

# Education Program Basic Skills Series



## Module Three

# Layout Planning

The following pages introduce the essential elements of planning for your model railway

- What do I want to model?
- Practical considerations
- Curve radius and point work
- Train length, stations and staging tracks
- Stub and through yards
- Track centres, clearances and gradients
- "S" curves
- Personal layout design criteria
- The squares method
- Drawing your track plan

## What do I want to model?

The fundamental question to answer before designing your model railway is what do you want to model. Your choices can be broken down into prototype, era, locality and purpose.

### Prototype

Prototype determines the railway you model such as Australian, British, North American, Logging or Narrow Gauge and extends to the actual Railway or Railroad you model e.g. Union Pacific, NSWGR, LNWR. If you want something different why not model CVRD's heavy duty metre gauge operation using locomotives such as sixteen wheeled 3600 hp SD45M number 869 shown in the attached photo.



### Era

Era is the time frame you are modelling such as steam, transition to diesel, diesel, current day or preserved lines. An example of this is preserved BR 9F 92214 a heavy freight locomotive shown hauling an excursion of a preserved branch line. You should also consider the locality of the modelled area and the purpose of the railway (railroad). Examples are a coal hauling branch line in West Virginia or a passenger and freight main line in rural NSW.



### Main line or Branch line

Mainline or branch line determines how you operate your layout.

Main line layouts emphasise train operations and operate frequent heavy trains hauled by powerful locomotives such as the two PN 93 class pictured on a container train.



Branch line layouts emphasise the scenery and operate infrequent light trains hauled by secondary motive power such as 4853 pictured on a short concentrate train.

## How do I want to operate my model railway?

The basic choices are central control panel or walk around control.

Central control panel operation has the throttles built into a fixed control panel. Point control is by powered point motors. The photo shows a throttle built into the layout fascia. This type of layout only needs access for maintenance purposes.

Walk around control uses plug in or radio throttles and local point control. The attached photo shows a typical walk around plug in throttle. This type of layout requires access, preferably walk in for operations and maintenance.



## Practical considerations

Treating your first layout as a training/learning exercise is a sound idea. A modest sized first layout allows you to decide what you do and don't want on a future more extensive layout. The following considerations can help you design a more enjoyable model railway.

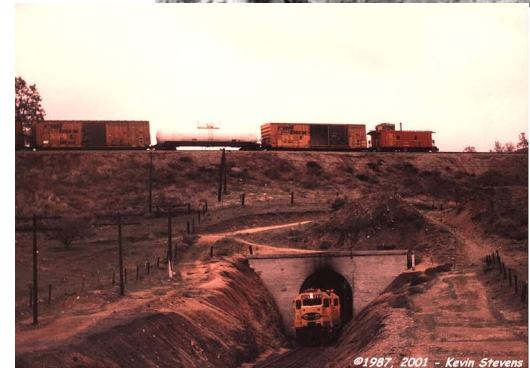


### Selective compression

It may seem attractive to model the entire Santa Fe but cost time and space considerations make it impractical. Even modelling a specific location full size becomes impractical.



Walong Loop in California where the track rises 30 metres in a spiral loop is over 400 metres in diameter. Trains over one and three quarter kilometres in length cross over their tail rounding the loop. In HO scale this is four and a half metres in diameter.



Our model railways are an impression of the railway we model. Selectively compressing the scene you want to model allows you to model the essence of the locality in a manageable space. The HO scale exhibition layout pictured based on Walong Loop set in winter measuring 1,200 mm by 1,800 mm gave an impression of the location and the trains that run over it.

### Deck height and accessibility

The height of your layout deck depends on the intended user. Access to your trains and track from the edge of your layout is independent of the scale and gauge you use. For planning purposes we need to keep all track work within reasonable reach from the edge of the layout.

A layout deck 1,000 mm high or lower allows you a reasonable reach from the layout edge of 750 mm. A 1,200 mm deck height allows you a reasonable reach from the layout edge of 600 mm.

### Access ways

If you will be the only operator of your layout you can use 450 mm to 600 mm wide access ways and operating areas.

If you intend to have regular operating sessions with a group of modellers you would be recommended to use 900 mm wide access ways and 1,200 mm wide operating areas in your layout design.

