Welcome To The Wyoming Division Historical Society

Modeling the Union Pacific from Cheyenne, Wyoming to Ogden, Utah.

Model Railroad Photography
Depth of Field Considerations and Solutions
and
Sky Replacement in Digital Photo Processing

Depth of field (DOF) became a problem in photographing the Wyoming Division layout after we started putting down scenery on the nine exceptionally long benches that generally have two levels. Here is the as built track plan of the

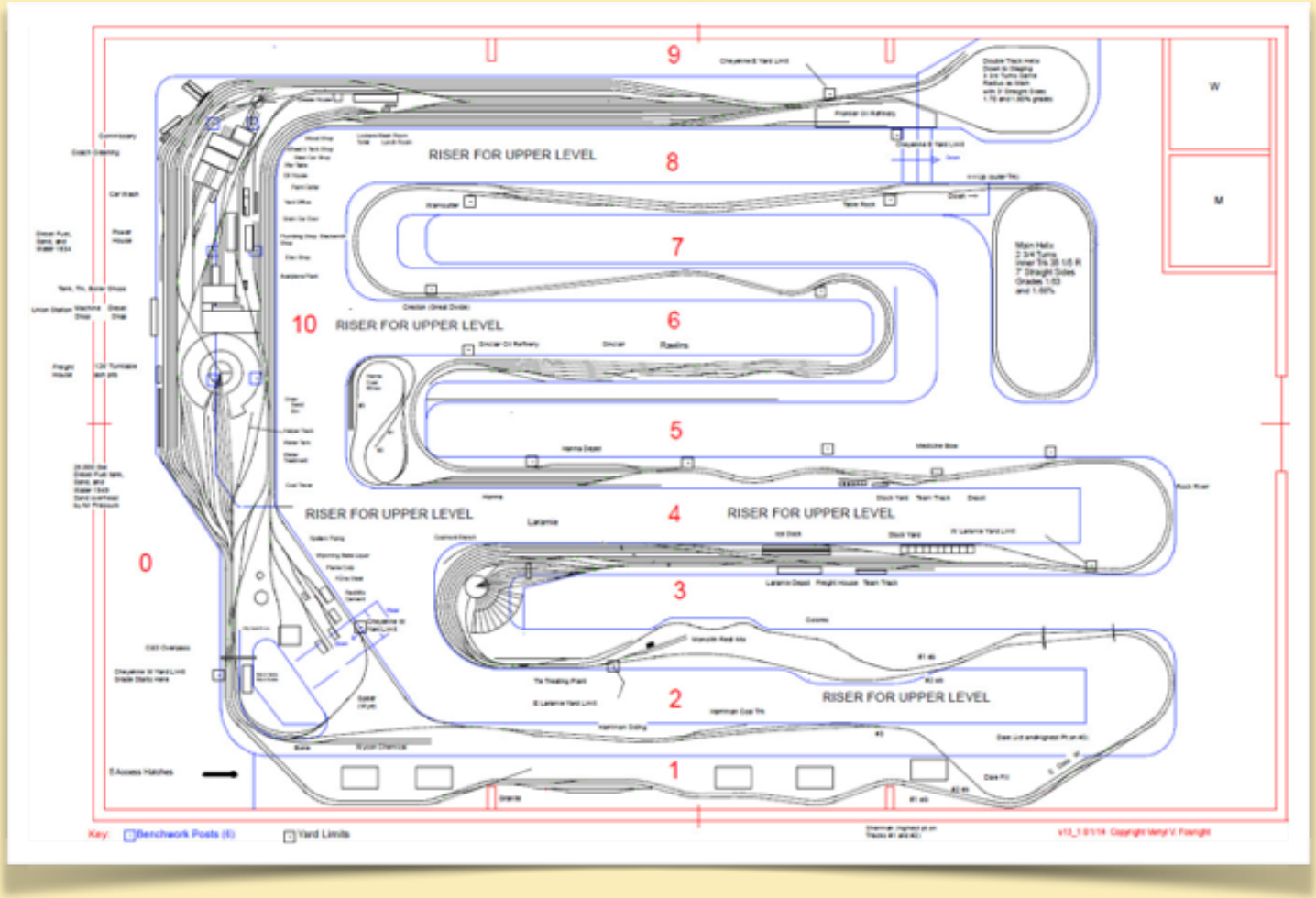

Figure 1. Upper level track plan inside the 50x 75-foot building. The front door is a double door on the center right.

The benches range from 37 to 60 feet long, and they average 47’ 7” long. The problem with photographing such a long scene is “Depth of field” which is the range of good focus in every camera/lens system. It is impossible to get every part of a single exposure of such long views in good focus with any camera placement inside the building.

Before I get into the solution of this problem—the only solution that exists—examine the following photo I took off the web. It is an excellent photo; it tells a good story and is clear and well developed, or “post processed,” if it was taken with a modern digital (non-film) camera.

