

# Layout presentation through general lighting

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**Bob #1** February 14, 2016, 10:33pm

It seems time to start a discussion about general layout lighting—not the small lights we put in buildings, but the big lights we use to generally illuminate the layout for daylight operation.

David plans to use a standard lighting valence on the new A&O to shield the viewer's eyes from the glare of bulbs of various types and create a museum diorama appearance. But what types of lights should be used, and how to can they installed to best ***present the layout?***

Today David bolted some temporary lighting valence boards to the "T's" under the garage. After turning out the rest of the lights the test area of the layout was alive! It was far more exciting than under the work lights erected for the construction crew. When do we start operating? 😊 As it turns out, a lot of thought and work went towards getting to this point.

For starters and to get readers up to speed, a lot of good background material is reflected in the following 2004 Youtube clinic videos of architect Boone Morrison. That said, some of David's A&O thinking is different, but I personally found watching these videos to be very helpful. There are five of them:

[Link to first of five](#)

[Link to second of five](#)

[Link to third of five](#)

[Link to fourth of five](#)

Note: The original links were removed from YouTube. The first 4 parts can still be found but the fifth is now missing.

After viewing these vids or skipping them, advance to the next post.

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**Bob #2** February 14, 2016, 10:33pm

Welcome back.

Now getting a lot more basic,

1. How can I get good looking light on the layout?

2. How can I get enough light on the equipment so that an op session goes smoothly?
3. How can I avoid heating the room so much that it smells like a gymnasium after an op session?

Is there hope for efficient lighting, or are we all destined to look like zombies under cheap and poor CFL bulbs after dark? The optimal answer may change over time. Today there appears to be at least one more efficient light solution. As a **spoiler**, that would be a mix of a specific T8 fluorescent lamp with halogen floods to partially overcome the fluorescent shortcomings.

Let's rewind a while and examine some of the important parameters of different lights.

1. Color temperature
2. Color rendering index or CRI
3. Efficiency, or lumens per watt
4. Beam pattern (does it cast sunlight shadows or simulate a rainy day?)
5. Beam pattern, putting light where you need it on the layout instead of where you don't in the aisles
6. Ability to turn on instantly
7. Ability to dim waaaaaaaay down
8. Cost of fixture and ballast
9. Suitability for photography

## COLOR TEMPERATURE

On better energy efficient lamps you can find a number expressed something like 4100K. The key is the number (x for a digit) XXXXK. The K stands for degrees Kelvin, and it describes something fundamental about the general color of the light emitted by the bulb.

Some guidance:

- 2000K to 2200K—Inside the firebox on a Rio Grande K36
- 2600K—Similar to a 60 watt tungsten bulb
- 2800K—Similar to a 100 watt tungsten bulb or a 50 watt MR16 halogen bulb
- 3000K—The old and delicate camera studio tungsten bulbs that last just a few hours and instantly broke when bumped, also the “kitchen and bathroom” fluorescent lamp color temperature

- 4100K—Standard cool white fluorescent
- 5000K—Mix of sun and clear blue sky, also the most common daylight fluorescent color.
- 6500K—Color of daylight in shade with a clear sky with high humidity.

It used to be said that photography requires 5000K lights. That was true in the days of color slide film, but a better digital camera can be set to a custom white balance to produce good photos under almost any color temperature.

On many layouts we need to mix two or more kinds of lights. For example, it may be difficult to wrap a 4 foot long T8 fluorescent around a 90 degree bend. So one of the first things we need to do is match the color temperature of different bulbs. Otherwise, we may produce pools of orange light in a sea of blue-green.

On a sunny day, light outdoors is not a uniform color. Direct sunlight is normally a bit yellower than light in the shade when there is some blue in the sky. So we can mix slightly yellower fill lights if they produce a noticeable shadow.

