Welcome To The Wyoming Division Historical Society

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

BUILDING THE WYOMING DIVISION

Innovative methods used in building a huge layout.

By
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(This is a revision of the original article, updated in places to Include new features of the actual layout)

This article describes the Wyoming Division HO scale layout I am building in a 3,750 square foot building with a separate 1,080 square foot shop in Cornville, AZ 17 miles from Sedona. The layout models in HO the 485 miles of the Union Pacific Railroad from Cheyenne to Ogden in 1957.

BASIC DESIGN

The layout is built on a two-level freestanding mushroom steel framework bench and has about 859 feet of track on each double main line. Including the main tracks through staging and the staging helix the length of each main is 1,006 feet. Including yards and branch lines on hidden track the layout has about 5,300 feet of track. The minimum main line track radius is 34 inches using Atlas Code 83 Flex Track. Peco and Shinohara turnouts and NCE radio control DCC are used.

There were 10 tunnels on this section of the Union Pacific, and I have modeled them all scaling them in length by using a linear equation as a scaling “factor” that makes the shorter real tunnels non-linearly shorter than the modeled short ones on the model.

I also modeled the grades proportional to the prototype average grades over selected lengths of track. I took those lengths and grades from a set of 1961 UP Profile Charts. On the charts I picked various locations between which there is a generally uniform up or down slope to the grade, and then calculated the average grade between those two points. The prototype on the prairie has few inundations generally, so this is easy to do, and any small variations have little effect on the average grade. Then I set the model grade for each portion at 1.6 times that prototype average.

The model grade runs from Cheyenne with the reference elevation of zero to +10.66 inches at Sherman. The model grade is 2.48% which is 1.6x the prototype 1.55%. This 2.48% sometimes requires helpers to take 25 to 30 car trains up the Hill. The model grade from Ogden up Weber Canyon and Echo Canyon (the Wasatch Mountains) is not so steep. It is about 1.8% model versus 1.14% prototype, again in a ratio of 1.6. Following prototype practice, helpers, if needed, are used eastbound from Ogden to Green River, Wyoming as well as up Sherman Hill. UP often cut off the helpers at Wasatch, Utah, but we go on to Green River to use the turntable there to turn the helpers back to Ogden.

The first three Figures show the original upper and lower deck track plans. (Minor additions to include more industry spurs were added later. The **revised track plans, v13.4,** are in the following article “Signals on the Wyoming Division” on this tab.)

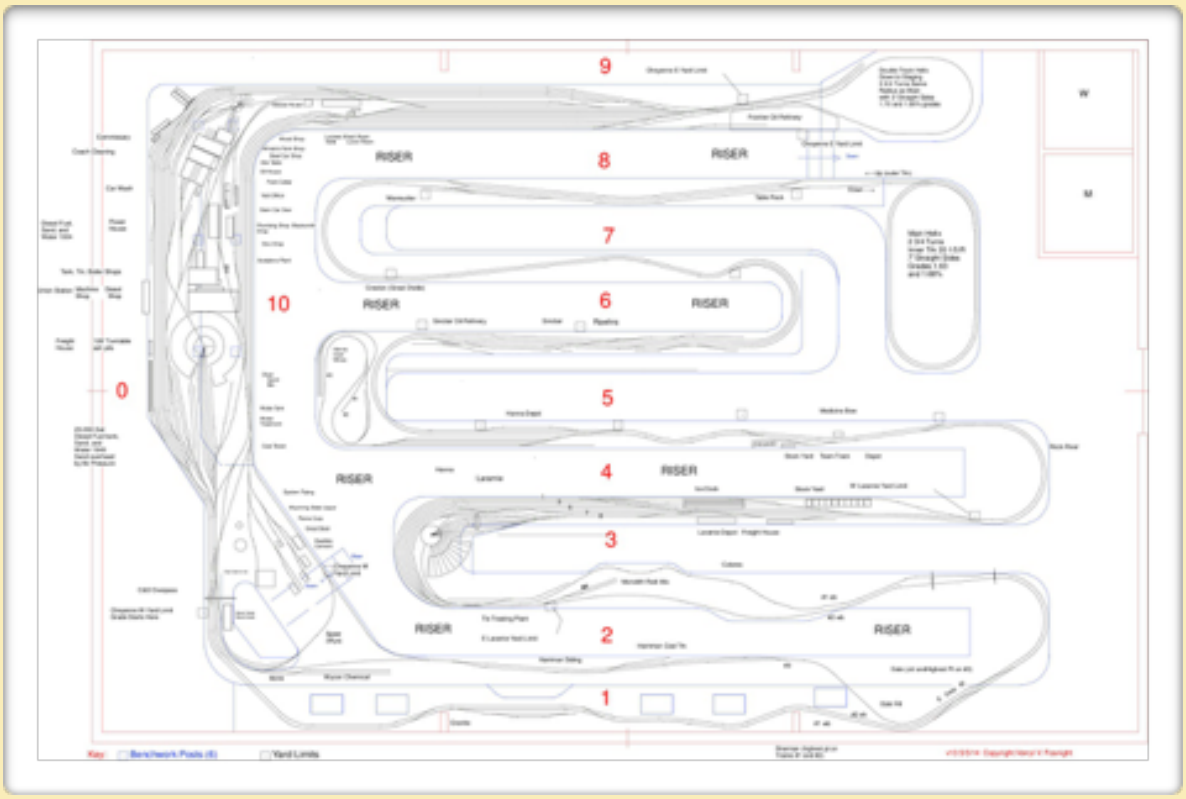

Figure 1. Upper level track plan

Two oval helices are in the track plan, as can be seen in any of the three drawings of the three levels. The upper level (black) and the lower level (green) contain all of the “sceniced” layout plus most of staging.

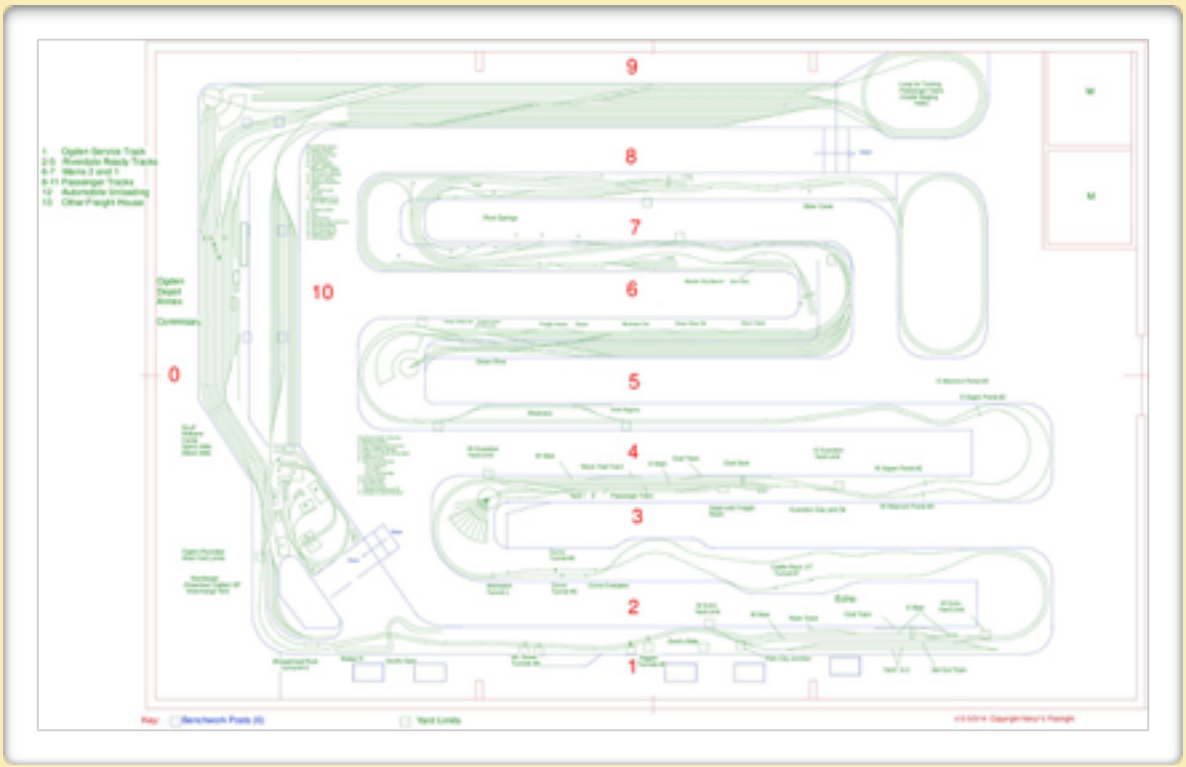

Figure 2. Lower level track plan

The hidden track on the orange third level is under the green lower level, but only parts of the 11 benches, facing aisles 0 through 10, are used for it.

