Layout design and operations bootcamp

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PRESENTED TO CALGARY MODEL RAILWAY SOCIETY

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Outline

What are our objectives?

- -Layout design criteria
- -Armstrong design goals

Best minimum curve radius

- -Operability and appearance

Smart layout design standards

- -Turnout sweet spots
- -Curve easement and superelevation

Outline

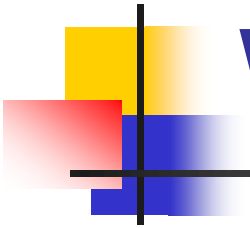
- -Aisle width

Mainline design

- -Armstrong's square planning technique
- -Eight HO-N-O minimum space track plan templates, including no-stoops
- -Staging

Freight yard design

Industrial and other trackage



What are our objectives?

What are our objectives?

A layout is typically a commitment of thousands of hours and dollars

-To obtain sustained value for our efforts and outlays I believe we should seek to create a *reliable*, *operation-based* layout that satisfies the owner's explicit *design criteria*

Reliable–run trains without the burden of mechanical and electrical problems

What are our objectives?

Operation–exploit an underutilized facet to maintain our interest, long term

- -Our perspective shifts from observing static scenes to operating moving trains
- -Complements other goals like R&D, detailing
- -If not explicitly built into original design, may be impractical to retrofit
- -Save multi-thousand $ cost of building anew

Mimic the prototype's business

Create a working model that appears to function as part of a multi-railroad, continental rail system, moving goods from producer to customer and people between cities

-Interactions of local and through freights

-Car interchange with connecting railroads

-Scheduled connections of passenger trains

What are our objectives?

Design criteria–John Armstrong's "Givens and 'druthers"

-Consciously specified by layout owner for designer to satisfy

-Allows owner to appreciate the possibilities and required trade-offs

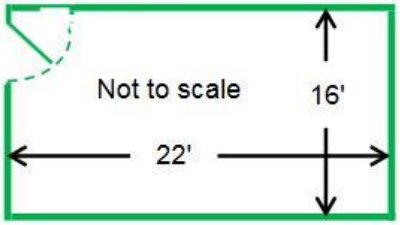
-The criteria should cover track and non-track space, in all three dimensions

Givens and 'druthers

Scale - HO Gauge - Standard

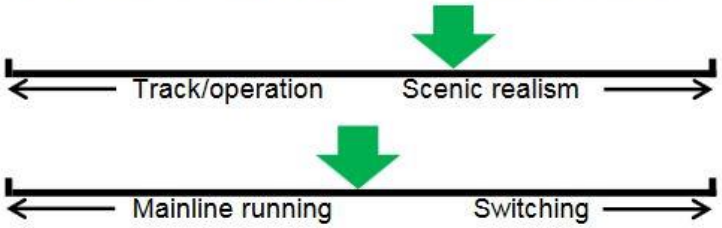
Prototype Era - Summer 1953 (late steam and first generation diesel)
Region - Central Montana
Railroads - Northern Pacific + Chicago, Burlington and Quincy

Space - 16' x 22' room, 8' ceiling, entrance door in one corner of room and no other obstacles



Governing rolling stock
125' NP Class Z5 Yellowstone (2-8-8-4)
126' NP Class Z8 Challenger (4-6-6-4)
85' domed passenger car, 50' standard height boxcar

Relative emphasis

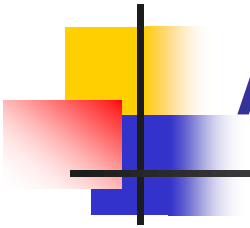


Typical operating crew count - 6 Eye level of owner in shoes - 65"

Operating priorities

-Long freight, 20+ cars
-Medium frt, 10-15 cars
-Local freight operations
-Helper operations
-Engine terminal activity
-Mainline psgr, 8-12 cars
-Branchline psgr, 3-4 cars
-Psgr train switching
-Commuter trains
-Timetable/fast clock

Pick your top four to six operating priorities and tailor the layout design



Armstrong design goals

The mainline is sufficiently long and oriented to convey the impression that the trains are going somewhere

- -Able to walk with a train without having to duck under sections of benchwork
- -Do not have to backtrack to follow a train around the end of a peninsula
- -Trains pass through the same segment of scenery only once