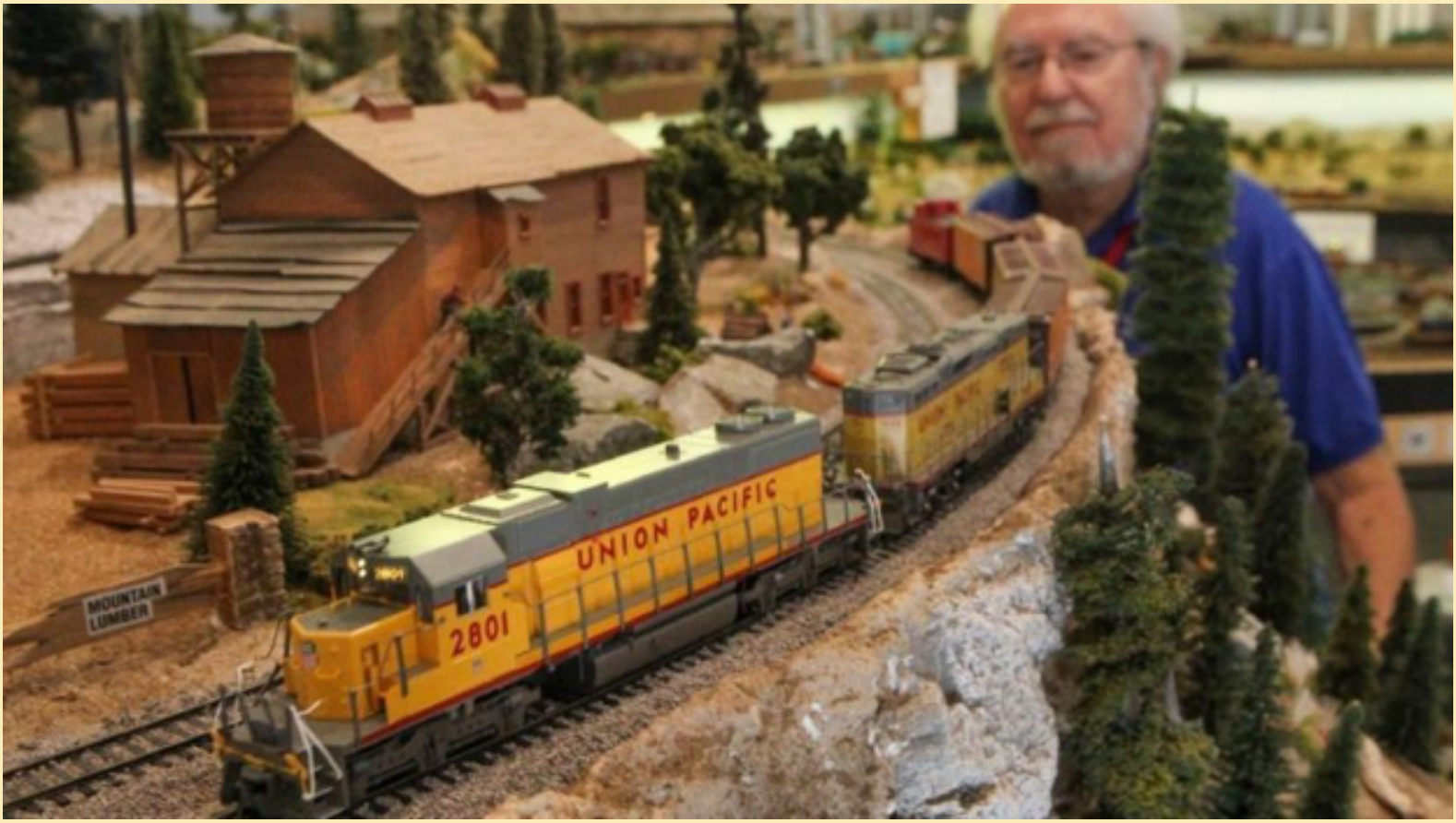

Figure 2. A photo meant as a close-up picture of the first loco and the structure, I would guess. Other elements of the photo are the model railroader and the rest of the train, and the far distant part of the layout behind him. Only the loco on the point of this short train is in sharp focus, and only the near end of the structure is in acceptable focus. The rest of the photo is badly fuzzy-out of focus.

Figure 3 below of the eastern slope of Sherman Hill on the Wyoming Division is a single photograph. In this photo of Harriman, Wyoming only the area around the hoppers and coal tower are in sharp focus. The poor focus is most noticeable at the extremes of camera-to-object distances, i.e., at the near objects in the lower right, and at the distance at the far pink sign and further on, the window.

This bench is about 60 feet long, of which about 45 feet are in the picture. It is impossible to get every part of that long of a view in good focus with a single exposure.

Figure 3. Harriman, Wyoming on the Harriman Cutoff (UP Track#3 on Sherman Hill). This is not a bad photo, but it has limited DOF. Nikon D80 camera at f/5, 1/50 sec, ISO 400

What is depth of field? Depth of field, or DOF, is the part of a photo that is in acceptable focus. Photography talks about “circle of confusion” in discussing DOF, but it does not have a universal definition of DOF, because it depends on visual acuity, viewing conditions, and the amount of enlargement. but we do not need precision. Like pornography, we know out-of-focus when we see it, and once we see it in a photograph, it is annoying for all time for that picture.

DOF is limited to a certain range of distance from the camera for a given camera and exposure settings. Why cannot we just adjust the camera-lens system or use better equipment to avoid it?

The simple answer is that it is just physics of light rays being refracted (bent) by any medium they travel through, except a vacuum. To understand it photographically, DOF is affected by the foour camera-lens constituents of any photograph exposure:

F stop: the ratio of the lens focal length divided by the adjustable diameter of the lens aperture (abbreviated as f/4, f/5.6,…,f/32), the aperture being the adjustable area of a lens that allows light to pass onto the detector

These “f stops” are ratios—f/4 is a large aperture area (lots of light to detector); f/32 is a small area (less light) larger f/ (pronounced “f stop”) numbers indicate less light admitted

Shutter speed: slower speed lets more light be admitted to the camera detector (film or digital electronic detector).

ISO: the sensitivity to light to which the detector is set (higher is better, but noise—spurious spots and/or “grainy” images can result if set too high). “Spurious spots” because those photons and electrons are sneaky little devils.

Lens Focal Length: This is either set by a fixed “F” lens, or variable for a zoom lens. A very long lens (big F) has a larger DOF, but only when the camera is a long way away from the subject.

In either case F it is nearly always picked to properly frame the subject. As such, F is a limited issue for DOF.

Further, for photographing a model railroad one is constrained by the benches and walls of the room, so a telephoto lens is not practical in a train room. (Well, maybe if you are a rivet counter.)

Practically speaking then, focal length is chosen not for DOF considerations.

This leaves three elements of exposure that are practically available to be traded off with each other to optimize a photo, indeed to a large extent, to even capture a photo, and one of the results to be optimized is depth of field.

But you may say. There must be a way to increase DOF of a single exposure, given good or excellent equipment.

- There is up to a limit, and the limit is surprisingly small except for photos of a very distant subject, for example mountains. DOF is greater for

high f/stop (small aperture),

which implies little light is admitted to the detector,

which implies a need for a slow shutter speed (shutter open longer to let in more light)

slow shutter speed requires a steady hand or a tripod to hold the camera (especially for 1/60 sec or slower)

Little light can also be compensated by a high ISO setting (high detector sensitivity) which allows a smaller aperture (large f/ number, meaning less light required. But this in turn can cause a “noisy” recording of the image (visual static for either film or for an electronic detector in a digital camera)

Film made to have a high ISO (high light sensitivity) tends to be “noisy,” because the light sensitive grains are larger) than low noise, “fine grain” film. The larger grains catch more light/unit of time. The ISO for a film is constant, that is not adjustable.

Digital camera detectors can be adjusted by their varying their electrical inputs, or even ganging adjacent pixels together, in effect forming large “grains.”

So, there is a limited range of the f/, shutter speed, and ISO setting combination that will produce a good single exposure photo. Depth of field tables can be found on the internet. Part of one is shown below in Figure 4 below.