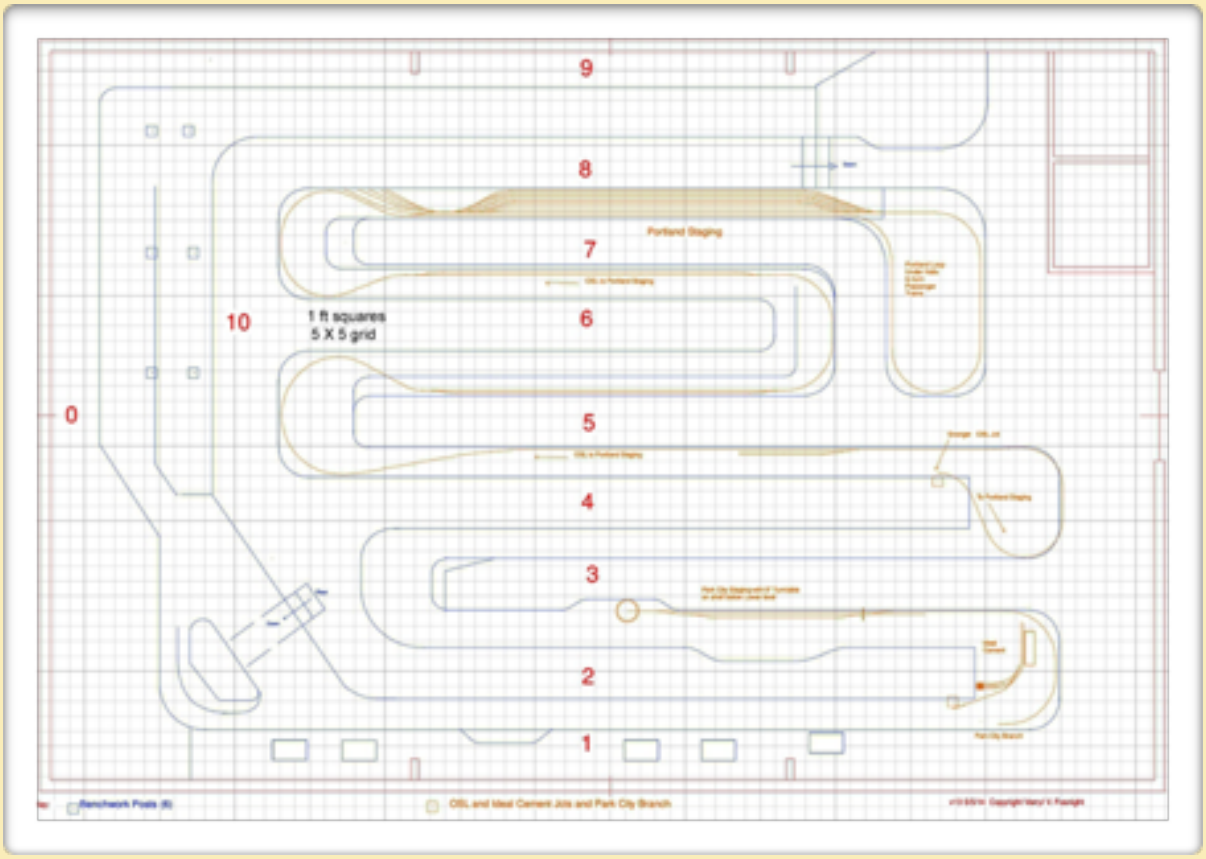

Figure 3. Hidden Track or third level track plan

Unfolding the Track Plan

To understand the track plan refer to Figure 3a and eliminate the smaller helix (upper right corner of Figures 1-3) in your mind, then straighten out all the benches with the black upper bench between #9 and #8 on the right (west on the prairie), and the green lower bench, #9-8, on the left (west), and imagine the main (large) oval helix in the middle. I have added a 90-degree bend to compress the drawing. What remains is track from Cheyenne to Ogden in a straight line, east to west. The main helix is still in the middle; it is approximately halfway between the two towns, Cheyenne, Wyoming and Ogden, Utah.

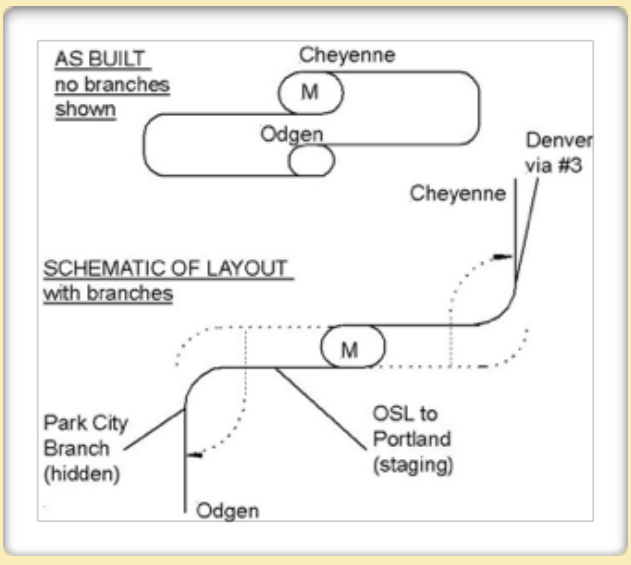

Figure 3a. Unfolding the main (upper and lower) levels of the track plan.

Adding the hidden orange level from Echo, Utah to an imaginary (on hidden track) Park City, Utah and the OSL to an imaginary Portland, Oregon completes the schematic. This way in your mind's eye you have the Wyoming Division HO layout.

LAYOUT CONSTRUCTION

The next photo shows the interior of the 75 x 50-foot (outside dimensions) building built specifically for the Wyoming Division. I drew the plans for the building to fit the layout bench and track plans that evolved over years in numerous versions. The track plan is currently v 13.4. The red painted lines outlining the benches were laid out just after the building was completed on the day after Thanksgiving, 2011. The lines outline the benches of varying widths and 41-inch-wide aisles. The benches range from 24 to 34 inches wide, but Cheyenne (upper level) and Ogden (lower level) are a whopping 84 inches wide. This 84" width for this one bench was felt necessary to model the entire Cheyenne yard from Tower A through the end of the freight yard. Cheyenne in the '50's had one of the largest steam facilities in the world, and I wanted to model it all.

Figure 4. Empty Building with benches laid out on floor

Fig. 5 shows an early picture of the layout steam yard. Part of Ogden can be seen on the lower level. The main helix is in the photo, that was temporarily connected to the beginning of the Laramie bench, so that both levels and both tracks of the railroad could be operated staging-to-Cheyenne-to-east Laramie-down the helix and back to Ogden into staging as a test of the trackage and NCE DCC wiring. This was our first "operating session," and about 15 or more modelers and operators came from all over Arizona for the event. As a layout built for operations, we were on our way!

At and after this operating test we corrected some wiring errors that showed up with multiple trains running at once. This was the end of phase I construction. We then rolled the caster fitted helix away, and started phase II, the construction of the Laramie and Hanna benches. At the west end of the Hanna bench we again set up the helix temporarily by lifting it and its casters off the floor onto blocks for stability and again had more test operating sessions with many guest operators.

When we were satisfied with phase II, we moved the helix again and built the final benches of phase III. Phase III involved building benches from the bottom-up; it was the benches between aisles 5 and 8. First we built the hidden bench for the OSL with track, then the lower level bench, plus track, and finally the upper level, and added track. Finally, we rolled the main helix to its final location and raised up on blocks.

Figure 5. Cheyenne Steam Yard from the north west on the upper level. Ogden is on the lower level. The main helix is connected to a temporary location, the bench at the east end of Laramie at this stage of construction to allow testing of track and DCC.

SWITCH PANELS FOR HARD TO REACH TURNOUTS

Shown in Fig. 6 below is the solution to the problem of reaching over the wide bench at Cheyenne. Lenny Wyatt, the contractor who built my Sedona home and erected the steel buildings for the layout and the shop, made panels with recessed electrical switches to control Tortoise switch machines. This was an idea I stole from Rick Fortrin of the Bay Area in California. On AutoCad Lenny drew the panels in UP colors with track diagrams and wired them to the Tortoise machines that are too far away to reach. The diagrams have LED lights that show the direction that each turnout is set for at that moment. The large circles are 1-inch diameter holes to reach in with one finger and operate a rocker switch. The rocker switches are much like slide switches in that they give an intuitive feeling for the direction the points move. There are 10 of these panels on this Cheyenne bench, but only 7 are in this photo plus one for the turntable. On these 10 panels are 60 electrical switches, some of which control two turnouts of a crossover that must be thrown together. Altogether these switches control about 66 Tortoise machines with turnouts.

Lenny made other panels for hard to reach turnouts, three in Ogden and staging, and one each at the Granite Quarry, Dale Junction, and at Echo, Utah.

Figure 6. Cheyenne from southwest. North Platte staging is the front 5 stub tracks on the lower level. They connect to the rest of staging at the lower right.

OVERALL VIEW OF MOST OF PHASES I + II (All but Cheyenne and Staging)

We started building benches at the small helix near the upper right corner of the track plans building across the top edge of the drawings, then turned to build down the left side (the wide bench) and continued with the benches visible in this photo, Fig. 7. This picture is a view of about 1/3 of the layout from across the east end of Cheyenne. It is taken toward the corner of the building from which the empty building was shot. Out of view to the left foreground is where we started building, the Cheyenne steam yard with Ogden out of site on the lower level. Connected to the very wide bench of the steam yard and around the corner is the Cheyenne freight yard, and staging is on the lower level below that, all out of sight.

