retrofit), the level of control desired, usability, cost, longevity and securiy. The choice of controls protocol will determine the system topology:

Daisy Chain:	Data passes through nodes (goes fixture-to-fixture) until it reaches the correct address
Bus:	Data is transmitted along a circuit until it reaches the correct branch
Star:	Data is received and transmitted from/to hubs to luminaires; the loss of a hub means the loss of communication to downstream devices
Tree:	Data is transmitted along a circuit until it reaches the correct branch, from where it can be re-routed to addional branches and nodes
Ring:	Data passes through nodes (similar to Daisy Chain)in a circular circuit
Mesh:	Every node acts as a hub transmitting and receiving data to/from all other hubs within range

Every topology provides a certain type of control, with both benefits and limitations based on how data is transmitted and received between devices.

For a more extensive analysis of controls, visit:
https://litelab.com/blog/the-digital-controls-conundrum-2

Regardless of the controls system that you adopt, it is important to consider that the system is a network of devices, provided by different manufacturers, and supported by separate entitites. This means careful consideration of the resourses required. For example, if you are using an advanced wireless system to collect data related to lux/hour exposure, then you will also have to consider where that data is being stored, and how it will be accessed and parsed, which might require additional technological infrastructure.

Similarly, with newer technologies, long term software and hardware compatibility is important, especially as devices are upgraded periodically via cloud-based applications. This can effect communication between a wireless control system and fixture drivers. These aspects of the network of devices that contribute to the overall lighting environment should be carefully reviewed with system commissioners and manufacturers, so that institutions understand the level of service that they can expect from different stakeholders, as well as the total system requirements and capabilities.

Lastly, it is important to consider obsolescence as a function of institutional requirements, not of technological development. The rate of change for LEDs is conditioned by the timelines of the technology sector, with new developments occuring almost biannually. However, not all (or possibly any) of the new features promised will add to the narrative and design requirements of a project.

Network