Depth of Field Table

Focal Length: 35 mm | Film Format, Digital Camera, or Circle of Confusion: Nikon D7000, D5100, D5000, D3200, D3100, D3000 | Units: feet, inches

Note how fast DOF narrows as Focal Length Calculate

Nikon D7000, D5100, D5000, D3200, D3100, D3000 Focal Length: 35 mm

Distance (feet)	f/1.4		f/2		f/2.8		f/4		f/5.6		f/8		f/11		f/16		f/22		f/32	
	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far
1	0' 11.9"	1' 0.1"	0' 11.9"	1' 0.1"	0' 11.9"	1' 0.2"	0' 11.8"	1' 0.2"	0' 11.7"	1' 0.3"	0' 11.6"	1' 0.4"	0' 11.4"	1' 0.6"	0' 11.2"	1' 0.9"	0' 10.9"	1' 1.3"	0' 10.5"	1' 2"
2	1' 11.7"	2' 0.3"	1' 11.6"	2' 0.5"	1' 11.4"	2' 0.7"	1' 11.1"	2' 0.9"	1' 10.8"	2' 1.3"	1' 10.3"	2' 1.9"	1' 9.7"	2' 2.8"	1' 8.9"	2' 4.2"	1' 7.8"	2' 6.5"	1' 6.5"	2' 10.3"
3	2' 11.3"	3' 0.7"	2' 11"	3' 1.1"	2' 10.6"	3' 1.5"	2' 10"	3' 2.2"	2' 9.3"	3' 3.2"	2' 8.3"	3' 4.7"	2' 7"	3' 7"	2' 5.3"	3' 10.7"	2' 3.2"	4' 5.3"	2' 0.7"	5' 6.6"
4	3' 10.7"	4' 1.3"	3' 10.2"	4' 1.9"	3' 9.5"	4' 2.8"	3' 8.6"	4' 4"	3' 7.3"	4' 5.9"	3' 5.6"	4' 8.8"	3' 3.4"	5' 1.4"	3' 0.7"	5' 9.5"	2' 9.4"	7' 1.3"	2' 5.7"	10' 6"

Figure 4. Portion of a depth of field table found on the net. This one is specific to my Nikon D7000 which I used to take the stack of photos assembled to make Figure 3. The depth of field I tended to use is underlined. We will consider this while discussing Figure 6 below.

The depth of field I underlined as one I tend to use ranges only from 2 ft 5.3 inches to 3 ft 10.7 inches or 17.4 inches! This DOF data led me to my first general procedure with my Nikon D7000:

- Increase f/stop to a small aperture: Limited affect, as seen in the previous table
- Assemble multiple exposures into a single image, using only the sharply in-focus parts of each exposure

This is called “Focus Stacking,” stacking the in-focus part of each exposure together to make a single image. This is commonly done in photographing insects or other tiny objects, but it can be done with expansive subjects like a layout.

Several software programs can do this stacking: CombineZP, PICOLAY, Helicon Focus, Zerene Stacker, Affinity Photos, and Photoshop

Helicon is easy to use (I hear the others are also), BUT

Several individual, identical exposures (except for the focuses) are required

Helicon Focus costs about $200

Using Helicon is very easy, I repeat,

but the process to obtain the numerous exposures, identical except for each focus is not as easy as it sounds….

Here was my exact method of acquiring multiple exposures for a Helicon stacked image:

Figure 5 LED lights used to get to higher f/ratio

*Note on #3 A DSLR or SLR (Digital Single Lens Reflex or a non-digital camera that uses film) camera uses a mirror and prism system to intercept the light through the lens up into the viewfinder for the photographer to see the view he is photographing. Fancier cameras have a “Mirror Up” setting that when the shutter is triggered the first time, that raises the mirror out of the way without tripping the shutter, so light can illuminate the film or detector instead of the viewfinder. Then a second trigger by the photographer a moment later trips the shutter. This pause between mirror movement and shutter release allows any camera vibration caused by so called “mirror flop” to damp out before the shutter is fired to capture the exposure.

1. Set up rig with lights and with camera on a tripod

2. Frame object in viewfinder and lock down both tripod and zoom lens to maintain image size for each shot

3. Set camera to “Mirror Up” setting*

4. Focus manually on the back screen with expanded magnification—the focus adjustment is a tiny amount*

5. Use a remote electronic trigger to raise mirror*

6. Wait for vibration to damp out*

7. Use remote trigger 2-3 seconds later to take photo

8. Repeat #2 - #7 and focus on a new object at new distance

9. Repeat from #2 above for each distance in focus.

10. Finally, download all shots and assemble (stack) in Helicon.

*Note on step #4: By focusing manually on the rear DSLR’s screen instead of through the viewfinder with its tiny view, one can see the viewfinder view on the rear screen of the camera, and, even better, one can magnify the size of the focusing image on the screen by 3 to 5x. This is important, because on most lens the tiny fraction of a turn to move the focus (in my case) about 4 feet from one drawer pull to the next (see Figure 6 below) was only about 1/8” on the lens focusing ring (the outer diameter ring on the lens). That is to say, the adjustment was very tiny and delicate.

Months later after my first series of shots with my Nikon D7000camera, I came across a clamp-on device that claims to fit virtually any DSLR lens and it is mounted in seconds. FocusMaker claims to be a “simple to use, lightweight tool.” It is an open disk that wraps around the lens and rotates with the focusing ring. This disk enlarges the effective outer diameter of the focusing ring. There are adjustable clips that attach to the rim of the disk to mark focus adjustment points to make the series of focus adjustments repeatable. A separate part of the FocusMaster is a stationary pointer that attaches to the. In focusing the disk rotates with the ring and allows a finer control of focus due to the much greater diameter of the path of the end of the disk moving in a circle. In the picture to the left the radius of the disk appears to be about three times that of the lens, so the radial distance movement of a point on the focusing ring would be three times as great. The clips on the stationary disk can be set to different locations around the disk rim for repeatable focusing points.

Helicon sells a device for $209 that is mounted between the camera (Nikon or Canon) like a teleconverter that purports to ease and automate focusing of multiple images.

Figure 6. FocusMaker: $60.15 at B&H Camera mail order.

*Note on steps #5 and #6: I used a small and lightweight electronic gizmo plugged into the camera that used the camera battery for power, and it hung by its thin cord from the camera. The cable connection to the camera is so light that no giggles can be transmitted to the camera. The small button on the small device could be pushed to first raise the mirror, then a second button press a few seconds later would trigger the shutter. Mirror flop would be damped out during the small amount of time between button presses. (I was repetitive, because I love the term “mirror flop.”) A Mirror Up setting and later shutter release via a mechanical cable release is an old trick we all used taking my astronomical photos with film cameras before digitals.

Here is a Helicon stacked image. It is a “stack” of about 8 or 9 individual images, each of which were carefully focused on the antique brass wire tray door handles at the top of the yellow bench face of the eastern slope of Sherman Hill on the model. There are two handles on each 8’ long door, and the hinges can be seen on the bottom of each door. This composite image has a much wider depth of field than a single exposure could obtain.