In the Fig. 7 photo Dale junction is visible at the far right at the end of the bench nearest the wall, and the yellow face of the Dale switch panel for the turnouts can be seen just below the bench edge. That switch panel is about 60 feet away from the camera. The bench to the far right is the Sherman Hill eastern slope, and the spline roadbed and track rests on the level bench top. The Harriman cutoff, Track #3 can just be made out winding toward Dale near the aisle edge of the bench. Just below that is the yellow Granite quarry switch panel, also on the front of the right-hand bench

The next bench left is the western slope of Sherman, and on it the spline supported tracks wind down to Laramie yard on the upper level of the bench in the center. Also seen is the end of the main helix in its second temporary place for the testing at the end of phase II.

Figure 7. Overall view of the layout Cheyenne to Hanna, Wyoming on the upper level. Laramie is in the center.

BUILDING FOR OPERATIONS

I am not building this layout as a commercial venture. Visitors are always welcome, and we take time to show them around explaining all the features to them. I am building the layout specifically for operations which will feature

•Long, through freight trains (as many as 30 cars plus engine, tender and caboose)

•Long drag freight trains across the entire layout including LCL pickups and setouts at 11 freight houses and numerous team tracks

•Local freight trains that will run between around Cheyenne and Green River and back, Ogden and Green River and back, plus intra-city locals around Cheyenne, Laramie, Green River, and Ogden and the vicinity (1 within each yard)

•Work trains as required

•Coal, iron ore, cement, trona (soda), and oil product trains from 4 coal mines, 1 iron ore mine, 1 cement plant, a trona mine, and 2 refineries

•Four large mills and packing plants

•The Laramie Tie Treating Plant, the Granite rock quarry, and the Wycon Chemical Plant (fertilizer from the soda)

•PFE trains will run across the layout with a few stops on the layout (for icing in Ogden and in Laramie and to set out or pick up an occasional car)

•Stock trains will serve Utah and Wyoming and the packing plants

•A daily Park City, Utah local will run from Ogden through Echo, Utah and on to Park City (see Fig. 3a)

•4 named Streamliner passenger trains and a few mixed trains for local passenger service and local freight

•A UP-SP exchange track for SP switching of the 13 businesses in downtown Ogden

•Helper service may be used up Sherman Hill west from Cheyenne and east up the Wasatch Mountains out of Ogden, if enough operators are present

•These Sherman and Wasatch grades require changing heavy loco power for lighter units across the near level "bowl" of Wyoming, so we do that at Laramie and at Evanston. When Green River is built, it will replace Evanston for this function, because Evanston has only a part time yardmaster who floats between there and Rawlins and Echo.

•There are two lengths of main line track that require left hand running, so the correct current of running, left or right, must be observed. These two areas are prototypical requirements due to grade differences in new and old tracks built years apart (east bound up the eastern slope of Sherman Hill and west bound from Ogden to the overpass and tunnels of Curvo).

"Operations" to me means having a model railroad party. I get to share my creation with other modelers and operate with them on it, and I find that is a lot more fun than running trains alone. Often when a person runs trains even with others present, he is running them "alone" in that there is no purpose other than to watch the train. I also like running trains just to watch them, but I really enjoy the cooperative nature of "ops," that is, running a lot of trains with the express purpose of moving passengers and freight from A to B as if to make a profit or at least efficiently, like real railroads try to do. It involves dispatching, calling engineers to run, running, switching, LCL service, yard work of classification or loco changes, hostlers changing locos in yards with the cooperation of road and yard crews, and helper operations. All these have the goal of delivering freight or passengers or picking up empty cars. Like real life it takes a lot of workers to accomplish the work of a real railroad, and that working together is a lot of fun. The bottom line is modelers take great pains to make layouts that look and sound like real scenes. Operations attempts to carry that realism into running the trains. (See the two later articles on this tab about "Lightweight Operations" and "Operations on the Wyoming Division" in which ops are simplified, so a newcomer to ops can enjoy without fear of embarrassment through failure of following arcane rules. These two operations articles also describe my unique Four Card Operating System for Double Track Rule 251D operations with Train Orders.)

During construction I had three "operating sessions" where 12-15 of us ran as many as 10 trains at once to test the track, rolling stock, locos and DCC system, and at the end of 2013 I hosted my first three monthly formal operating sessions with 27, 28 and 35 operators in which we ran trains using and testing my car forwarding system of my own design.

I installed a 16-phone communication system to simulate prototype operations in 1957. There are 8 phones connected from both the upper level and the lower level to two dispatchers, each with his own master phone to the 8 phones on his level. Often a single dispatcher mans both phones and fills in the 5-foot-long train sheet to log in "on sheet" calls. The dispatcher(s) sit at a desk on the mezzanine, a 7-foot wide viewing platform suspended over the center of the 75-foot-long building.

In 2019 we started using 10 FRS radios for the dispatcher and 9 others, because none of the operators on the layout would answer a phone call from dispatch, making it impossible for the DS to issue orders. Now we use the radio to call one of those 9 key operators to get messages to the right operator on the layout.

GENESIS OF THE WYOMING DIVISION

I had a small attic HO layout in the early 1970's with my young boys, but a home move and career changes ended that effort. In 2002 I visited a NMRA convention meeting in Long Beach, California and was hooked again on model railroading. At that time, I still lived in California, but was in the process of building a home with an astronomy observatory under the dark skies of Sedona, Arizona. I began drawing an HO track plan to model Cheyenne to Ogden. I meant at first to build it in the basement storage room of the new home. My grandiosity soon outgrew that 10 x 50 foot space, and then I decided that when I moved to the new house, I would build a layout in the whole manufactured home in Sedona that I bought to live in while I finished the new home across Sedona. By the time I moved into the new home my plans had grown to its 2½ car garage, then further to the 3 rooms upstairs, and then finally they filled the entire 1,200 square foot manufactured home. I did reserve the kitchen and part of the family room in that manufactured house for a crew area, because all along I wanted to have operations.

THE BUILDINGS THAT HOUSE THE LAYOUT

In 2008 I gave up the manufactured home idea as unworkable, because the noise and traffic of operators and parking required would have disturbed my neighbors in that quiet retirement community. I shopped around for a vacant commercial building I could buy, because I did not want to model in a rented space. The thought of having to tear a layout down if the owner's goals or needs changed deterred me from renting. Instead, I bought a 0.6-acre vacant lot in Cornville, Arizona, about 17 miles from my new home to build a steel building. Two years later I had designed the 50 x 75 foot layout building with a separate 30 x 36 foot shop, and a year later, Lenny Wyatt, the contractor who built my house and the layout switch panels, had both buildings up, a water well drilled, and it was ready to start building the layout that I had drawn and polished using the *3rdPlanIt* software.

The building is 50 x 75 feet outside dimensions with a 4 in 12 pitched roof above 12 foot tall walls. Inside the building is the 75 foot long by 7 foot wide viewing mezzanine set on a pair of support beams at each end and suspended in the middle from two oversized girders spaced 25 feet from each end of the building, and those girders span the 50 foot width of the building. There are no posts inside the entire interior of the building except for the lower ends of these 2 very large I beams which are about 18 inches wide at shoulder height at 25 and 50 feet along the 75-foot building sides. The headroom under the floor of the mezzanine is 8 feet, and on top of the mezzanine there is also a minimum of about 7 feet of head room beneath the pitched roof. Every upper level aisle is on a 17-inch wooden riser, leaving about 6' 7" of headroom from the riser to the bottom of the mezzanine. There are double 36-inch-wide doors at the front and at the rear of the building.

Since Arizona is so hot, I installed geothermal heating and cooling in the building. Instead of air flow blown over condensing coils outside to convert the gaseous Freon back into a liquid in the heat pump cycle, the geothermal system pumps the gas down into pipes buried in 10 outdoor wells, each about 180 feet deep. The constant 72-degree F ground temperature below about 10 is the heat sink that makes the phase change back to a liquid very efficient compared to blowing 105-degree F air across coils. There are two heat pumps hung from those giant beams that support the mezzanine. The humidity in the layout building is as dry as is most of Arizona.

I also erected a 30 x 36-foot shop building to keep dust from the layout in its own building. In it is a 10" radial arm saw, a 9" table saw with a 4 x 8 foot top for plywood, a portable table saw, cut off saws for wood and for steel, two drill presses, a 3" modelers' table saw, a belt sander, a band saw, and other tools, and storage. It has double 36" personnel doors like the main building, and a 10-foot-wide roll up door to handle large items and my pickup truck. The shop has a swamp cooler that keeps it cool if you must work out there, but it does get very humid if run a few hours.

After holding regular monthly operating sessions for about 24 months, in December 2014 Lenny and I added on a 20 '-9" long extension to the shop building to make a 20 x 30-foot crew lounge. I added a refrigerator and 8-foot long kitchen cabinets. With folding tables and chairs, it gives us a nice place to eat lunch. I also hung an 84-inch-wide screen and wired the room for a projector out on the floor, so we could have clinics.

OTHER BUILDING REQUIREMENTS

To comply with the local building code I had to do a flood and water runoff plan, have adequate parking of 13 spaces including a handicap space, a hard surface parking (asphalt), and fire sprinklers in both buildings, and an approved water well and a septic tank system with adequate grading and fill for the septic drain field. The building height had to be approved to withstand local wind shear.