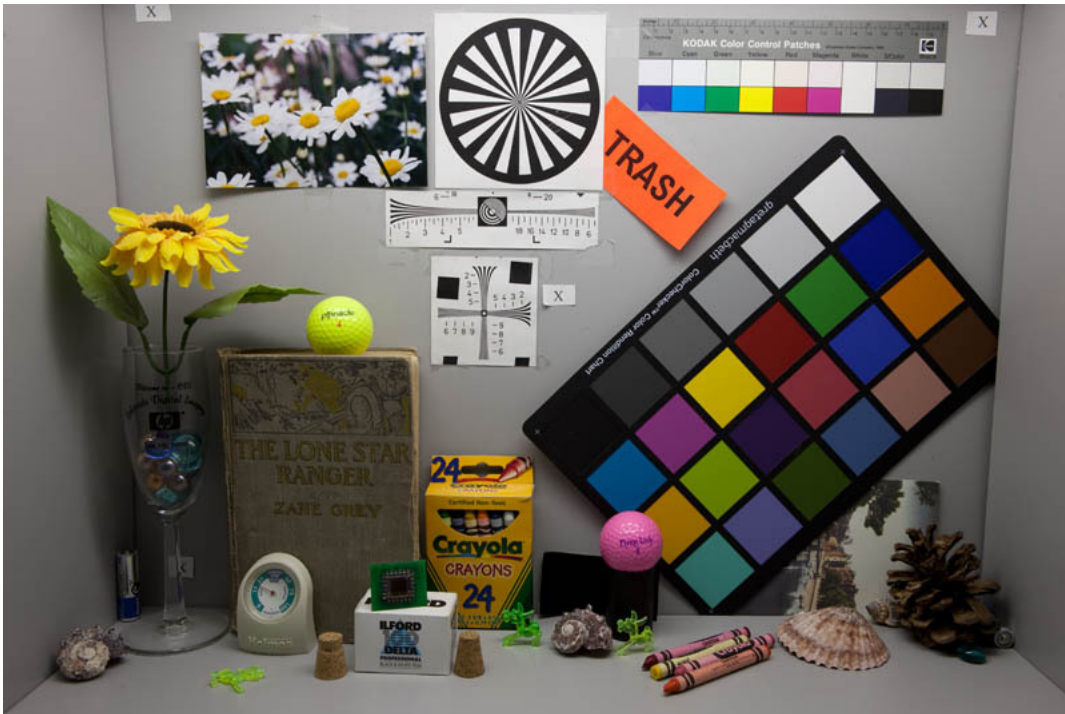
### **COLOR RENDERING INDEX**

This number, which ranges between 0 and 100, gives us an idea of how accurate colors will appear when viewed under that light, relative to their appearance in full sunlight. Most tungsten bulbs have a CRI close to 100. The best fluorescent lamps can have a CRI in the mid 90's. Most of the CFLs available at the home store are so poor the CRI is not printed on the package. Generally speaking, when the CRI is less than 90 or so, many colors look dull and muted, particularly reds and oranges.

Guidance:

1. 100—perfect
2. 95—excellent
3. 85—some colors starting to look dull
4. 75—many colors looking sterile
5. 65—faces look ashen, like a zombie
6. no CRI listed—stay away!

Here are two previously-posted photos that show how colors change appearance under lights with different CRIs.



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**Bob** #3 February 14, 2016, 10:33pm

### EFFICIENCY

The tungsten bulbs we typically use in our homes are not very efficient. That is why many types of tungsten bulbs are being outlawed in the US and the EU. Some fluorescent lamps emit 6 or more times the light per watt compared to an equivalent tungsten bulb. So if we are lighting a large basement layout, incorporating fluorescent lights can greatly reduce both heat load and energy consumption.

## **BEAM PATTERN**

What kind of day do you want to recreate? Sunny with crisp shadows that make details pop, or a dreary, rainy day? A sunny day is easy to recreate with MR16 halogen flood lights, but darned near impossible with 4 foot long fluorescent bulbs. With careful selection, the two can be mixed to create distinct shadows.

How does the brightness of light change from the front to rear of the layout? From a point source such as a halogen bulb, brightness diminishes according to one divided by the square of the distance. An object twice as far only receives one fourth the light. However, for a line source, such as end-to-end 4 foot fluorescent bulbs, brightness diminishes by one divided by the distance. So a line source will get more light into the far recesses of deep scenes.