Figure 7. Harriman Cutoff siding and Harriman Track #3 and siding up the eastern slope of Sherman Hill. Early use of Helicon to stack 7 or 8 exposures. Nikon D7000, f/8, 1/200 sec, ISO1600 45mm focal length on DF camera (67mm equivalent for full 35mm detector size)

In each exposure I followed the above 9 step procedure before step 10, stacking in Helicon. I focused on each antique brass drawer pull on the top of the wire tray 6" tall x 8 ft long doors. Manual focusing was very touchy and difficult; a delicate and tiny twist of focusing the lens focusing ring (~⅛ inch turn measured on the focusing ring rim!). As noted above I focused via the rear screen at 3x to 5x power to increase resolution, and I used the remote mirror up/ shutter release. This image is much better that Figure 6, but the focus is still poor on the lower right corner (phone poles and signals), because I had no object there to focus on—or I was negligent in finding one.

Figure 8. Harriman up close. The distance of camera to wall (upper left) is about 47 feet. Note how the entire image is in focus thanks to Helicon and the process detailed above. Nikon D7000 f/8, 1/200 sec, 38 mm (57mm full frame eq.) Post processed using (Luminar 4 which I love!!!!!!!!!).

Figure 9. Western slope of Sherman Hill. Good focus all over, but it is a bit grainy due to high ISO and maybe I over did the structure details adjustment in post processing. Thanks to Helicon and the process detailed above Nikon D7000 f/8, 1/200 sec, 22 mm Full Frame equivalent 33 mm, ISO 1600, Post processing Luminar 4.

The Sherman Hill is technically a mountain pass, but it is more of a miles wide broad plain with no sheer canyon walls. It was a natural route over the Rockies for the 1860's Transcontinental Railroad. The summit at Sherman, WY was 8,013 feet, which in the 1860's was the highest elevation for any railroad ever. The white structure is the Sherman Depot at the upper center of the photo. Dale Junction that joins the Harriman Cutoff, Track #3, to Tracks #1 and #2 is at the left, and the Hermosa Tunnel, twin shafts are at the right. This model is an accurate representation of the two tunnels drilled under a low mountain crest. Tracks #1 and #2 wind down the western slope of the Hill separated by some distance. The newer 1905 Track #2 lost elevation more slowly than the older #1 to the left. For that reason, the current of running is changed at Dale Junction to left hand running down the steeper track #1 into Laramie, so the milder grade up (#2) may be used up eastbound from Laramie.

It took a lot of careful and time-consuming work to create these stacked Luminar images, and I was justifiably proud of them. So proud that I emailed some of them to Paul Saumure, my IT genius in Long Beach California. Paul keeps my 8 desktop computers and 3 iPads humming. Whenever I have a problem with any of them, I call him and he remotely logs on to that machine, and before I have explained and shown him what is wrong, he proceeds to fix it. He is a man who has truly found his niche in life.

Right away after my email of Helicon stacked photos to Paul, he emailed this Long Beach nighttime photo of a walkway leading down to the Long Beach Marina and the view of the water and lights beyond perhaps a mile away. It was

- taken at night,
- nothing but ambient night light,
- handheld
- no tripod,
- no temporary, intermediate focus objects used
- no manual focusing
- magnified screens
- just point and shoot
- one "exposure"

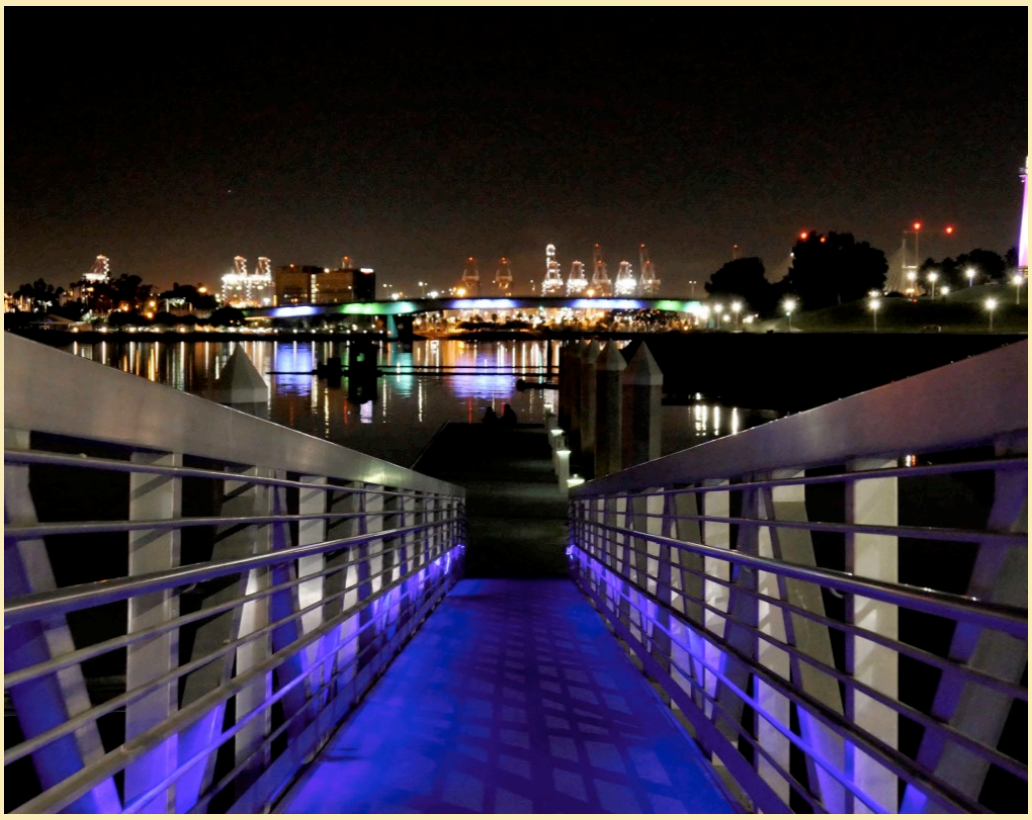

Figure 10. Paul's handheld focus stacked, one click shot with his new Lumix G9 camera.

Well, not actually one exposure, but a burst of about 30 of them on a 1 second video clip—but he only pressed the shutter release once! Paul went with me years ago to buy my Nikon D80, and to get the mirror lock feature, I bought my Nikon D7000. He took this with his new Panasonic Lumix G9, and I repeat handheld, auto focusing, etc. I immediately bought one from the B&H Photo website. B&H is in New York City. I buy photo equipment from them and Adorama in NYC. With it came a "kit" lens, an excellent Leica 12-60 mm zoom lens. The camera is a mirrorless Micro Four Thirds camera, that is its detector has a crop factor of 2x. Its sensor has 21.77 megapixels, effective to 20.3 megapixels. Both the camera and the lens have five axis image stabilization.