MUSHROOM DESIGN AND DESIGN CONSIDERATIONS

I took control of the buildings in November of 2011, and three of us immediately laid out the pattern of benches on the concrete floor shown in Fig. 4. The aisles are all 41 inches wide, and the spaces between the wider lines are for a free-standing mushroom design of benches. I built the layout in 3 phases. Each phase involves a new section of level benches on which we added spline with cork roadbed after sealing all exposed wood with a light gold prairie dry grass tinted sealer. We then wired the track for NCE DCC radio operations, and we tested the track and wiring periodically with op sessions before we continued bench/track building. The benches are very sturdy and have steel frameworks made from 1½" square steel tubing welded to form uprights to hold a flat surface for each of the two mushroom levels. The next photo shows a typical bench end on, and this happens to be the last new benches of phase I.

The square tube steel legs are in an "F" shape with a second leg from the cross line down to the floor (or an "h" with a "–" over it). The steel has been painted with the same light-yellow sealer that is used to seal the wood, but the open end of one of the 1½" square tubes can be seen on the left-hand member. Of the two benches under construction in the foreground, the central aisle will eventually have a 17" high riser to walk on and to reach the top level on either side of the aisle. The other two aisles, to the far right and far left will have no risers, so the lower level benches are worked from the concrete floor. Eventually, both the riser and the concrete aisles will be carpeted.

The backs of the benches have a sheet of ½" plywood screwed to it on the long leg of the F with self-tapping screws. The plywood sheets are not on these benches yet. This full 4 x 8foot vertical sheet of plywood forms a shear panel to keep the leg pairs from tilting together or apart into a trapezoidal shape. The top sheets of ½" plywood are level over the whole building to within ¼"as determined by a water-in-tube level, and they serve as shear panels in the horizontal plane.

Track is not laid on the flat plywood surfaces except for yards. These flat surfaces are all at the same elevation over the floor. Spline roadbed with cork on it is blocked up to the proper elevation to model the prototype grades. If a yard is at an elevated level above the bench top, we use a separate sheet of plywood for it. The top plywood sheet of the bench is there only for structural strength and to support the elevated spline or a yard plywood sheet. The structural bench top also keeps an expensive locomotive from crashing all the way to the concrete floor should one fall off the spline roadbed before scenery is finished.

Figure 8. Bench details before an end cap for these two benches was built to connect them. The F shaped steel leg assemblies are 8 feet apart and painted to match the prairie. The upper level benches rest on the top horizontal member of the F.

The drawing below, Fig. 8a, shows a bench plan end on. Note the wire chases or ducts with hinged doors for each level. The chases for the upper levels are formed on one side from the curved backdrop. The chases run the full length of all benches. Those for the lower level have about 5 ½" square cross section. Those for the upper level have a similar cross section area. Not all the wiring goes in the chases, but we try to put anything that would need access, even occasional access, in a chase where it is out of sight, but on the bench front to be easily accessible. This includes DCC circuit breakers and bus bars in pairs (in lieu of terminal strips) to connect power districts to the wiring mains. The 10 AWG DCC main power buses and the 18 AWG feeders up to the tracks (and where used any 14 AWG sub power buses) are generally not in the chases but are run to where the tracks go. All connections are soldered except the brass buses, so with good soldering techniques they are fool proof, and accessibility to the wires is not important. Also take note of the 17" riser for operators to reach the upper level. The risers are at least 41" wide to make nice wide aisles to accommodate many operators.

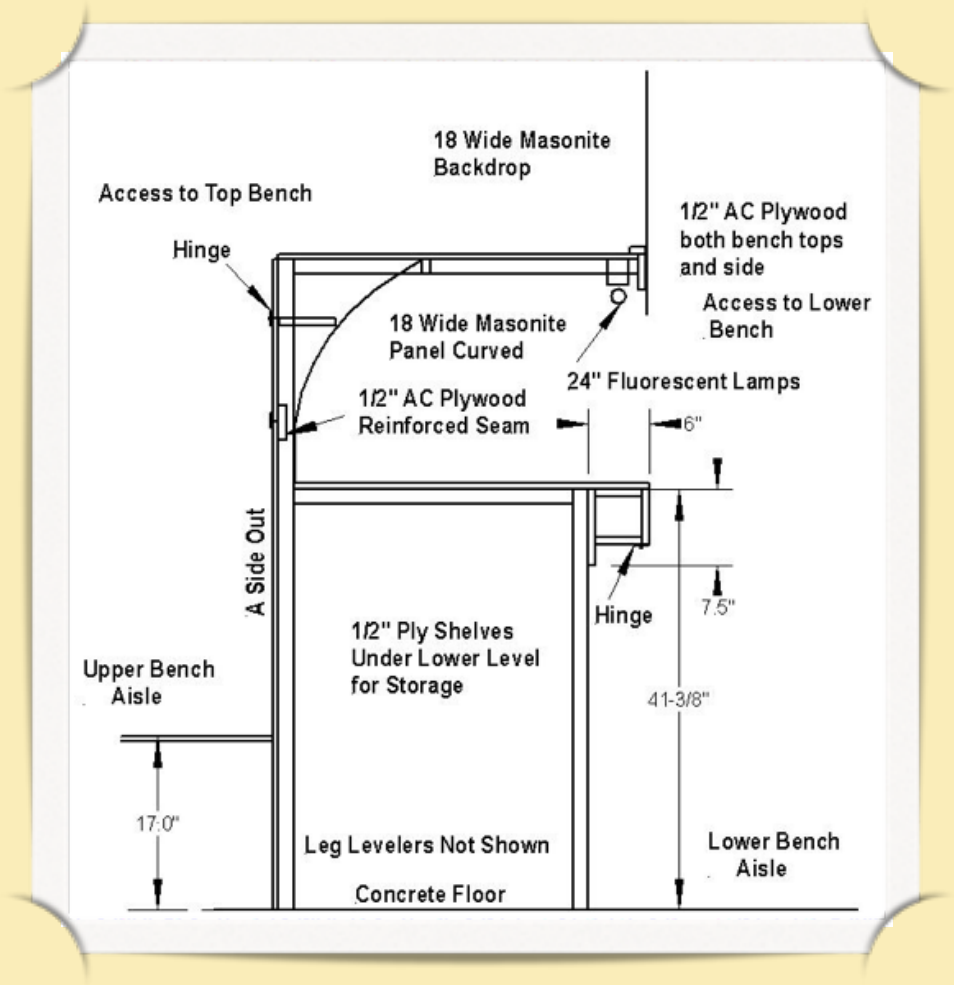

Figure 8a. Bench details, end view. The F shaped (plus a second leg) have 3/8" carriage bolts screwed into nuts welded to each leg for levelers.

I call this a "free standing mushroom" design, because there are no benches attached to or supported by walls. This has four disadvantages and four very big advantages. First, not using the walls to support benches puts a premium on bench stability, so I use the ½" plywood sides for shear panels like on a house wall. The top of each bench is also a sheet of ½" plywood screwed to the steel, and it is a shear panel as well. Together the two sheets of plywood keep the legs from twisting in any direction, and the result is a very rigid bench. The track elevation is controlled by blocking the spline roadbed or level yard plywood base up to the desired height above the bench, and the total block height is adjusted by screws through two blocks, so the blocks do not have to be cut to an exact length.

The second disadvantage to a mushroom design is that it takes a lot more floor space than if benches were attached to walls.

The third disadvantage is that the extra lumber required to build the riser is not a trivial expense either in time or money. And I have yet to see a discussion of the end of the riser in any book or article on mushrooms. There must be an operator accessible end, either steps or a ramp. Either takes a lot of lateral room, so an operator has a chance to see steps or the ramp ahead of him, so he can account for it as he walks to not stumble. This extra space requirement may be hard to accommodate except for a very large layout.

Finally, a mushroom unfortunately takes a very high ceiling. The Wyoming division uses 17" risers, so that inside a standard "8-foot ceiling," which is usually 94," the head room is only about 6 ½ feet. In my case I tried to get away with 10 foot outside walls in my design, and then 11, but had to settle on 12-foot walls to get a reasonable balance of head room under and over the mezzanine. That head room is about 6 feet 7 inches under the 7-foot-wide mezzanine. The extra building height played out as extra expense in the extra length of heavy steel and extra walls to meet wind shear code requirements.

The four chief advantages to the mushroom design is that with a mushroom design, every other aisle on either level are for one level only, and the alternate aisles are used exclusively for the other level. This means that with appropriate backdrops, which do not have to be overly tall, operators on different levels cannot see each other. Indeed, each can see only forward or back on his own track, not onto another level, so the effect is like being out in the country where the tracks before you or left or right are all that are visible. The second advantage is even more important. Since all operators in any aisle are working the same level, there is little possibility of interference between them, and there is no need to stagger upper level and lower level yards. The third advantage is the large amount of storage below the lower level benches. I believe that these two mushroom advantages, if you have the room for it, outweigh the first three disadvantages. The fourth advantage is the space under the risers are clear to be used for building wiring. Remember that ideally you want no walls or posts in your layout room, but without them there is no way to route wires for 117v lights or electrical outlets, not even via the ceiling, because what goes up must come down. But with the riser Romex cable can be pulled to any bench. Just leave some screwed down panels for access to junction boxes.

It is most simple to plan all benches with a common elevation over the floor. With varying bench heights construction and precision would be difficult. That is why we block the track up to elevation with respect to the lowest surface. It is possible, but difficult to have a riverbed or canyon across a bench. Fortunately, my layout is on the prairie. Even Sherman Hill is just a high prairie, and the Wasatch mountains loom above Ogden. Cheyenne is elevation zero for the upper level of the layout. Ogden is elevation zero for the lower level.