## **DIMMING**

Dimming a fluorescent lamp is an exercise in futility. There are some bulbs, ballasts and dimmers that can be dimmed, but not over the wide range of a tungsten bulb. For those who want to model sunrise and sunset, with a smooth change in light level in between, tungsten is the only solution. For the rest of us, night falls very abruptly!

## **COST OF FIXTURE AND BALLAST**

The days of cheap T12 fluorescent shop fixtures with magnetic ballasts are numbered. For efficiency the world is switching to T8 instant start bulbs with electronic ballasts. Right now electronic ballast fixtures seem to sell at a premium. However, there is no hum or flicker.

Shooting video under the old magnetic ballasts produced a slow cyclic shift in color temperature between yellow and blue-green. Electronic ballasts work at high frequencies and do not produce this problem.

## **SUITABILITY FOR PHOTOGRAPHY**

The human eye and brain have an amazing ability to dismiss local color shifts produced by lights of different color temperatures. However, the camera does not. Lights must be closely matched for good photos.

As stated previously, there is no longer a need to restrict lights to 5000K for good photos. Although most asian-designed cameras produce orange photos under tungsten lights, the better cameras can be set-up with a custom white balance. This adjustment involves a way to let the camera estimate illuminant color by shooting a white piece of paper.

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**Bob** #4 February 14, 2016, 10:33pm

So... what about on the A&O?

After studying manufacturer's data, measuring bulbs with a \$20,000 lab spectroradiometer, and photographic testing, one solution seemed to pop-out:

- Philips F32T8/930 4-foot linear fluorescent lamps for general lighting, mounted end-to-end behind a valence.
- Track light cans with 40-60 watt incandescent bulbs for corner illumination.
- 12 volt MR16 halogen flood lights spaced 4-8 feet apart, aimed almost parallel to the rails to cast a grazing, simulated sunlight shadow and give pop to details.

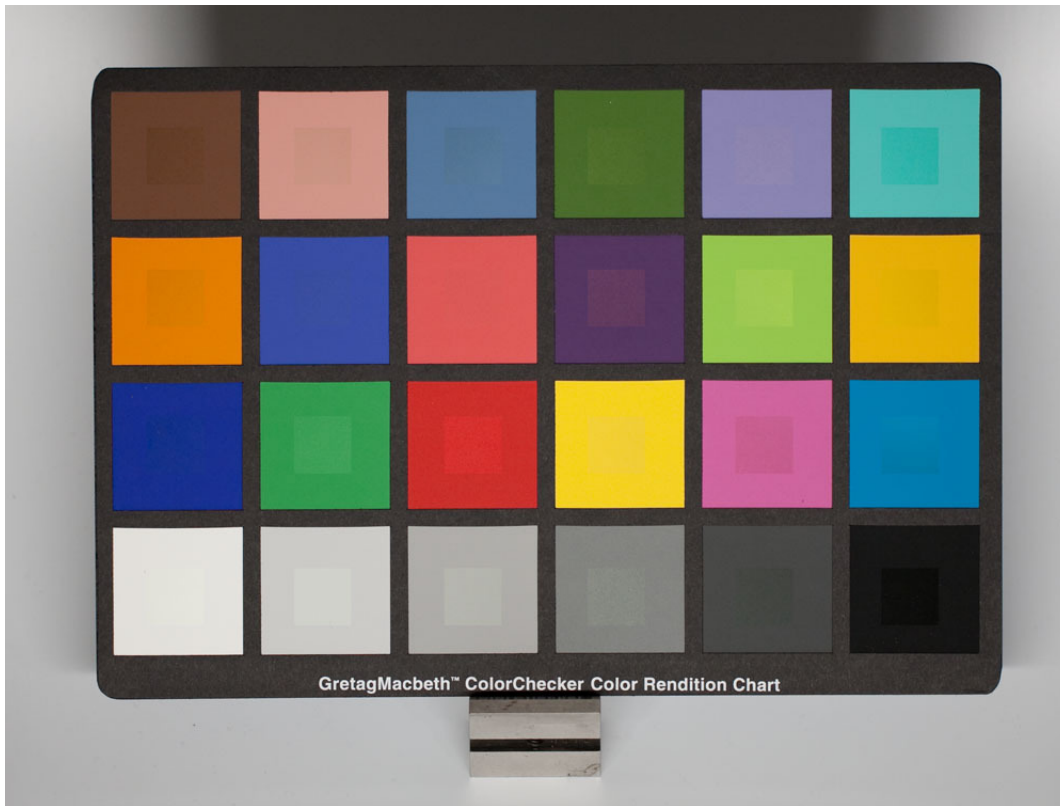
This particular Philips bulb has a color temperature of 3000K, slightly bluer than tungsten bulbs at 2600K-2800K and almost the same as a halogen. But it also has a CRI of 95. Getting this high of a CRI means that the bulb produces less light and costs more than bulbs from the home store, about \$5 each.