Armstrong design goals

-Mainline is largely in the open, not buried in tunnels or behind buildings

-Trains are at a good viewing height

-Views of scenes are controlled to increase realism and the perceived length of run

-Sharpness of the track curves is disguised

-Layout has staging tracks and/or off-line interchanges

Armstrong design goals

Once off stage trains can be readily turned for the return trip

All important track and scenic features are within arm's reach–benchwork not more than 27" deep

Track is a big proportion of the scenery

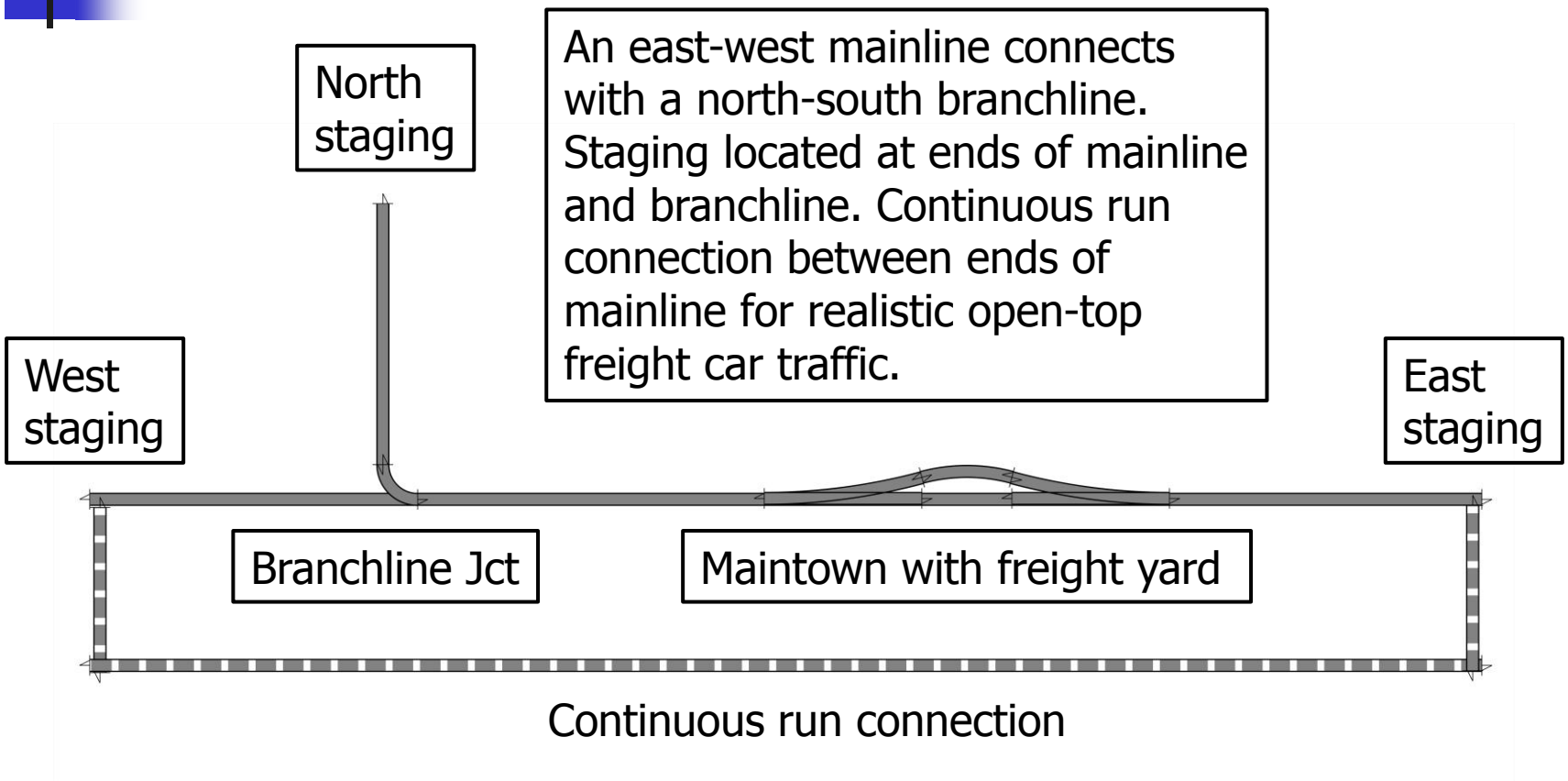
Armstrong design goals

One does not have to crawl under benchwork to enter the layout area

The track schematic handles open-top freight car traffic realistically

-For example, visible loaded cars always run east and visible empties always run west