Leaving Cheyenne headed west the tracks climb up our Sherman Hill. As soon as the tracks leave the obligatory level yard (so cars do not roll away), they start to rise on spline roadbed. When a yard appears, we revert to plywood to make it level, and the plywood of most yards are blocked up to that level. And so on across the whole upper level, the tracks rising or falling on spline roadbed up to or from a level plywood yard. The main helix is built to conform to the elevation at its upper end. At its lower end the process is continued of spline-level plywood-and so on down to Ogden, which is 42 3/8” off the concrete floor. The photo below shows long sections of spline all glued up and still flat on the both the upper and lower level benches. Allen Montgomery is about halfway down an upper aisle adding spring clamps to splines. Together we have a LOT of clamps.

Contrary to my admonition about single level benches, both these benches have lowered sections of surfaces (shelves, really) to model rivers. But note that each lowered area is a full span between steel legs, which eases the support of the bases using vertical wood members screwed to the sides of the square steel tube. To those vertical members are screwed cleats to support the “shelves.”

Figure 8b. gluing up 6 strip spline. The center strip is doubled to facilitate fastening down cork and supports.

The concrete man made the floor very smooth and level for us, but we improved on it by using a water level, about 75 feet of water filled tubing. With the meniscus at one end at bench top the bench at the meniscus at the other end was adjusted with the leveling feet welded into the steel legs.

OTHER BENCH FEATURES AND DCC WIRING

The photo below in Fig. 9 shows a bench being assembled with cork on spline roadbed being put in place. Wire chases are being built here. In Fig. 9 below. The lower chase is shown before its door was attached. The backdrop of the lower level is curved out to near the center of the underside of the upper level bench to make the upper duct. Doors on the far side, open to the back of this curved space, on the back of the lower level but the front of the upper level, and they open just below the upper level bench tops for the wire chases. (Refer back to Fig.8a.)

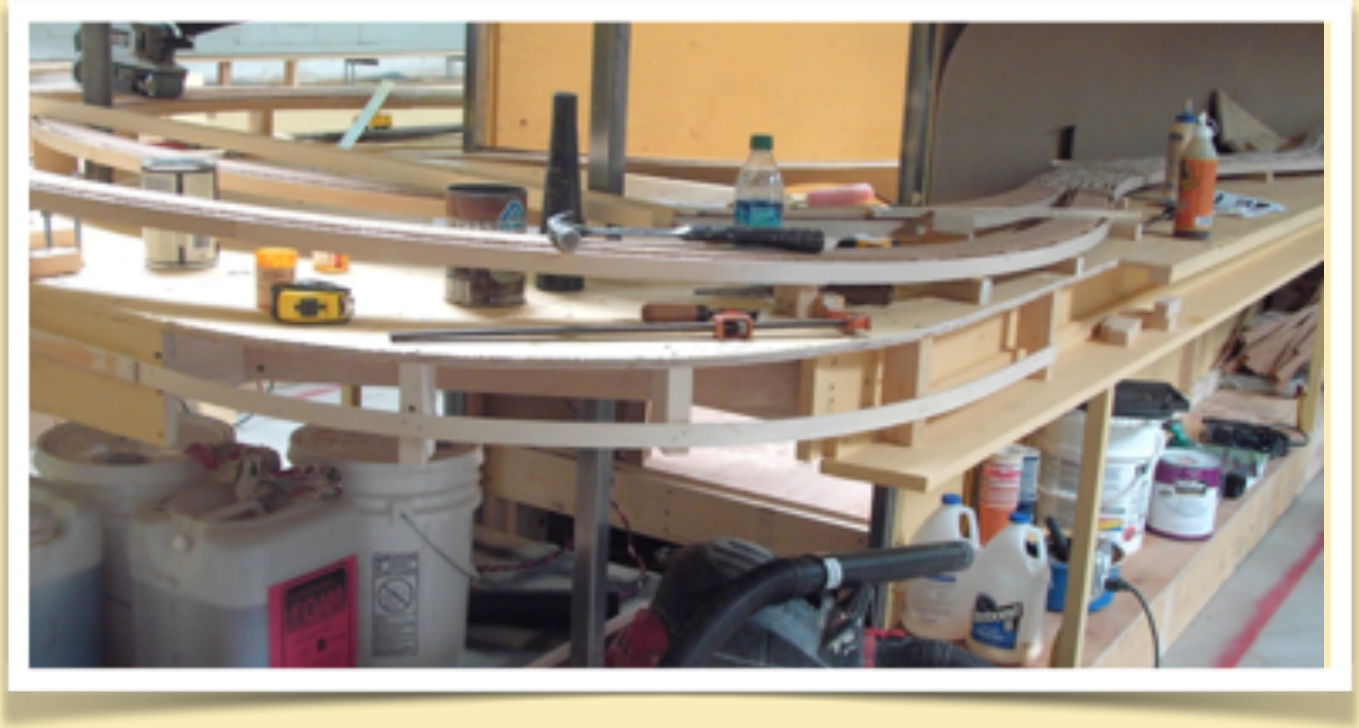

Figure 9. Lower level bench details for wire chase. The unpainted steel F legs are welded back-to-back here at an end cap.

The unfinished and doorless lower level wire chase is just under the front edge of the lower bench. It is being used here as a route for the OSL hidden track, instead of for wires. The first strip of poplar wrapping around the bench end has been nail gunned into place angled down to the floor of the wire chase/track route. Five more strips were glued and nailed building outward and separated with blocks of wood to make the spline for the hidden OSL roadbed here. The non-hidden lower level roadbed is above it (with the hammer laying in it) and is only fixed into its final elevation at the left-hand end. The spline roadbed to the right will soon be raised up and fastened to blocks to rest it at its proper elevation over the constant height plywood bench. The second spline roadbed for the other track is on a far inner radius of the bench end (it is best seen across from the orange color bottle of Gorilla Glue at the far right.)

Brass bus bars used are also usually mounted inside the wire chases or occasionally on the bottom of the upper level bench. The bus bars I use are a heavy brass bar with 8 large wire holes large enough for a #10 AWG wire, and the brass is mounted on a nylon holder. The brass bar has separate tapped holes and

screws into the 8 large wire holes. I use the bus bars in pairs to make a terminal strip. Terminal strips are commonly used for DCC to separate wiring between power districts and between breaker districts to facilitate disconnecting a given section of the layout from the rest to isolate shorts. I prefer the bus bars in pairs, because no jumpers are required as for terminal strips.

Also visible in Fig. 9 are some of the 24" single T8 florescent tube fixtures placed on the underside of the upper level benches to light the lower level. The fixtures are placed end to end, and with the average lower level "shelf height" of about 18 inches, the lighting is bright and uniform. The end to end was a bad choice. It is very hard to remove burned out tubes with no space between. One half an inch would have made a great difference.

I imported minimum orders of 1,000 of the florescent fixtures and 4,000 each of the 8 screw bus bars at a small fraction of the unit cost from local big box stores, which import them from China just like I did. Together two of the bus bars make a nifty terminal strip with no need for jumpers, and at a cost of less than $0.10 each per pair. I have many of each left; email me if you need any cheap.

BENCH CONSTRUCTION IN THREE PHASES

Some of the completed benches from Laramie through Hanna, Wyoming on the upper level are shown in Fig. 10 taken from part way up the other set of stairs to the mezzanine. Laramie is in the distant center with Sherman Hill to the far left, and parts of the lower level can be seen.

Figure 10. About 1/3 of the layout looking toward Laramie and Cheyenne from the mezzanine steps. Medicine Bow is on the right on the upper level. Some lower level tracks can be seen on the left at Castle Rock, Utah.

As can be seen in the photos, we have barely a start on scenery, but it is unimportant at this stage, because I am building for operations. Before scenery goes much further, I intend to concentrate on structures, which are very important for ops— train crews need to know where the switching spots are, and the best way to mark them is with a building with a sign. Scenery will be last.

We have tested and have adopted the Bragdon Enterprises geodesic foam product for our scenery hills and plains after applying about 75 square feet of it on one bench. As can be seen in the immediate foreground, we have continued the process by cutting the building insulation foam into shapes and hot gluing them in place, so some of the layout is ready for the cover sheet of foam.

HELICES

The layout has two helices. The larger connects the levels of benches at the center of the layout. It can be seen in Figures 5 and 11. The smaller, also shone in Fig. 11, connects the ends of the layout (Cheyenne and Ogden) to the staging. The extreme end of the sceniced part of the layout is here at the east end of Cheyenne which is the Frontier Refinery on the upper level just before the tracks enter the staging helix that connects to staging on the lower level.