Stacking of multiple exposures is semi-automatic, in camera. Lumix makes excellent video cameras, and the G9 has video camera heritage. For focus stacked images, it is first set to its "Post Focus" mode, then you frame and depress the shutter release button ½ down to set the exposure and to auto focus. Then you press the shutter release all the way down to shoot a 1 second video, that is a burst of about 30 exposures that are focused over the whole imaged distance range. Because of the two five axis image stabilizations, if you steady yourself you need no tripod.

To stack the 30 or so images you "click" 3 "buttons" in turn on the camera's touch screen (like an iPad or cell phone), and the camera assembles a "post focus image," to use the manual's terminology, but we know it as a "focus stacked" image. The in-camera stacking takes about 45 seconds.

After the focus stacked image is rendered, I always examine it on the camera screen at 3-5x, examining areas imaged from near to far. Usually it is a good capture, but occasionally I must reshoot because I have giggled the camera during that one second of exposure. One day, I leaned over a bench sideways to shoot down the bench, and holding it that way was awkward, and I giggled the camera for several shots, but I could see that they were bad, so I could reshoot them over using a 10" tall mini tripod set on the bench. But if I can plant myself firmly with good balance, the Lumix G9 never fails to get a motion free set of exposures.

For my very large layout I often want images of the long bench or benches to show the size of the layout, and for those shots I always use focus stacking (Post Focus, as Lumix calls it). For details of a single structure I could shoot a regular photo, but with a few extra "clicks" or touches, I can insure a deep depth of field for even moderately deep scenes. It is so easy and so little extra trouble, I now nearly always shoot focus stacked images of the Wyoming Division.

As a final note, there is one other way to get large DOF images of a 60 foot bench, but Lenny discouraged me from chopping a series of 12 foot square holes in the building walls, in order to shoot with a telephoto lens from > 100 feet away.

Here are a few more G9 focus stacked shots of the layout. First the Hanna coal mines a "4 x 8 foot" layout (everyone should have one) tacked on the end of the bench just east of Rawlins.

Figure 11. An in-camera focus stacked image from my new Lumix G9 camera: Hanna Coal mines region with coal marshalling yard at right edge. The double mains curve around this bench end cap inside the mines at right center. The next bench over is the Red Desert bench, identified by its own backdrop. Even the UP drawn map of the Ogden yards hanging on the far wall about 30 feet away are in focus, as is the front bench edge about 4 or 5 feet away. Camera: Panasonic Lumix G9 mirrorless 4/3 crop factor sensor f/4, 1/60 sec, ISO 200, Focal length 12 mm (24 mm 35 mm equivalent) Note how the video frames and stacking allow a much bigger aperture (f/4, more light), a lower ISO for less detector noise, and the 5 axis stabilization works well at the slower 1/60 sec shutter speed.

The next example is of the benches left to right Hanna, Laramie, tie treating plant and western slope of Sherman Hill, and eastern slope on far right. The west industrial part of Cheyenne is in the foreground.

Figure 12. Another long-range Lumix G9 focus stacked image. This is taken from a middle step of the second set of stairs up to the viewing mezzanine. The Cheyenne industrial structures and tracks are perhaps 10 feet away from the camera, and the window and far wall are about 70 feet distant. Post processing for color, contrast, saturation, structure and other tweeks for this and all images are done using Luminar 4.

Figure 13 below of the 5 tracks entering Cheyenne near the west yard limits illustrates how the Lumix G9 in-camera photo stacking works. On the left is a single frame of the 1 second video. It is from near the middle of the burst of exposures as seen by the progress indicator across the bottom, and I would presume that the focus is somewhere near the middle, but it is hard to tell just where it is on this small print. On the right is the final focus stacked image. This image has been post processed in Luminar 4 to improve the shadows and highlights, etc. The effect of stacking is easy to see here; all 5 tracks are sharply in focus (1 or 2 feet away from the camera on a 12” tall mini tripod, as is the UP Ogden yard drawing hung on the far wall about 41 feet away.

Figure 13. A single frame of the Lumix G9 in-camera focus stacked video frame (left) and the final stacked image assembled from the approximately 30 video frames (right). Stacked image: f/5.6, 1/125 sec, ISO 800, at 14 mm focal length (28 mm full 35 mm frame equivalent)

The five Cheyenne tracks in Figure 13 are, from left to right: 1. west bound main, 2. east bound main, 3. track to Harriman Cutoff, 4. Denver track approaching Speer Wye, and 5. Cheyenne UP stock yard track. The stock yard barn is on the far right. Figure 12 was taken from the mezzanine steps on the left.

USING FOCUS STACKING FOR SCENES OF SMALLER EXTENT

After stacking long scenes of the long benches, I noticed that occasionally more compact scenes had fuzzy areas near and far from the main subject in the photo. So, I began focus stacking nearly all scenes.

This is the Rock Springs Union Pacific Coal Mine #4 I took focus stacked. The tracks near the camera and the hills and rocks distant are in good focus.

Figure 14. The Rock Springs, Wyoming coal mine UP #4. A focus stacked image taken with the Lumix G9 camera about 4 feet away from the centerpiece tipple. Other parameters are f/3.5, 1/640 sec., ISO 1600. The DOF chart in Figure 4 for a different camera and lens (roughly equivalent to the G9) gives an approximate DOF of 3 ½ to 4 ¼ feet. The near edge of the scene was probably less than 4 feet, and the right edge was greater that 5 feet. This focus stacked image shows good focus all over.

Post processing was done with Luminar 4. Even using the two LED lights on tripods, I needed a fair amount of post processing adjustment to lighten up the dark shadow under the tipple. This is on the lower level, so the preponderance of light on the scene was from the continuous string of fluorescent lights mounted under the overhanging upper level. Shadows of the tipple's legs can be seen against the corrugated back sheet.

Below in Figure 15 is a small scene taken from the mezzanine with the camera about 16 feet away from the Monolith Redi-mix structures. This small scene is taken from about 16 feet away from the mezzanine. The image covers about 10 feet in width, so it is somewhat between a long view of a whole bench (~60 feet deep taken from 3-6 feet away from the near edge, and a closeup of a small area scene, such as is seen in Figure 14 above. You can judge the size of this image in Figure 15 by comparison to the 8-foot-long x 6 inch high wire tray doors that are across the 42-inch-wide upper level aisle. That aisle is used by operators passing or switching this industry, so this view from the mezzanine shows the rear of the plant.