### Layout size

While we'd all like a very large layout there are practical limitations to the size of your layout. Home layouts larger than around 20 square metres in addition to the construction and equipment costs, require a lot of maintenance to keep the track clean and the rolling stock in good condition. A 20 square metre layout would occupy a space three metres wide by six to seven metres long.

### Basic research

Seeing other modellers layouts provides a wealth of track planning ideas. NMRA Australasian Region Divisions meet monthly at members home layouts. Visiting these meetings as well as meeting local railway modellers will let you see a variety of layout designs. Meeting locations and times are available from local divisional superintendents. Superintendents contact details are listed on the Region web site [nmra.org.au](http://nmra.org.au)



## Curve Radius and Point work

The most important layout planning decision you need to make is the curve radius

For railway modellers there are three classes of curve radius to consider

- Prototype minimum
- NMRA Recommended Practice RP 11
- Manufacturers recommended minimum radius

### Prototype Minimum Curve Radius and point work

This is the minimum radius the real rolling stock can negotiate at low speed. The manufacturers operating handbook for the EMD SD40 series locomotives quotes a single unit minimum radius of 193 feet. ( in HO scale 675 mm) for a single unit and an AAR minimum radius of 338 feet. (in HO scale 1183 mm) The North American Association American Railroads minimum radius is with the locomotive coupled to a fifty foot freight car.

Models operating on curves of this radius look superb as the attached upper photo shows.

Point work scaled from prototype drawings fit in with using prototypical curve radii. These models are scaled down replicas of real point work. They do require considerable space and fit in with using prototype minimum radius curves

### NMRA Recommended Practice RP 11

The SD40 is 66 feet long. NMRA RP11 would classify the SD40 as curvature class "O". In HO scale the recommended curve radius for class "O" rolling stock is 32 inches or 812 mm. Details of NMRA RP 11 are available on the NMRA web site; <http://www.nmra.org/>

NMRA RP 11 radius curves are a good compromise between appearance and operability as shown by the photo on the left of two BR coaches on an 812 mm radius curve

Major manufactures such as PECO produce point work with curve radius similar to NMRA RP 11 requirements. Their 16.5 mm gauge medium radius point work has a radius of 914 mm and a divergence angle of 12 degrees. These point work designs save considerable space on your layout compared to replicas of real point work.

### Manufacturers recommended minimum radius

This radius is the one listed in the catalogue or the literature in the package the model comes in. Lacking any information, a radius of twice the length of the model is a good guide for diesel and electric locomotives .

Most OO scale models of British railways rolling stock have a Manufacturers recommended minimum curve radius of 438 mm. PECO and other manufacturers manufacture point work of 438 mm radius.

Models operating on the minimum recommended curve radius operate reliably at the expense of appearance as shown by the photo on the right. Hiding these sharp curves or viewing them from the inside of the curve as shown by the lower photo reduces the unsightly effect .



# Train length, stations, passing tracks and staging tracks

The length of your trains has considerable effect on your track plan, particularly stations and staging tracks. Our eyes perceive a train is long if it is longer than a 180 degree bend of your main line curves and consists of more than seven vehicles.

## Train length

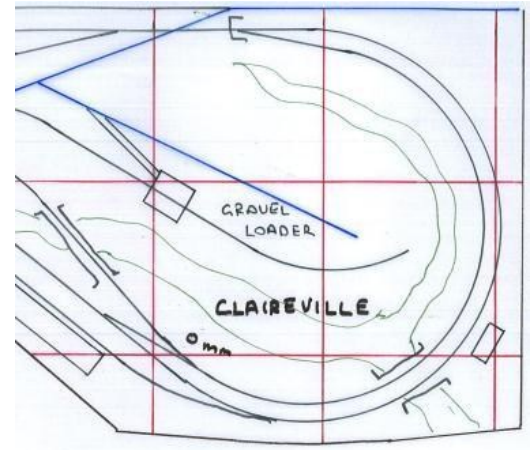
Experience shows the longest reliable operational train is around three quarters of a circle of your layouts minimum design curve radius.



This gives you a longer train than you might think. Using the manufacturers recommended curve radius for OO scale British models the longest reliable operational train is around 2,100 mm long. This allows you to operate a passenger train consisting of a mainline diesel locomotive and seven passenger coaches. As the photo shows a seven coach passenger train is a reasonable looking main line train.