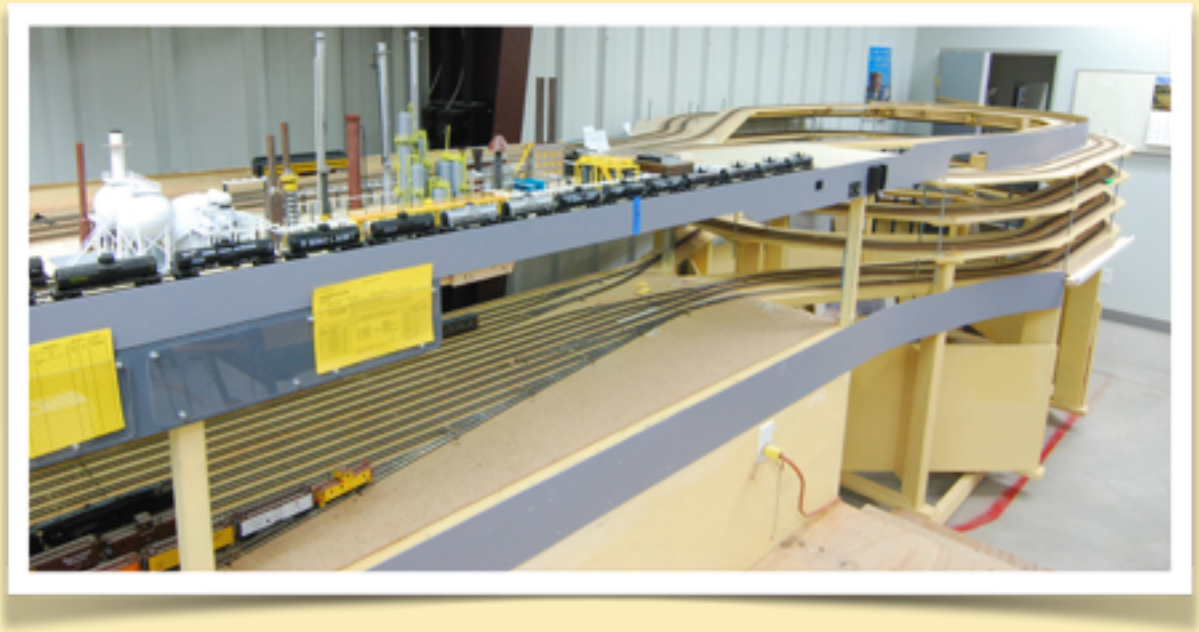

Figure 11. Staging helix connecting east Cheyenne on the upper level to staging on the lower level. Frontier oil is on the upper level. A small part of staging is visible.

The other end of staging, not shown, connects to the west end of Ogden, so the point to point layout is made into a circle with the staging serving both ends of the layout, and the larger main helix in the middle.

The main helix is shown with the smaller staging helix in the next photo. The main helix connects the upper and lower benches together in the middle of the layout, one half of the way from Cheyenne to Ogden, putting Rock Springs, WY the on the lower level of the layout just west of the main helix.

Figure 12. Across the aisle from the Staging Helix is the Main Helix. Each helix connects ½ of the upper level of the benches to ½ of the lower level. The edge of the Portland staging yard is seen at the bottom of the stack of benches. The lead to the Portland turning loop that runs under the main helix is visible also.

In this Fig. 12 a third and lowest level can be seen. Technically this third level is hidden track (OSL) from a junction at the elevation of the lower bench tracks about 3 benches away from this view (behind the camera). From the OSL-main junction on the lower level, that hidden OSL track immediately doubles as shown in Fig. 9 down in elevation under the now middle level to end in the auxiliary staging yard just visible in the photo. This yard is "Portland, Oregon," and the hidden track is the Oregon Short Line (OSL) that leaves the UP main at Granger, Wyoming. For clarity see the green and orange track plans of these two levels.

The smaller (staging) Helix has 3½ turns of double track on a minimum 36-inch radius and is oval in shape with 36-inch straight sides. The maximum grade is 1.45%. The small helix structure also supports two turning loops, one for each bench level to turn passenger trains leaving east through Cheyenne and back into Cheyenne (upper level, black track plan). This loop connects to a 3-track staging yard behind the Cheyenne classification yard tracks, so that for their next run passenger trains are pointing in the opposite direction, that is back toward Ogden (and through Ogden to LA or Oakland/San Francisco). This also will be clear by looking at the black track plan. An east bound train through Cheyenne to "Chicago" traverses the loop and returns with its locos pointed west as if it had gone to Chicago and returned. The upper loop is the inner turn of three tracks on the top of the small helix shown in Fig. 12. The lower level loop is the outer loop of three (green track plan), and it does the same function for west bound trains through Ogden to "LA," the "Bay Area," or "Portland." Just a bit of it can be seen on the bottom level of the small helix in Fig. 12.

The double track Main Helix is similar with 2¾ turns, a minimum 36-inch radius, oval shaped, but with 84-inch straight sides, which gives a maximum grade of 1.68%. Together with the Staging Helix the Main Helix connected to each end of the two layout levels make continuous loops of each whole main, although we always run point to point.

OTHER VIEWS OF THE LAYOUT

Below is the back-shop area of the Cheyenne Steam Locomotive and car shop area from the back of the 84-inch-wide Cheyenne bench. The steam yard runs to the right in the photo and the classification yard to the left. The classification tracks are the center 7 of the 9 at the far right of the bench that is on the left reaching away from the camera. The other 2 are a runaround track and the Denver track (see below). The tracks on extreme left side of the bench running off into the distance is the east passenger staging. Trains come into this view from the Cheyenne depot to the right and go to the turning loop on the staging helix (best seen in the previous photo) and return to stand on these tracks as if they had gone on through Nebraska to anywhere you want—Chicago, KC, St. Louis, etc.

Figure 13. Cheyenne on the upper level and Ogden on the lower level. A small part of Ogden on the lower level can also be seen. The 4 tracks on the left edge of the upper bench are passenger staging to hold future west bound trains.

Figure 14, next, shows more of the steam yard of Cheyenne from the other side of the 84-inch-wide bench. There are 4 passenger mains in front of the depot. Across from them is a transfer table between the Steel Car Shop and the Wheel and Tank Shop. The Electric Shop and the Tank and Tin Shop are behind the Machine Shop, which is just east of the turntable. This is a recent photo from Jan 2020, and parts of the completed scratch built round house are shown.

Figure 14. Jan 2020 overhead view from mezzanine of east end of the Cheyenne Steam Yard

Below in figure 15 is the view at the west end of Cheyenne. In the center is the Speer wye that is the junction between the Harriman Cutoff track #3 up Sherman Hill and the Denver track south, both of which connect to Cheyenne just west of the town. At that point the main is 4 tracks. In the previous description of the east Cheyenne yard I mentioned the Denver track. This Denver track leaves the wye and goes along the Cheyenne yard on the edge of the bench to connect to the staging helix to go down into staging. Accessed from the Denver track, say from the Harriman Cutoff (the far corner of the wye, staging becomes Denver. The Denver track should be a hidden track, but I sneaked it along the edge of the Cheyenne yard because it was impossible to find a workable way to make it a hidden track into staging, that is running under the bench and behind the 10 Tortoise switch panels on the far side of the bench.

In the background of this photo, in addition to Track #3, the Harriman Cutoff, are the two other mains up Sherman Hill, #1 and #2, on spline. I modified the design to widen this bench to the wall to put more space between #3 and #1 plus #2 mains. That made a long duckunder aisle, so to make as much headroom as possible we stair stepped this bench. Those steps can be seen.

The dates of these tracks are 1860's, 1906, and 1951 for Numbers 1, 2, and 3. This picture was taken in October 2013 about 23 months after we laid out the red paint bench lines of Fig. 4.

Figure 15. The Tower A (not shown yet) crossovers in the foreground with tracks 1 and 2 up Sherman Hill at the far wall. Speer wye is in the center and off the west turnout of it is the Harriman Cutoff Track #3 towards Dale in the distance.

In the distance is Dale Junction, where the Harriman Cutoff (Track #3) joins tracks #1 and #2. Number 3 is 19 miles longer than #1 and it bypasses 50 feet of the Sherman summit, so it is the primary freight route up the Hill from Cheyenne leaving the steeper #1 as the primary route up Sherman Hill. We modeled all 3 of the crossovers at Dale between #1 and #2, because we use them to change the current of running down into Laramie, as does the UP. The old right-hand Track #2 is steeper up the Hill from Laramie going east to Cheyenne, so we follow UP procedures and take the steep #2 left hand going west down the Hill. We return to right hand running just inside the Laramie yard limits. Also shown in the picture is the eastern portal to the double tunnel #1, Hermosa Tunnel.

OSL, THE 186-FOOT-LONG HIDDEN TRACK TO "PORTLAND"

I also designed in a route to Portland, Oregon via the old Oregon Short Line (OSL) from Granger, Wyoming just west of Green River. This can be seen on the orange track plan. On the Wyoming Division layout, the OSL junctions with the mains and immediately becomes a hidden single track behind and angling down to run under some benches toward "Portland," which is another staging yard under the lower level of the bench facing aisle 7. The next photo shows the beginning of the hidden OSL through the "mouse hole," visible through the scenery cardboard strips, ¼ of the way from the left in the middle. The track through the hole (see red arrow) is hidden track that takes the OSL track under a mountain that we have not yet covered with scenery foam. The hidden OSL runs under the two mains that will be through Aspen and Altamont Tunnels under the scenery and around the edge of the bench end cap on spline/cork roadbed to reverse the track back toward "Portland." This reversing loop is shown during its construction in Fig. 9.