You can check the focus at the extremes of the lower right corner, on the lower level about 2 ½ feet below the upper bench top, and the electrical poles and snow fences in the upper left corner, which are about 20 feet away. If I had taken time to look up a web DOF chart, I would find it to be about 3 ½ feet to ∞ for these camera settings, so focus stacking was not needed. But it would have taken me 5 times as long to look such a table up as to take and assemble the focus stacked image inside the camera, which is about 1 ½ minutes.

Figure 15. A smaller scene that was taken semi-automatically with the Lumix G9 camera stationed about 16 feet away from the center of the scene. After I took it, I looked up the DOF on a chart like the one in Figure 4, and it was obvious that a single exposure would have sufficed to capture a well-focused image. However, it was easier to make a G9 focus stacked image than to go to a computer and look up the depth of field table. That would not be true had I needed to use Helicon or another equivalent program, which require many different exposures, each meticulously focused, a tripod, etc. as detailed b the procedure above.

This distance between the camera and the scene, as in Figure 14 versus Figure 15, may be important, if you suspect that focus stacking is necessary. This decision is critical if you use the Helicon program (or another) procedure of the assembly of multiple shots. It certainly is worthwhile to avoid the use of a tripod, external lights, ideally a mirror-up setting, and multiple focusing for many exposures at different distances from the camera. In such cases, referral to DOF charts on the web is worth the extra time.

Post Processing Sky Replacement

How to Extend the Backdrop Sky to the Top of Layout Photos

As you have noticed, I take a lot of photos of the Wyoming Division that show the large size of the layout. Such details nearly always include the top edge of the backdrops and the upper parts of the building, and that darned bright yellow mezzanine is hard to avoid. Now that we have been adding scenery and structures, small areas that warrant more locally focus images, I am starting to take more pictures of those smaller details, and I can frame and/or crop to cut off the peripheral details, but for the “grand scale” of the layout photos it would be nice for a few to have both the grand scale and a sky-only-sans-building-structure. Figures 15 and 16 illustrate what I mean.

Figure 16 Part of Wamsutter, Wyoming. See what I mean by that darned mezzanine. Photo by Verryl, no post processing, so shadows and exposure could be fixed. Note how the lower right of even this tight shot is blurred by low DOF from the large aperture (f/1.8) to get a fast shutter speed of 1/200 sec, at a reasonably moderate ISO of 200. Focal length 30 mm (60 mm full frame equivalent)

Here is the same scene with the sky and building structure parts replaced in post processing, again by Paul.

Figure 17. The same scene, but with a dramatic stock sky replacing sky and the upper building parts of the image. Post processing, including sky replacement, with Luminar 4 by Paul Saumure.

Or another sky; see if you like this better.

Figure 18. Wamsutter again with a different sky. Photo and post processing by Paul, including sky replacement, with Luminar 4.

I admit that such sky replacements are nifty in an artistic sense, that is if your emphasis of the photo is the details of scenery or structures or locos or cars. But if you want to emphasize that this is a layout, and “look how great it looks in this room,” or if you want to emphasis that the layout is for others to operate on with you, then you may just want to crop most of the structure away above the backdrop and leave some of the building showing. Often you cannot do so effectively, especially if the photo is anything but taken square to the backdrop.

About the height of the backdrops on the Wyoming Division. When it became time to put up the Masonite for the backdrops, we used C clamps to erect some example sheets of various heights. We decided the present heights would be sufficient for scenic effects, but not so high as to incite claustrophobia in operators. Heads and shoulders of other operators on neighboring aisles can be seen, but not much else except the building’s roof and tops of the walls…and that darned mezzanine. I am happy with the height of the backdrop; as with any mushroom bench design, when you are focused on operating at any bench, you can only see the layout in front of you and to your left (west) or right (east); it is just like standing on the prairie beside the tracks.

SKY REPLACEMENT AND Luminar 4

The sky replacements above (Figures 17 and 18) were done using Luminar 4’s AI Sky Replacement function. “AI” stands for Artificial Intelligence, which means just a few mouse clicks and the program does the replacement for you. Now you can do this manually with nearly any photo processing program, Photoshop, etc. BUT, those require that you outline the sky precisely and manually with the mouse controlling the cursor, and “painting” around the non-sky elements of the image—try that with the leaves of a tree or skinny telephone poles obscuring the sky. You flub up tracing around the 5 poles or the stove pipe, or the bit of tree, or the corner of the left hand shed in Figure 18, and you have sky where roof or pole or pipe should be. And it takes a lot of time as well as effort to do this edging “painting,” especially if you make an error, in which case it is a real pain to have to go back and start over.

Luminar 4’s AI Sky Replacement tool does all that mask tracing for you. . . IF, the original sky extends all the way to the top of the original image. In other words, in Figure 16, Luminar would not recognize any sky, and thus would not act at all. So, one must fool it with a temporary artificial sky that extends all the way to the top. The temporary sky does not have to be pretty or believable to a human. It just should look like sky on the top edge of the photo.

I now use Luminar 4 as a post processing (PP) program. I have used Photoshop (PS)and Photoshop Elements (I own 3 versions of Elements) since about 1997, and I have a copy of Photoshop 5 from about 1997. I can attest to the difficulty of the Adobe PS programs. PS is only available for about $12/month, and that is forever. Luminar is much easier to use, even though it is new to Windows. And it is much faster to process a photo than PS or PSE. Luminar started out for Windows with Luminar 2017, then Luminar 2018, and now the new version is Luminar 4, which costs $59 one time with free updates promised forever, and if you watch some videos by non-employee Luminar users on YouTube, you may find a $10 discount key.

Disclosure: It is primarily an Apple Mac program being converted to Windows, so it initially had some growing pains, depending on which Windows machine was used, but lately I have had zero issues. It is a memory hog still, so it can be slow for an older machine. I just bought a new computer with an Intel (R) Core i9 32Gb Processor (64 bit). It is a gamer’s computer. I bought it because I hate to wait, and because I love Luminar.

SKY REPLACEMENT PROCEDURE USING Luminar 4

Luminar 4 has “AI Sky Replacement” as a built-in tool. It does not work if the sky does not continue to the top of the image. My model railroad is inside a building with extensive building structure over the painted "sky“ backgrounds, so the program must be "fooled" with some temporary sky added to cover the ceiling, sprinkler pipe, yellow mezzanine stairs, and lights. This temporary sky does not have to be neat or realistic. It just must look like sky to the program.

Figure 19 below shows a photo with a low backdrop and lots of distraction above from the under girders of the mezzanine and the lights. The sign above the backdrop and the hanging yard map are necessary only for operators running trains, so they do not need to be saved.

Figure 19. a rather drab original image right out of the G9 camera that is not yet post processed. It is about to get a new sky to cover the mezzanine and signs, which are needed only by operators during a session. Cropping would help, but only a little, because of the angle that the oblique view makes. And the coal tower sticks up just beyond the backdrop/sky. In addition, the backdrop wraps around the end of the bench, so something must be done about that.