## Stations and passing tracks

The 2,100 mm long train from the previous example needs a passenger platform as long as the train. A straight platform to accommodate this train with a manufacturers recommended curve radius curve at each end will require a space around 3,000 mm long. A straight passing track to accommodate our 2,100 mm long train with a curve at each end requires a space around 3,300 mm long. Wrapping all or part of the station or passing loop around a curve can save considerable space on your layout. The track plan on the right illustrates this technique.



## Stub and Through Yards

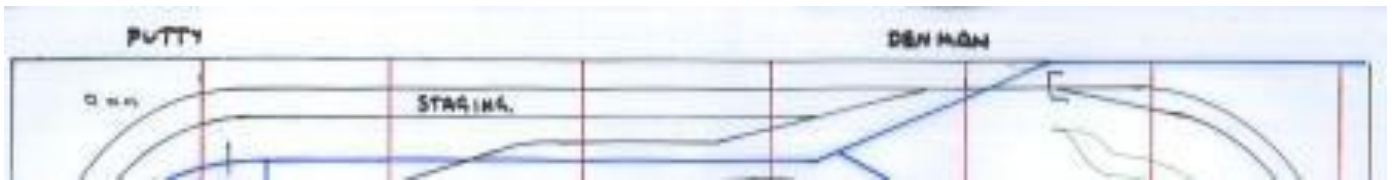
Associated with rail terminals (passenger and freight) will be marshalling and holding yards. These yards can be stub yards where trains must exit the same place they entered (dead end tracks). In through yards trains can enter and exit the other end of the yard.

## Staging tracks

We need to thank our British compatriots for the concept of staging tracks or in their words "Fiddle yards". These out of plain sight tracks represent the rest of the railway you are modelling. The staging tracks allow trains to come from somewhere and depart to somewhere else. Staging tracks allow you to change the order of trains and change out vehicles or whole trains. They require around the same space as a passing track. While staging tracks occupy space on your layout, the operational advantage they give you is worth the space consumed.



The photo shows part of the staging track on a working layout. The attached track plan shows the staging yard occupies almost the whole of the 3,600 mm long layout but is out of sight behind scenery or a divider.



## Track centres, clearances and gradients

Track centres, clearances and gradients affect your track plan.

### Track centres and clearances

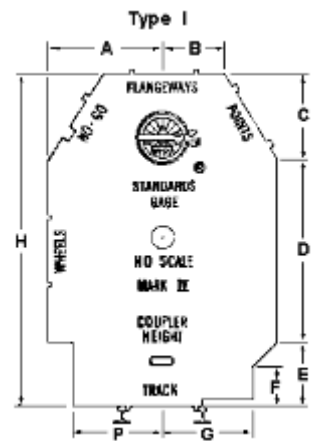
Layouts using prototype or NMRA RP 11 curve radius need to use the track centres shown in NMRA S8. Details of NMRA S8 are shown on the NMRA web site <http://www.nmra.org/>

Track centres on layouts using the manufacturers recommended minimum radius curves should adopt the track centres used by the manufacturers sectional track. For 16.5 mm gauge track the readily available PECO and Hornby track systems use 67 mm track centres.

The horizontal and vertical clearances from the track centre line depend on the era and location you model and the curve radius you choose. NMRA S7 provides a range of clearances on straight track depending on era modelled. Details of NMRA S7 are shown on the NMRA web site (<http://www.nmra.org/>) The NMRA Standards gauge is a handy way of checking clearances on your layout

Horizontal clearances on curves need to be modified from the NMRA S7 clearances to account for the geometry of rolling stock on curves, NMRA S8 provides inside and outside curve clearances for curves to NMRA RP 11.

The PECO and Hornby 16.5 mm gauge track systems require an outside clearance of 40 mm and an inside clearance of 30 mm to provide adequate clearance for most rolling stock capable of negotiating these curves.



### Gradients

Ideally railways are flat. Climbing gradients requires additional power to move the train. Currently designed railways use gradients of the order of one in one hundred. Nineteenth century built railways used gradients between one in forty and one in fifty. Some lines have used gradients around one in thirty which is the maximum gradient recommended for Main and Branch lines where the topography did not allow the use of gentler gradients.