A note on halogen bulbs. The cheapest import MR16 lamps seem to have a greenish cast to them. I prefer GE bulbs and buy them when bulk packages go on sale. You probably want the widest flood beam pattern.

We can mix and match this fluorescent bulb with tungsten lamps. Here is Macbeth color checker photographed under a 50 watt MR16 halogen, then the F32T8/930. The two appear almost identical, despite using identical color settings for both.



Now let's compare the two together. I digitally cut out small squares from the halogen photo and placed them on top of the fluorescent photo.



Most of the overlaid squares are barely visible, indicating an excellent color match between the two lights.

It appears that we have found a combination of lights that can be readily mixed together without lifeless color and without jarring changes in overall color balance. Models photograph beautifully under either light.

So... if you want to experiment with this combination, where do you find the Philips bulbs? In Colorado I was never able to find a local source that would let me buy just one. I had to order a case of 25 from an online retailer. But after finding detailed color information from the Philips web site, I was fairly confident that this lamp would perform well. And I was willing to have a lifetime supply of shop light bulbs if they did not work to the satisfaction of the Grandi Capi (big boss.)

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**Bob** #5 February 14, 2016, 10:34pm

### **Sunny Day vs. Cloudy Day**

Here is an old NMRA heritage box car photographed under a halogen spot light that reasonably well simulates shadows on a sunny day.





Notice how the light, which was carefully angled to the side, makes details pop. To simulate a cloudy day, use a diffused light source. This is the same box car illuminated by a pair of photographic compact fluorescent lights in large diffused light banks (Lowel Ego lights.)



On the A&O 2.0 we hope to use occasional halogen spot lights to add pop and shadows to the 4 foot T8 fluorescent bulbs. Where the spot lights are widely spaced, we may install a metal tin can "cookie" over the spots to create more of a sun/cloud shadow pattern.

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**Bob** #6 February 14, 2016, 10:34pm

Today the first lighting valences went up on the layout. Most of our work session was spent planning and testing.

Campbell's soup, on the top level behind Rick (left), gets the first valence. This one hides a single 4 foot F32T8/TL930 fluorescent lamp. The valence gives a nice shadowbox effect and the character of the layout will quickly change from here out.



Rick complained that he could see the fluorescent tube.