Good generic track schematic



Best minimum curve radius

The information in this section has been adapted from an article by Joe Fugate, Powerful new curve radius insights for any scale*, published in* Model Railroad Hobbyist Magazine, First Quarter 2009, pp. 45 – 54*. The numerous photos in the article of rolling stock situated on track of various curve radii, and photographed from different angles, are insightful. An electronic copy of the entire back issue is available for download at no cost at* http://model-railroad-hobbyist.com/magazine/mrh-2009-Q1

Best minimum curve radius

Maybe the most significant question after choice of scale

-Governing rolling stock from Givens and 'druthers is a key reference point

Three dimensions to the answer

-Minimum radius without derailments

-Minimum radius for which trains look OK

-Minimum radius on which cars will couple

Minimum radius no derails

Some rolling stock may track reliably at this radius, but just barely

Rules of thumb (valid for any scale)

-For industrial spurs = 2 x car length

-For mainline = 2.5 x car length if all cars similar lengths

-Mainline = 3 x longest car if lengths vary

Minimum radius to look OK

The appearance of a train on a curve is a function of the viewer's perspective

-If viewed from above + outside the curve, looks OK at a radius = 4 x car length

-If viewed from above + inside the curve, looks OK at a radius = 3.5 x car length

-Appearance even better viewed close to eye level–looks OK at as little as 2.5 x car length if viewer is inside the curve

Minimum radius to couple -body mounted couplers

This standard is very sensitive to the variability of car length + coupler style

-If all cars are the same length, reliable coupling radius = 2 to 2.5 x car length

-If car lengths vary, reliable coupling radius = 3.5 to 4 x longest car

-If mixing car lengths as well as scale + non-scale Kadee style couplers, need 4 to 4.5 x

So the best radius is …

… the *smallest* radius that meets tracking, appearance and coupling needs

To keep this number reasonable

-Build layout high, closer to eye level

-Orient aisles so operators are inside curves

-Use different minimums based on each track's traffic–40' freight cars, 85' psgr cars

So the best radius is …

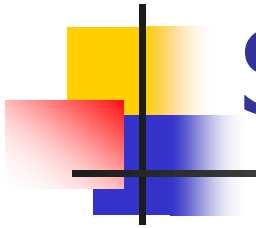
-Pick one brand and style of couplers

-If running mixed car lengths keep tracks at ends of yard straight for reliable coupling

Avoid S-curve derailments

-Install straight track segments between opposing curves, for *entire* layout

-Straight section must be at least as long as longest equipment running on track segment



Smart layout design standards

Smart layout design standards

Refers to minimum curve radius, turnout size, train length, track grade, aisle width

May be sensible to use distinct sets of standards for different parts of the layout

- -Mainline versus branchline
- -Freight yard versus coach yard
- -Industrial trackage

Don't waste space

NMRA straight turnout #	Frog angle in degrees	Minimum radius of diverging route (radius of closure rail) in inches		
		N	HO	O
4	14.3	7 (9)	14 (15)	29 (30)
4½*	12.5	---	22	---
5	11.4	12 (14)	23 (26)	48 (52)
6	**9.5**	**19 (24)**	**35 (43)**	**74 (83)**
7	**8.2**	**24 (?)**	**45 (49)**	**94 (?)**
8	7.2	32 (37)	60 (67)	126 (132)

Figures are per the new 2015 NMRA Recommended Practice RP-12 (pre-2015 values shown in parentheses)

* Atlas HO #4 "Custom-line" turnout is actually a pre-2015 NMRA #4½

Turnout sweet spots

NMRA straight turnout #	Frog angle in degrees	Min. rad. in inches	
		N	HO
Roco HO code 83 15-degree	**15.0**	---	**34**
4	14.3	7	14
5	11.4	12	23
Peco HO code 75/100 12-degree			
- Small straight	12.0	---	24
- Medium straight	**12.0**	---	**30**
- Large straight	12.0	---	30
Roco HO code 83 10-degree	10.0	---	77
6	**9.5**	**19**	**35**
7	**8.2**	**24**	**45**