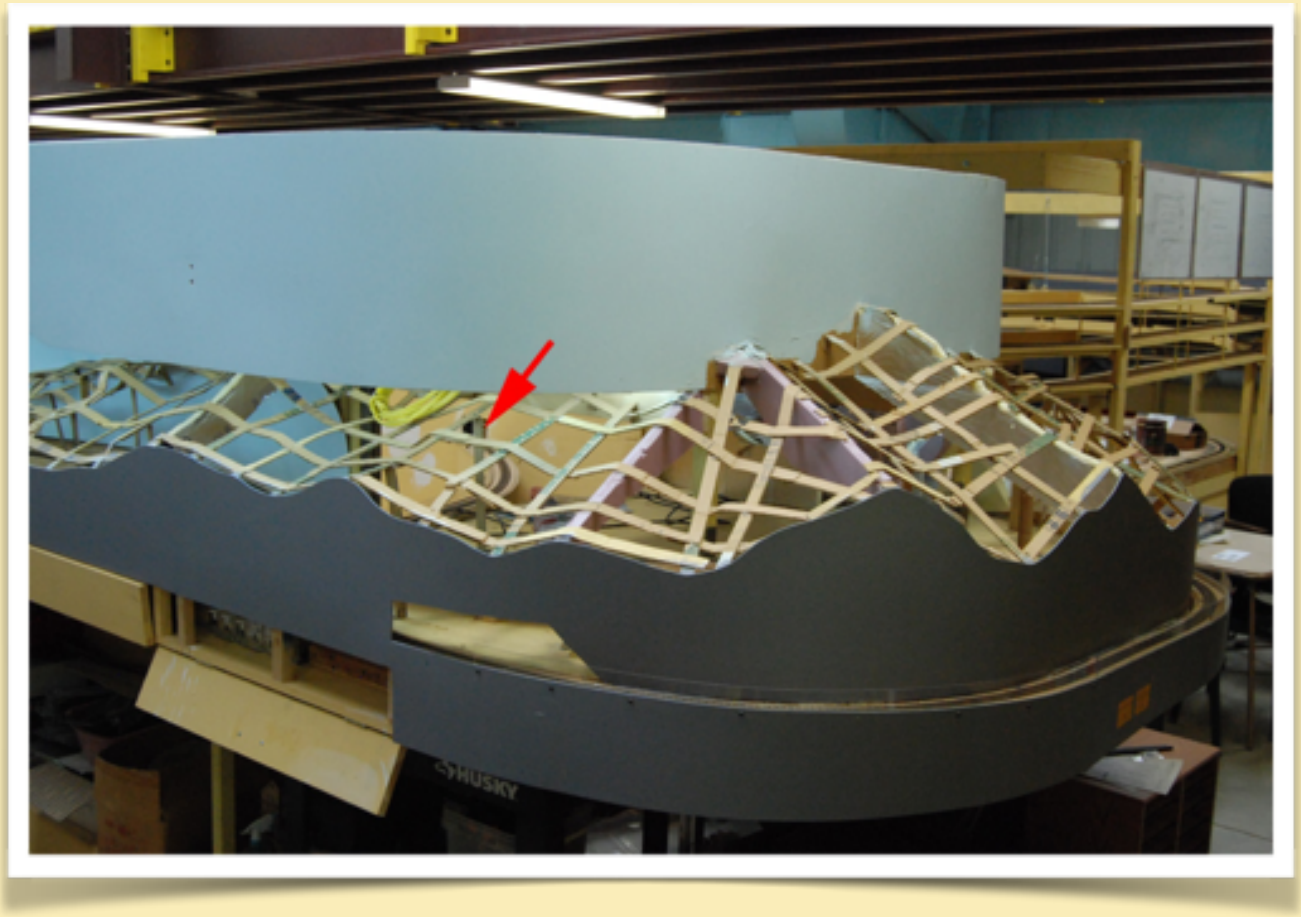

Figure 16. OSL hidden track seen through incomplete scenery. It then emerges around the edge of the lower bench.

The whole Portland staging yard is at the end of the hidden OSL track, and it is shown in the next photo. The edge of the right-hand end of this yard can be seen in Photo 12 in the third layer down.

The Portland staging yard is on a 24-inch-wide shelf under the lower level. The shelf is only 9 ½ inches tall, so the yard is not usually worked except to store trains. We normally stage all nine Portland staging tracks with about 7 freights and 2 passenger trains that are set up before the session. As trains leave Portland, only a few more freights and passengers go to the yard each session, so it is not a busy yard, and there is nothing to do there but turn the whole trains, to await being sent out again. (Recall the turning loop described under Figure 12—it is the track at the edge of the bench here, and the loop is to the lower right on a shelf under the main helix.)

Since “Portland” is a hidden staging yard, all trains to or from it are through trains, so their car cards can be remarked with new destinations represented by the main staging yard, that is, they are not broken up in Portland, only sent out whole again in the opposite direction. They leave Portland as east bound “new” trains bound for North Platte, Nebraska (staging accessed through Cheyenne). They could be re-carded for switching at intermediate locations, but usually I am too busy to attend to the details to do so; it is enough to remark each card or block card to go to “NP” (North Platte) or Denver, both of which are actually main staging. Portland is a handy supplement to main staging, because as a roving Superintendent I can assign a train to an operator without bothering the main staging YM who is always busy.

Figure 17. Portland staging yard shown under the lower level. The outer track leads to the turning loop positioned under the main helix. None of the tracks are stub tracks; they all connect to the OSL (far end) or the turning loop (behind the camera).

PARK CITY BRANCH

The next picture shows the first part of the Park City Branch soon after its junction with Track #2 in Echo, Utah, both of which are to the left. This single track rapidly loses elevation to become a hidden track under the front edge of the bench as seen here. Under that bench, on the next aisle, it goes into a 3-track yard and is terminated beyond that in a 9" manual turntable. This is the destination for the Park City Local, a one train a session switching job, to be run out of Ogden to the far left of this bench and back with a stop in Echo to switch cars on both its coming and going from Ogden.

The Ideal Cement plant, Red Devil Brand, is also seen here, at least some of its buildings early in its building. The Local takes all traffic from Echo including the covered hopper cement cars back to Ogden with it, or leaves east bound ones in the Echo yard for other trains. One of many through Manifest trains could pick up east bound cars headed away from Echo and Ideal Cement to the right (east) toward Cheyenne, but more likely the Ogden-Green River Local will do this.

Lenny made a switch panel for Echo and Park City and the Ideal Cement Co., and it is seen here. The turnouts in the plant are beyond reach here (over the trestle spanning the Weber River), so his switch panel makes a clear map of the track work in the plant which is somewhat complex and further complicated by a short yard lead that only allows two cars of eight (shown by looking over the trestle) to be picked up or spotted at once.

Figure 18. Park City Branch hidden track on a grade down to under the lower bench just east of Echo, Utah.

CHEYENNE ROUNDHOUSE

Allen Montgomery built most of the major Cheyenne yard structures built as shown in the previous photos.

Lenny Wyatt scratch built the Passenger House of the Cheyenne roundhouse. The prototype had 48 stalls divided into two separate buildings, the Passenger House and the Freight House. Lenny's version (now completed) has 11 passenger stalls and 18 freight stalls, for a total of 29 stalls, which is all that could fit on the reduced radius available on our bench. The Passenger House is shown in Figure 19 during construction. Doing the entire 20 stalls would have necessitated increasing the outside (and inside) diameter of the house and moving it back from the turntable pit, or else making the stall tracks cross each other near the pit. Neither alternative was acceptable.

Lenny drew the brick walls and the window frames on AutoCad. He printed out the wooden walls from 1/8" plywood. The brick for the walls was painted on plain paper on an ink jet printer, and the sheets were glued to the flat 1/8" plywood walls. See Fig. 20. The brick support posts at the building corners and between sections were made by gluing a second layer of plywood to the wall and then wrapping the printed

Figure 19. Passenger House, part of Cheyenne's split roundhouse, being test fit in Cheyenne on the upper bench.

Figure 20. Passenger house brick detail.

brick paper around the wall and each post. Using a great deal of care and more patience than I could summon, he managed to get the crease of the folded paper exactly into the inner bent corners or around the outside corners with the preprinted brick lined up perfectly just as they would appear if laid by brick layers.

The window frames were a size that we could not find commercially with their pattern of 4 - 5 - 4 vertical glass panes wide. Drawing them on AutoCad was hard, but straight forward. He then had them laser cut from plywood at a commercial shop in Phoenix. The next two pictures show the completed Passenger House.

Figure 21. Side and front of the Passenger House in Cheyenne on the upper bench.

Figure 22. Rear of Passenger House in Cheyenne on the upper bench.

There are more roundhouse details in a subsequent article solely about it.

PHASE III: THE REST OF THE BENCHES

Figure 23 shows the layout from the mezzanine looking out over the last benches built. This was phase III. The far right-hand bench was the starting point of bench construction, and the next three benches right to left were the final phase III. They connect to the main helix, which is at the center of the layout if main staging is counted. Phase II is shown in Fig.7. In those photos the main helix was in a temporary location at the bench that was the beginning of Laramie. We put it there so we could conveniently run trains over both ends of the layout, i.e., through both Cheyenne to staging and through Ogden and through staging.

This half shows Rawlins, Wyoming and Sinclair Refinery on the far left left, next the barren prairie, the Red Desert, and on the right Wamsutter, Wyoming with a center siding between the two main tracks. Cheyenne is on the far bench across the top, and the Cheyenne classification yard is on the top level on the far right. Part of Rock Springs, Wyoming and the east end of the Green River yard is visible on the lower level.