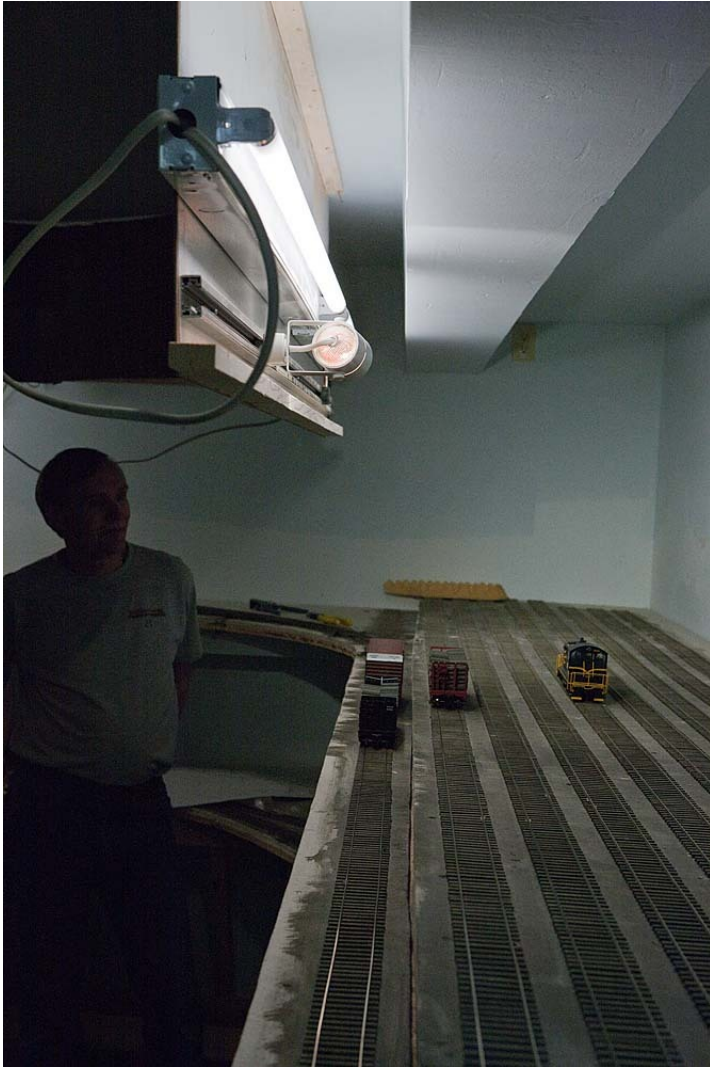
Rick and David work on an 8 foot valence for the 16th Street hump yard. This one includes a track light strip along the bottom for widely-spaced halogen floods that create a crisper shadow and simulate the addition of the sun. Even still, most of the light will come from the 3000K fluorescents.



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**Bob** #7 February 14, 2016, 10:34pm

The 8 foot valence is installed, with a single halogen flood on the track. Another will be needed at the far end. Note that since this photo was made and posted, we moved the fluorescent tube to the bottom and the halogen track to the top. that way, it will be a lot harder to be blinded by the halogen.



Light stays nicely on the staging yard with little spilled into the aisle. The camera does not readily see the small color mismatch between a tungsten halogen lamp and the high-CRI fluorescent bulb.



By generating some mild shadows with the halogen “sun” lamp, and getting some shallow-angle light on the near side of the equipment, details pop. Unweathered and patched equipment will not be normal on the A&O 2.0. These are just lighting test stand-ins.