A typical use of gradients on a model railway is to allow a train to cross over another train. The over head clearance between Adelaide and Perth is 7,200 mm. In HO scale this is 83 mm. Allowing twelve mm for the road bed, three mm for the ballast and five mm for the track. The track needs to rise a total of 103 mm. allowing for a slight tolerance say 105 mm. Gaining this height would require

- 10,500 mm for a one in a hundred gradient (1%)
- 5,200 mm for a one in fifty gradient (2%)
- 4,200 mm for a one in forty gradient (2.5%)
- 3,150 mm for a one in thirty gradient (3.3%)

The length of these slopes need to be taken into account in your track planning.

Models of diesel locomotives with all wheel drives are little troubled by gradients. Models of steam locomotives have fewer driving wheels and less space inside the model for weight above the driving wheels than models of diesel locomotives. Consequently model steam locomotives can't pull as hard as model diesel locomotives. The haulage power of models of steam locomotives can be considerably reduced on gradients.



## “S” curves

A long train sweeping through a “S” curve looks impressive, however due to the size of our layouts “S” curves can have a sting in their tail. The effect on the couplers of your models negotiating a S curve on a model railway needs to be considered in your track planning. If the straight distance between the curves is too short the couplers on your rolling stock might not have sufficient side swing to accommodate the differing side movement of the ends of adjacent vehicles.

A good rule of thumb is to separate the reverse curves of an “S” curve by a length of straight track longer than your longest vehicle fitted with body mounted couplers. This is shown in the photo above right.

Cross overs and yard tracks can also introduce “S” curves onto your layout. Using the next larger radius points than your minimum radius points will eliminate potential “S” curve problems in your cross overs and yard track work as shown in the photo.

Alternatively you can arrange your track plan to eliminate the “S” curves. The top track layout in the photo looks more attractive to the eye, eliminates the “S” curve and increases the capacity of passing loops and yard tracks.

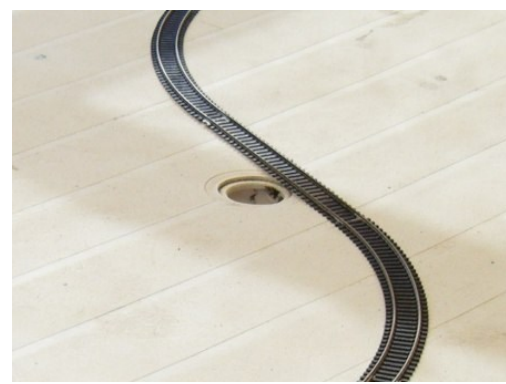
## Personal Layout Design Criteria

It’s your layout. The criteria you design it to is up to you. A layout design criteria allows you to design your layout and know it will accommodate your chosen rolling stock and the length trains you want to operate.

The attached layout design criteria guided the design and construction of a layout still giving railway modelling enjoyment after more than fifteen years. The initial design criteria for the layout was;

- Design motive power EMD SD40T-2
- Minimum main line curve radius 504 mm
- Curved track spacing 67 mm
- Train length 2,100 mm
- Single track main line
- Two visible passing sidings
- Three train staging yard
- Peco Medium radius point work
- Trains pass through a scene once in a trip around the layout.
- Walk around access by train crews

The attached photo shows the layout design criteria as to motive power operation has been well and truly met even if scenery development is a little tardy.



# The squares method

The squares method of estimating the track planning potential of the space available for your layout was developed by the late John Armstrong in the 1950's.

## The track planning square



A track planning square contains, as shown in the photo above right, a 90 degree curve of your minimum curve radius, the next larger curve radius and the curved track clearance. The size of the track planning square depends on the scale of your models and the curve radius you choose.