Figure 23. The other half of the layout from the mezzanine.

FOUR MAIN YARDS TO WORK IN OP SESSIONS

Figure 24 shows the rest of the Green River, Wyoming yard. The turntable is at the far end of this bench, as will be the roundhouse, and the Green River coal tower. The four yards, Green River, Cheyenne, Laramie, and Ogden are major yards with full time yardmasters (YM). Green River and Laramie are busy enough to require an assistant, who we call Classification Foremen. Green River is just east of the OSL junction at Granger, Wyoming (across the aisle to the left here), so cars bound for Portland on the OSL must be dropped in Green River to be put on a Portland bound train. Likewise, cars bound for LA or Oakland (staging through Ogden) must be pulled from Portland trains to await a train for those eventual destinations.

Laramie is worked in the same manner. East bound trains through Laramie must have any cars bound for Denver (on the Denver track—the “hidden track” sneaking along the Cheyenne bench edge) pulled to be held for the next Denver train. Denver trains on the prototype and the layout both bypass Cheyenne by going down the east slope of Sherman Hill on Track #3, the Harriman Cutoff, through the Speer Wye (Figure 15), and past Cheyenne and, on the layout, down the small helix into staging—staging in this case is “Denver.”

Furthermore, at both Green River and Laramie, Big Boys and Gas Turbines used for freights up the Wasatch Mountains or up Sherman Hill, respectively, are replaced with Challengers or FEF steam locomotives or diesel consists. And to return the heavies back down these mountains, the Big Boys and Turbines replace the lighter power at these yards. So, these are two very busy yards.

Figure 24 The rest of Green River yard looking west. The OSL junction at Granger Wyoming is around the far bend near the end of the next bench.

Additionally, Rock Springs on the next two benches to the right of Fig. 24, has no yard (on the model, that is). Allen Montgomery suggested we eliminate the yard there and use the space to add 21 industries to be switched. All incoming and outcoming traffic therefore is through Green River. Rock Springs is a full-time job; it is a giant 110 foot long facing point-trailing point switching puzzle, and it is a long way to the two crossovers to effect a runaround move.

STAGING

For a layout built for operations, staging is probably the most important part of the model. Staging on the Wyoming Division is in four locations. Following convention, staging is not part of the layout with scenery; it represents distant places that trains "go to" or "come from" the layout like actors leave and enter a theater stage from the wings. The four locations are

1.Main Staging on the lower level between Ogden "on" the layout and the Staging Helix, connected to Cheyenne "on" the layout at its other end

2.North Platte, Nebraska—adjacent and perpendicular to the main staging is a 5 track stub yard about 17 feet long to hold trains ready to enter the layout through main staging, up the staging helix, and heading west through Cheyenne "on" the layout (see the green track plan)

3.East Bound Passenger Staging, the 4 tracks joining the east bound passenger tracks out of Cheyenne. See the photo above of east Cheyenne in Figure 13.

4.Portland, the 9 track staging yard under the Rock Springs bench accessible via OSL.

The next photo shows the main staging spread out on the lower level bench to the left. The North Platte staging is just beyond the Ogden roundhouse and has a yellow UP 4 unit F set on it (behind the

25. Ogden round house with staging to the left and Ogden to the right on the lower level and more panels for staging and Ogden.

partial backdrop at the red arrow). This also shows the 3 staging switch panels to control the Tortoise machines near the roundhouse. To the right is Ogden “on” the layout, and counting from the bench edge inward are the Locomotive track to the turntable and coal tower, 4 Ogden Ready tracks, two mains on into staging to the west, and 4 passenger tracks in front of the depot with associated passenger car storage, clean out and provisioning tracks, and the Freight House. The brass coal tower (green arrow) has not been painted yet, and only part of it has been set in place. Some of the wiring of the upper level (Cheyenne) can be seen above the roundhouse.

The main staging plus North Platte has over 551 feet of track divided into 5 roughly equal sections for west (beyond Ogden) Passenger staging, unit trains (PFE, soda, coal, iron ore), west (beyond Ogden) classification, and east (east of Cheyenne or North Platte) staging. All of this is in 31 tracks each long enough for a 30-car train plus locomotive, tender, and caboose, or a 15-car passenger train and locos. The minimum track length for all main line yards is 17 feet on the layout and in staging, including Portland.

The 4-track east-of-Cheyenne passenger staging yard to simulate destinations to Chicago, Kansas City, St. Louis, etc. (79 feet of track) was noted in a photo above in the **OTHER VIEWS OF THE LAYOUT** section in Fig. 13. Those 4 tracks are connected to the turning loop on the top of the staging helix.

The Portland yard is under the lower level. It is the origin and destination for OSL freights, especially PFE specials, and the City of Portland, and the Portland Rose. It is shown in Figures 12 and 17.

The minimum track length for any yard track is 17 feet. Altogether there is room for the storage of 33 complete trains which can be ready to run at the beginning of an operating session, and that number leaves at least one free track in each staging section for runaround moves. It is unrealistic to pack the staging that full at the start of or at any time during an operating session. But for our last session we had 31 trains ready at the start of a session, most in staging, and others distributed over the layout in Cheyenne, Ogden,

Laramie, and Hanna. Soon after a session starts there is be ample room to receive trains back into staging from those that start out on the middle of the layout. Others that start in staging and leave near the beginning of the session will not begin to arrive back for over an hour. Thus, a session will start with ample trains running and ready to run, and the Staging Yardmaster and his two assistants should not be overwhelmed at any one time during a session.

BACKDROP ART

One of the most common positive comments by visitors to the layout is the beauty and grandeur of the backdrops. They were done by Kelly Daniels, a local artist. He "Photoshopped" images of the actual Wyoming and Utah locations, including skies, animals, people, vehicles, and structures—old and new—into images and then assembling them into long scenes extended over the entire layout. They are printed on vinyl on his commercial printer and then applied to the Masonite backdrop panels. Photos of them appear throughout this article.

LATER ADDITIONS TO THE LAYOUT

In October and November 2016 Allen Montgomery took a research trip to Wyoming and returned with the names and locations of some industries we could add to the layout to have more spots to switch. He also wanted to revise the Laramie yard track plan to make it easier to work (or harder to goof up). He made the Laramie changes, and I drew them up as track plan v13.4 (see second paragraph below). This added 6 new industries along the Laramie backdrop west of the Depot and Freight House. He also moved the Stock Yard and improved the yard access from the west to reduce congestion.

Elsewhere on the upper level Allen added tracks to switch new industries: 4 industries in Medicine Bow, 2 in Hanna, 4 in Rawlins, and 4 in Wamsutter. On the lower level he added tracks and 4 industries to switch in Evanston. Of the new businesses, 9 were oil distributors, which was practical because the layout has two refineries, Frontier Oil in Cheyenne and Sinclair Oil in Rawlins. There is a lot of competition between them, at least which name gets added as a destination on tank car cards.

The **revised track plans (v13.4)** are in the following article "Signals on the Wyoming Division" on this tab.

PHOTOS ON SLICKPIC

I have a complete set of photos on SlickPic, the web photo sharing site. The link is

http://www.slickpic.com/s/Y41MN1MTTATUA0/WyomingDivisionHOOperationLayout?preview There are sub albums inside this album including photos of us operating.

SUMMARY

We started construction as the building was being completed just after Thanksgiving, 2011. Through May 2014 we have built the 9 benches, laid 1,006 feet of double track main, 630 feet of staging, the OSL and its staging, built the two helices and have the DCC wiring done to date and tested. We have used over 5,000 feet of code 83 flex track. (Eventually, we used nearly 300 feet more for a total of about 5,300 feet to add more industrial spots in Laramie, Rawlins, Wamsutter, and Evanston.

The track work performs beautifully and makes operating a pleasure. The steel framework under the ½" plywood benches with ½" plywood shear panels and spline/cork roadbed and careful track work can be partially credited for that, but most of the credit goes to Allen Montgomery who laid the great part of it.

The backdrops are sensational and very realistic and are faithful to 1957. After 4 years I still see new details that I formally have missed.

We now use 15 NCE boosters for the DCC system (was 7 in the original published article) and it works great after a lot of testing and fiddling to eliminate crossed polarities. When there is an infrequent DCC problem the readily accessible wire trays are very handy. We shoot a screw into them to hold the doors closed, and that is an indication of how infrequently we need to enter one. The spot welding of risers to each section of track has worked out very well. There are no unsightly large solder globs to be seen on the track, ties do not melt, and it is extremely reliable.

Through February 2020 we have had nearly 100 formal operating sessions using my own system of single trick car cards and block cards for car and block forwarding system with locomotive cards to choose locos, and a unique train order sheet, and it all worked well together. We have missed only one monthly op session since 2012, and we have had 6 Invitational 3 day meets, and participated in one Desert Ops Session. I have in the past had training sessions to teach the operating system where a road crew of an engineer and a conductor/brakeman work together to operate the throttle and the cards on the clipboard, with Allen or me closely supervising. But for the past few years I just work with a new operator until he can operate a freight alone. That is usually only until the end of the first or second bench.

The best news is that my new and unique car forwarding Car Card system worked well considering the complicated operating scheme based on the prototype UP Wyoming Division as outlined above. I will describe it in a future article.