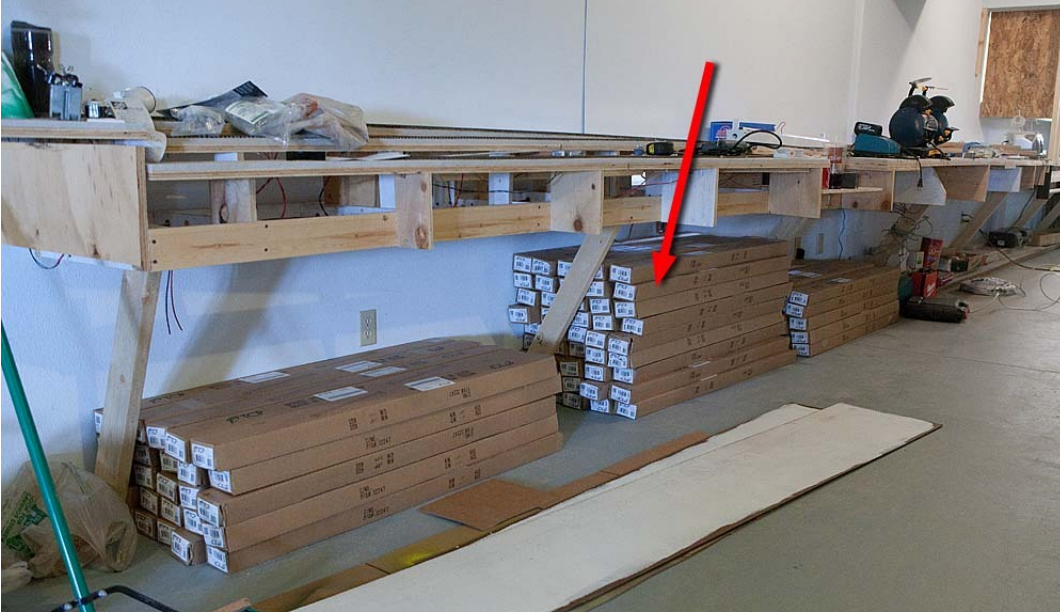


When ballast is in the brightness value of the tracks will drop and equipment will stand-out. The cardboard at the back lowers the brightness value of the back wall in anticipation of a backdrop.

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**Bob** #8 February 14, 2016, 10:34pm

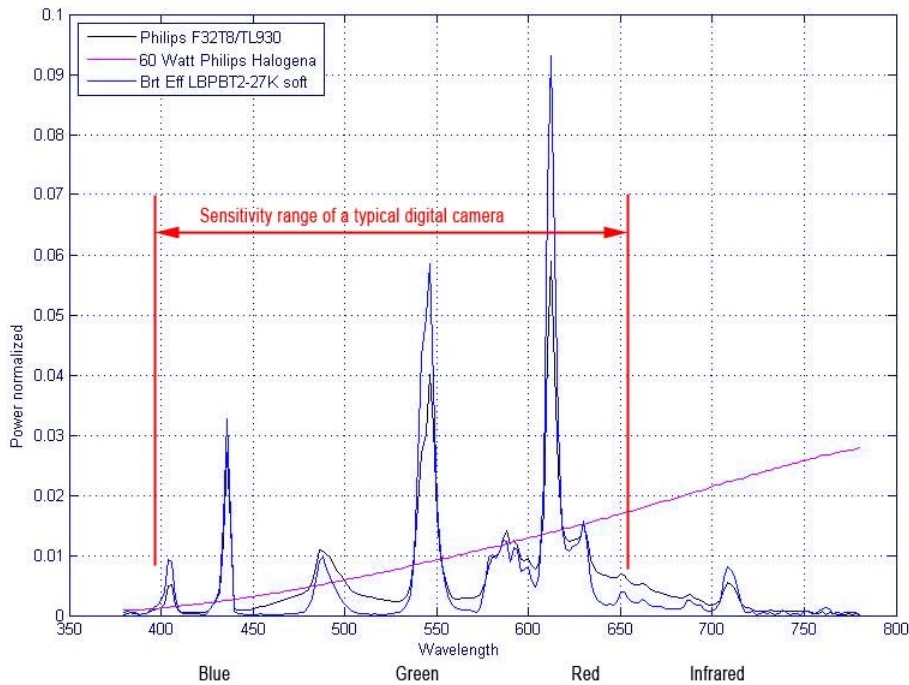
So... that's 3 fluorescent fixtures down and a great big pile more to go! 😬 Time to order a few more cases of bulbs.



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**Bob** #9 February 14, 2016, 10:34pm

Getting back to the science behind the lighting design, here are normalized spectral power distributions for a halogen lamp (magenta line), the Philips bulb (black line) and a “tungsten color” spiral compact fluorescent lamp. (Note that there are no *good* tungsten-color compact fluorescent lamps that I could find.)



The main thing to notice is how the compact fluorescent bulb emits almost no light in huge portions of the visible light spectrum. By comparison the Philips bulb with a CRI or color rendering index of 95 (100 being perfect) tries to fill-in the valleys and smooth the big peaks. Neither is a perfect match to a real halogen bulb but the Philips F32T8/TL930 is a far better approximation.

A really good compact fluorescent lamp should be feasible with a tungsten-equivalent color, but a commercial offering would be highly unlikely due to the consumer desire for cheap at all costs and governmental mononumerosis for efficiency above all else. The phosphor mix in the Philips bulb is both more costly and less efficient than the mix in a fluorescent lamp that makes one's face look as though last night something happened that turned you into a "zombie."