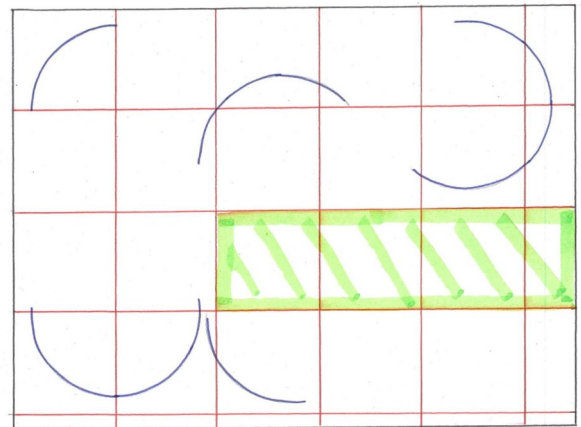
For the HO scale SD40T-2 used previously the minimum radius track planning square is 611 mm. The NMRA RP 11 curve radius track planning square for our SD40T-2 is 914 mm.

The track planning square is simple to use, for example; a 180 degree curve of track requires a space two squares wide by one square long and a return loop requires a space two squares wide by four squares long.

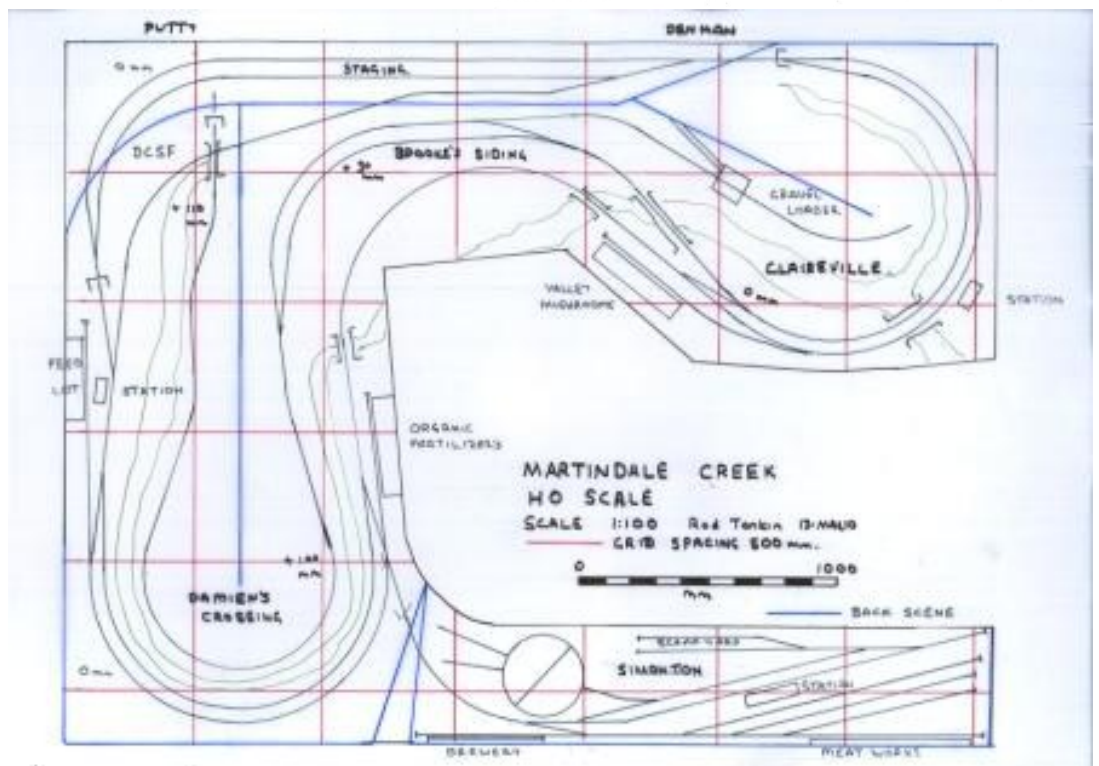
## Using the track planning square

You simply lay a grid of your layout squares over your layout space. Once you have done this you can see the track planning possibilities of your layout space.

The diagram shows the track planning possibilities of a layout space 2,250 mm wide by 3,600 mm long using the SD40's minimum radius track planning square of 611 mm. For initial layout purposes the access way is allowed a space one square wide.