Figure 20. Sky replacement, showing flawed first steps. The original sky did not reach top of photo (see Figure 19).

Since the original sky ended with the backdrop, and above that was the capture of the mezzanine and other extraneous building parts plus two signs for operators, which are of interest only during an op session or on a treatise on our operations:

- First, I cropped the image cutting off a lot of the upper part. It started out with an aspect ratio of 4:3, and I cropped it to nearly 16:9 (1.777…), the actual crop being about 1.85…. This got rid of a lot of the mezzanine.
- Second, I used the Luminar 4 clone and stamp tool to paint the non-sky parts that I wanted to be sky. First, I selected a spot of existing sky near where I wanted to paint ("stamp") over some non-sky. Magnifying the photo greatly on the Luminar screen helped in doing this. I even added some cloned sky to the far end, as if the backdrop continued straight to the end of the photo. I took care not to stamp out the towers of the refinery. Fortunately, their background was sky on the original backdrop, so I did not have to paint/stamp around them (see Figure 18). And I carefully (!! See below) stamped around the peak of the roof where there was no sky. This roof peak to paint around was the reason for my choosing this photo on which to replace the sky. Since this was my first try of adding sky, I thought this was good enough. But then…
- Figure 19 was my original finished product—I thought, until I added it to this article and saw these flaws:
  - If you look closely at the peak of the roof near the aisle, there is a thin sliver of yellow that I did not brush out in the cloning of sky process. I checked it at the full size of the image, and it is clearly visible. It looks like it could be cloud, and for use here, I might not bother to correct it, but…
  - The cloud on the left edge is obviously cloned; it is at least 3 different swipes of the "brush," and maybe 6 or 8 from the looks of its left end.
- This was my first attempt at cloning and stamping, and it takes some experience to get it right. Originally, I was willing to accept the cloned cloud look, but it plus the yellow streak made me go on to step 3 below.
- Third, I opened Luminar 4 and fixed the yellow streak with a very small brush with the photo at high magnification. I ignored the cloned cloud, because…
- Fourth, I used the AI Sky Replacement tool to replace all the existing sky, which was the original backdrop sky, plus the cloned sky at the far end, plus the botched cloned portion at the left side.
  - I opened the AI Sky Replacement tool and selected the supplied first of the 29 supplied skies to use with the tool, and one mouse click, and I was done…
  - except for other post processing. The result is Figure 21.
  - Fortunately, the image did not require much more post processing, because the starting point was Figure 18, which had already gone through PP.
- Notes:
  - Errors like I made are easy to correct. You can go back and start fresh from any of the steps you took by moving down the list of "History" (history of adjustments to the photo). This list shows all the steps used on the image.
  - You can add your own sky photos by selecting "Load Custom Sky Image…." I am careful to use a sky with the sun angle and position matching the Wyoming/Utah scene. This supplied "Blue Sky 1" was fine, since south is a direction out of the backdrop, so it looks natural here.
- Post Processing took less than a minute:
  - I increased the color temperature a tiny 3 counts on its slider and added 0.35 of a stop exposure.
  - I increased the AI Accent (in the AI Enhance tool) a fair amount to 31
  - I increased the AI Structure slider to 14

IMPORTANT: I now do post processing (PP) before I do any sky replacing, so the adjustments of PP do not change the new sky. There is more on this below in the **SKY REPLACEMENT WITHOUT LUMINAR'S AI SKY REPLACEMENT (New Layer Mask)** section.

The finished image is below in Figure 21 below.

Figure 21. Completed AI Sky Replacement from Luminar 4. Note how the sky is replaced even through the ironwork gaps of the coal tower. Compare this result to the two previous images.

MULTIPLE SKY REPLACEMENTS

Even if either method yields a continuous sky (no gaps), and if it is blotchy, obviously cloned (like in Figure 20), or otherwise flawed, you can always do a second AI Sky Replacement. That one will fix all goofs. Figure 21 is one such image.

SKY REPLACEMENT WITH LUMINAR'S AI SKY REPLACEMENT and Using a New Layer Mask to Start

This is the most sophisticated method, but the most sensitive to errors, unless you are a lot better than I in using the mouse as a brush. It uses the conventional edit mask to fill in the top with sky, then uses Luminar 4's AI Sky Replacement tool to fill in the top with a temporary sky to fool AI Sky Replacement and make it work. Recall that it will not work unless sky is across all the very top of the photo.

Here is the original photo, right out of the camera—I did post processing last, but I now think it would be better to do it first to avoid adjustments to the new sky. Here are detailed instructions for a Windows 10 machine (Macs use some different keys for some functions. Here is the original photo:

Figure 22. Original out of the camera photo of Medicine Bow, Wyoming. I want to get rid of the fluorescent light and the building part on the top. I could crop those parts away, but the slight angle of the backdrop would take most of the backdrop off the left side, and that might look odd. I will instead use a standard masking technique. If nothing else, it will illustrate how handy Luminar's AI Sky Replacement tool is.

This is the procedure on my Windows 10 machine (some shortcut keys may be different on a Mac):

1. Import your image using "+" button under "File" and choosing "Edit Single Image" option.
2. Do PP on image first—to avoid changing the replaced sky.
3. Set Library-Edit-Info upper right to [Edit].
4. Select "Layers" (icon of stacked sheets upper right)
5. Select "+" to add new layer
6. Select "Add New Image Layer" (This opens a Win Explorer "Open" page)
7. Find and Select sky to use. Choose one where the sun is in the right direction to match orientation of your layout
8. Double click to open
9. The new sky will cover the entire canvas
   9.1. Do not worry. The original image is on a layer beneath it.
   9.2. You may be concerned if there is a strip of land across the bottom of the imported sky. Again, don't worry, it will go away in the following steps.
10. Click "Layer Transform" This gives a dashed line border all around the new sky layer.
    10.1.1 It also puts Top/Bottom/Left/Right/all 4 corners handles to stretch or squeeze the new sky layer.
    10.2. These handles do not move the layer out of the box; they only can resize it. You can do so if you wish.
    10.3. There will also be a hand in the body of the new sky layer that may be used to move the sky layer up or down.
    10.4. Use the hand to push the sky layer up to where its lowest horizon level is just above the underlying highest level.
    10.5. It matters not that some of the lower layer (the photo of the model) is covered by either new sky or new horizon.

Figure 23. The original layer (bottom part of the Figure) is still all there, but the top 60%, or so, is under the lower part of the new sky layer after step 10.4.