If anyone is curious, these emission spectra were measured using an insanely-expensive Photo Research PR-705 Spectroradiometer that samples every 2 nanometers.

A second thing to note is that, by locating 4 foot fluorescent lights almost end-to-end, we get a continuous line source of light. Brightness of light falls off linearly with distance when we use a line source. On the other hand, light falls off according to the square of the distance from a point light source. Using a line of fluorescent lamps gives us a more uniform light on the layout in both close and deep areas.

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**Bob** #10 February 14, 2016, 10:34pm

A significant amount of lighting valence went up this weekend. In this photo, we see new fixtures over the right-side Havens Yard, but the fixture at the end of the aisle is not yet powered and so creates a dark spot. Also the right frontmost fixture is not yet powered. The seeming instrument of torture on the bottom of the rightmost valence is a collection of clamps generously donated by Jackson and in use to glue a stiffening board to the bottom of the fascia front. There will also be Masonite bottom shield strips attached horizontally on the valences, each custom-cut to hide lights from operator positions and limit light spillage on the to-be-carpeted aisle.



On the left side of the aisle there are several MR16 halogen spots aimed towards the viewer to wash the sides of cars with light and make details pop. Yet the lights cannot be seen from this position, and after the Masonite shields they won't be visible except when leaning far into the scene. Nor do they reveal their presence with a shocking change in color, as the high CRI fluorescent bulbs have been matched in color.

Here is the view from the far end of the aisle, standing by the Millport Rescue Mission. This is an amazing transformation from a layout illuminated from a few crude shop lights in the aisle producing a "K-Mart blue light special effect" to diorama lighting over the layout that directs the viewer's eye to the trains. The skew of the vertical supports is from wide angle lens perspective effects caused by aiming the camera a little bit downward. Plastic sheets drape over previously-installed control panels for protection.





The underside of pre-stressed concrete “T” beams creates a few obstructions in the under-garage ceiling. Here the valence starts out under the base of a “T” then jogs out into the aisle to generally follow the edge of benchwork.

It will be fun to observe the area’s further transformation once David paints the fascia and ceiling above the aisle a very dark green. Also the blank blue walls will be full of backdrop buildings, and the yards ballasted in black. Both will “eat” light, so that the brighter-painted rolling stock becomes the stars of the stage, to borrow a bit from the late Frank Ellison. Light leaks on the newly-installed valence will also be sealed.

Curiously it appears that when the track to valence distance is short, relatively few MR16 halogen floods are needed to give punch to equipment details as long as they simulate early morning or late afternoon light (i.e, are aimed nearly horizontally down the track.) We might go with about an 8 foot spacing between halogens. 35 watt MR16 halogens spaced every 4 feet would double the electrical load. Spacing 50 watt lamps 8 feet apart adds 70% to the electrical load. 35 watt MR16s would add only 50% to the load.

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**Craig** #11 February 14, 2016, 10:34pm

Looking good guys. Sorry we couldn’t be there to help out this past weekend, but I must say we had a GREAT time working on those SAC Bombers 😊 Even got to crawl around in a RAF Vulcan 😊

Looks like you guys did a lot of work on the area. Can't wait to see it in person.

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**Rex\_Beistle** #12 February 14, 2016, 10:34pm

The valance and lighting are really bringing the A&O to life. My compliments to the typical work of the A&O thinkers and planners & doers too!

I will be watching, I fully expect to read about Bob closing the loop between rolling cars & retarders.

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**Frolin** #13 June 28, 2016, 12:12am

Videos - where'd they go ?

...YouTube says not available.

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**Bob** #14 June 28, 2016, 12:28pm

The videos were unfortunately taken down several years ago. Sorry.

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**Bob** #15 July 25, 2016, 3:33pm

Here are updated links to Boone Morrison's clinic videos. The URLs changed but I found them again on Youtube.

**Part 1**

**Part 2**

**Part 3**

**Part 4**

**Part 5**