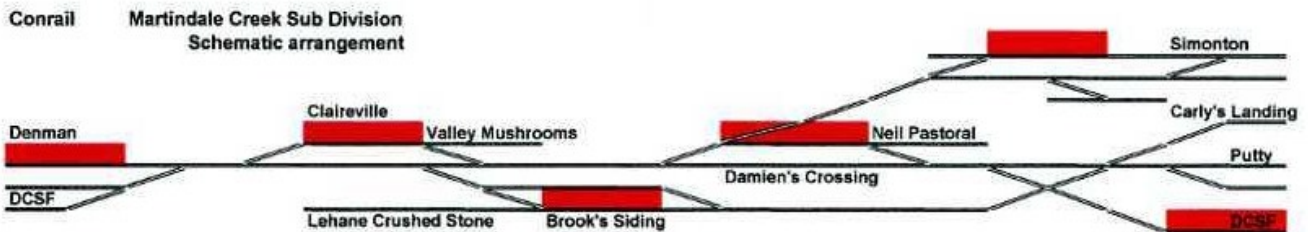
The attached track plan shows the HO scale layout developed off the squares diagram shown on the right. Originally in 1996 only the main line and staging tracks were built. The yard was added in 1998. The tight radius curved branch line was added in 2005. It's still not finished.





## Number of operational trains on your layout

The number of trains you can operate on your layout is dependent on the design of your layout. A reasonable rule of thumb is you need a clear path around your layout with a train in each passing loop and the staging yard/yards with one track clear. This approach allows any train on the layout to move without requiring any other train to move. The schematic arrangement above is of the layout plan shown on the previous page . The red bars repre-



sent a train in a passing siding or staging yard track. The rule of thumb approach allows up to six trains to operate on the layout. Physical access limitations around the 2.7 meter by 3.6 metre layout means the practical number of train crews operating trains on the layout is three.

## Drawing your track plan

Drawings of your track plan are needed for a few reasons. These include

- Records of your design as it progresses.
- As an aid to building your layout
- Publication

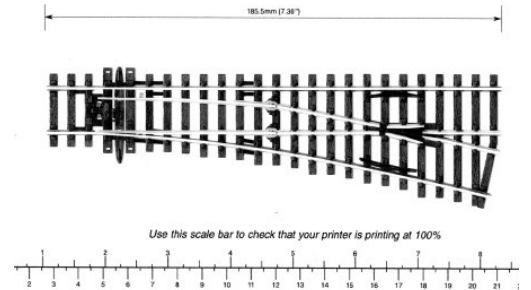
Modern drafting uses computers. If computing is your thing there are excellent layout design drafting packages to choose from. Us old lags can use a pencil. A 2B pencil and 5 mm grid squared paper is easy to use if you're not computer minded.

I've found a scale of one to ten useful for hand drawn layout design drawings. They are easy to read and a reasonable size to handle. I've found preparing a heavily drawn outline of your layout space to scale an advantage. I then lay lunch wrap paper (its much cheaper than tracing paper ) over the master outline and try different track plans in the available space. All you need to draw your layout plans are a 300 millimetre steel ruler, protractor, school compass, clutch pencils and most importantly an eraser. Once you are satisfied with your design scan it and print out copies for use during the construction phase.

Aim for a reasonable design. Don't get too concerned with hair splittingly accurate drawings. Once you start building additional options often become obvious. Allow some latitude in your design. Rooms are often not square. Marking the centre point of curves on your drawings helps layout the curves on your layout during construction.

## Laying out complex track work

Laying out complex track work in one tenth scale is a little fiddly. PECO's web site (<http://www.peco-uk.com/>) has down loadable, printable full size arrangements of all their point work. These are easily printed out and arranged on your road bed so you can trial layout your track work as shown in the attached photo.



## Record your design as it progresses

Recording the development of your design helps you with options. There is an old engineering joke that the project would have performed much better if it had been built to the drawings. Your drawings are a guide to building your layout. If you can't follow the drawings, check there is not an error in the drawings or a mismeasurement of your layout space. Noting changes to the design as you progress will allow you to review your design.

## Publication

Model railway magazines love publishing articles about layouts. Supplying a reasonable layout plan with your article helps it get published. The track plan on the right was hand drawn.

## Further reading

"Track planning for realistic operation" by John Armstrong  
Kalmbach Publications.

"102 track plans" Kalmbach Publications.

Design Your Layout (almost) Like Magic – Lyndon Spence (NMRA web site/clinic presentations)

Layout Planning – Phil Moore (NMRA web site/clinic presentations)

Basic Model Railroad Operations Part 1 (NMRA web site/clinic presentations)