11. Click “Edit Mask” and select “Brush”
    11.1. On the top band over the layered image click to set “Size.” Two concentric circles will appear. We will set it later.
    11.2. The annular area between them is the “soft” part. Its opacity declines from the set opacity of the inner circle from that value down to 0. This “softness” is there to help you “paint” edges close to your desired boundaries, e.g. to paint away parts of the top layer, say, the brown ground and trees and horizon, of the upper layer. This “soft” part of the brush works to remove image parts on the top, active layer, but just not as thoroughly or drastically as the inner circle’s full opacity does. The full opacity of the inner circle is set to 50% to start, so the outer ring falls off from 50% to 0%. Just remember you can go over an area over and over and remove progressively more of that layer for any setting less than 100%. We’ll set the opacity in a minute also.
    11.3. With an idea of the brush settings, I usually start out with the preset levels, and start to paint away (that is erase) the unneeded parts of the top layer to reveal the valuable part of the lower, original image layer, that is in this case, everything but the sky and the upper parts of the layout building. I try to be careful not to brush away any of the new sky that I need to leave in place of the old sky underneath, but some of the new sky must go, because of the angle of the camera to the bench.
    11.4. The moment you click the “Edit Mask” button, the cursor turns into the double circle “brush,” and the image reverts back to the underlying original photo (the lower layer), so you begin to brush, as you can see in Figure 24.

Early in the process this is what it looks like. (the double circle brush—now the cursor—does not show, because I used the cursor to outline the Luminar screen in the screen capture.) The cursor here was a double circle a little larger than the white three story building, The Virginian Hotel.

Figure 24. Just getting started editing the layer mask. The double circle “brush,” does not show in this cropped photo, because I used the cursor to outline the Luminar screen in the screen capture. As you can see in places some of the new layer is being revealed as the old part is brushed away Actually, the proper way to think of it is the mask is brushed away, that is, edited. The opacity of the brush is automatically set to 50% (center circle) and decreases to 0 with the diameter of the outer circle. This lack of total opacity (total is 100%) leaves some of the original layer visible with each pass of the brush.

12. This large brush-low opacity is continued with abandon all over the upper parts of the image. The soft edge is a safety reminder to keep the brush away from the parts of the original layer that should not be touched and lost.
13. If however, some of the desired part is wiped away, you can change the brush at any time in this Edit Mask step to “Erase” and undo that mistake.
14. Soon it is time to do the edge along the border of the land/building/trees-sky. The red roofed building and the trees around it must not be brushed, ideally not at all. This is hard to do, so you should change the size of the brush to much smaller and increase the opacity. I think I

changed them from size 100 to 20 and eventually to about 12, and the opacity to 77%. Set yours to whatever works.

15. then to make it easier, I increased the size of the image beyond the “Fit to Screen” setting to as large as it took to brush all the nooks and crannies.

This is how it looks so far. I did 3 “Edit Masks” with the brush; I needed 3 because I was not skilled enough to do it all in one. The last was tiny and transparency about 82; I used it to erase the clouds a bit from “overspray” on the hotel’s red roof. I did not quite cover the handrail in the upper corner, but that is OK, because I will next replace all this sky—maybe the AI Sky Replacement will recognize this part as sky.

Figure 25. The image with the edited mask prior to the AI Sky Replacement, which I think will work for the next step even with the handrail showing through in the upper left corner.

16. Now that there is all sky at the top, even with the handrails showing through, I did an AI Sky Replacement with the Luminar 4’s provided sky “Blue Sky 2.” It is on a drop-down list on the AI Sky Replacement tool.

    The result is Figure 26 below.

Figure 26. Completed sky replacement done partially by the old-fashioned way of an edit mask to add sky above backdrop. As easy as the last step of replacing sky is, one can see why Luminar's AI Sky Replacement is such a big step forward. The long and difficult editing a mask is fundamentally the way one would do it using Photoshop, Lightroom, Affinity, Gimp or any other software. It is slow and mistake prone, especially near the horizon or around objects projecting up over the sky such as a post or tree.

Post processing for color, tint, exposure, and other tweeks were done last, but I was limited in their use because each one impacted the new sky. I did PP first to tone up the structures and scenery, and—this is important—I made the original backdrop bluer. My first attempt did not yield a good color match between the replacement sky and the backdrop. The AI Sky Replacement seemed to not replace a fuzzy narrow band just above the horizon. I think that it works at least partly by a contrast-edge sensing. To fix that is another reason to do PP first.

HYBRID SKY REPLACEMENT

Here is an alternate method that may be faster, and would be as good as you wanted, that is, for as much time and effort that you would want to put into it. Make the mask and clean part of it away replacing the level one non-sky and sky parts near, but not too near the original horizon, and leaving the original sky at the horizon and just above it as is. It looks like this.

Figure 27. The original photo has been masked and the mask removed down to near the horizon. The original sky is left right at and about 1/16” above the horizon, except for around The Virginian Hotel. The dull smoky looking backdrop near the hotel clearly reveals the mask was not edged closely to the horizon/hotel, but it is just a preliminary step.

Following the Figure 27 step, do a Luminar 4 AI Sky Replacement. I got this unsatisfactory image, Figure 28 below.

Figure 28. Well, this was a start. It needs more brushing away of the mask near the horizon and especially around the hotel. To do so I would go back in the “History” list (clock icon in lower right corner of screen) and start before the AI Sky Replacement with another round of mask editing. You can do as many mask edits as desired, and it is advisable to go so far then click “Done,” so you will not have to redo a whole long string of brush strokes if you foul up.

I could have done the extra mask work suggested in the Figure 27 caption, but I decided to try a different AI Sky Replacement without touching up the horizon. I tried 3 other Luminar 4 supplied skies, and none covered up the gray sky, but this one is fairly believable????

Figure 29. Sunset and it looks like it may rain. Hey! We’re model railroaders, and we’re supposed to have big imaginations.

In the future I think I will try the Hybrid method only if I can choose a replacement sky about the same color as the sky to be replaced. It may be that the Artificial Intelligence of the Luminar Sky Replacement tool is too intelligent, whatever that means. It seems to judge existing pixels by some sky color or other criteria, such that it can only replace what is clearly (to it) as sky. Comparing the problem sky around the hotel in Figures 27 and 28, it may be that there was too much contrast between the replacement sky and the sky to be replaced, so that the AI “judged” that the “horizon” was not the hotel but the old sky. Using a replacement sky about the same color or quality as the sky to be replaced may work better, in that it may make an abrupt contrast change (sky-to-building in this case) more recognizable. After all, the Luminar AI Sky Replacement tool discriminates the gaps between leaves, and iron struts, and poles as in Figure 19 and its legend. These features have an abrupt contrast change.

Anything that may ease the burden of edging a mask as in step 14 above, is worth a try.

Well, I have managed to get into the artistic side of photography, the realm of in-the-eye-of-the-photographer.

Say goodnight, Gracie