Curve easements

Reduced coupler lurch

-Better train appearance

-Fewer derailments

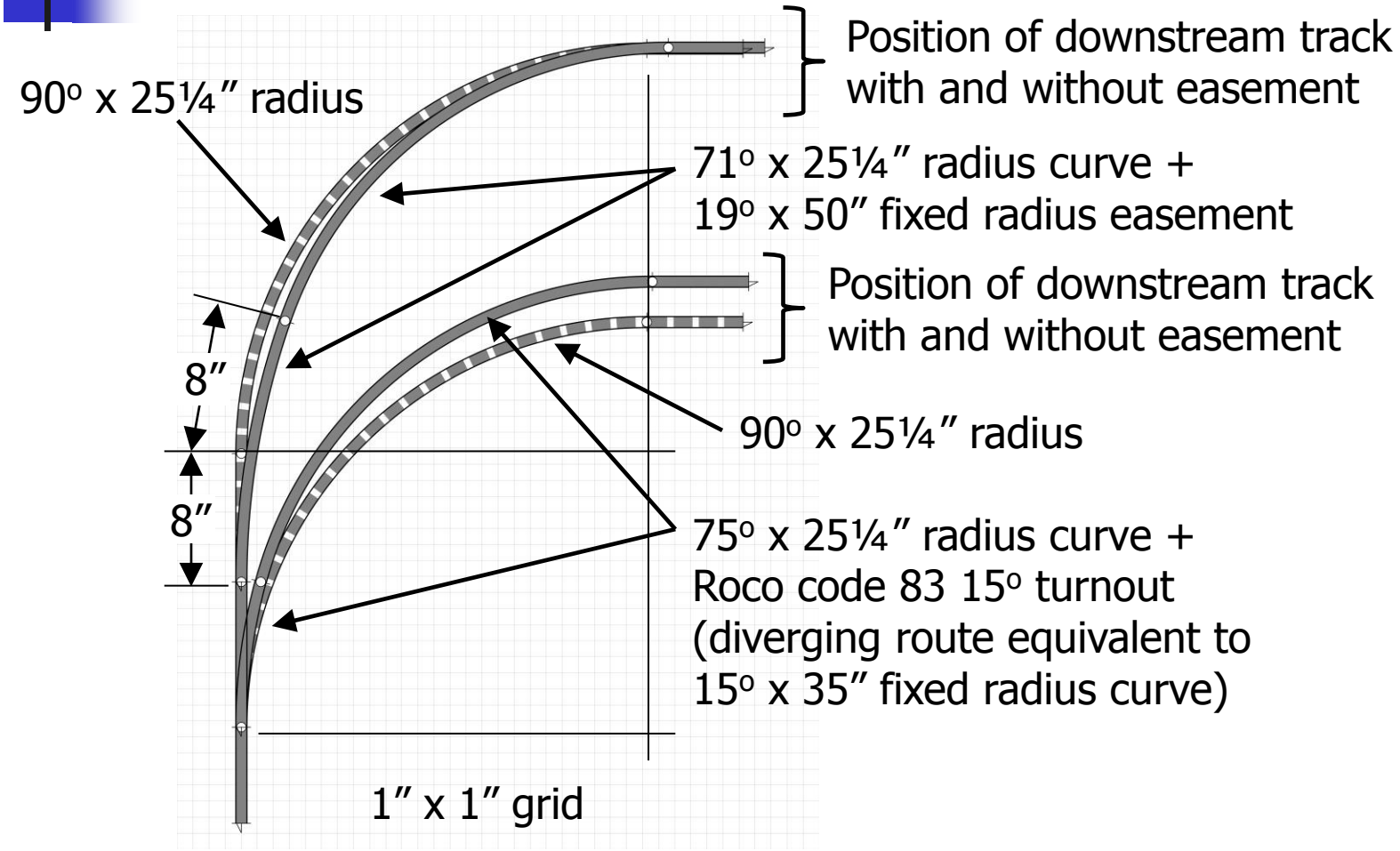
-Stiff equipment may tolerate a slightly smaller minimum radius

Good, but not free

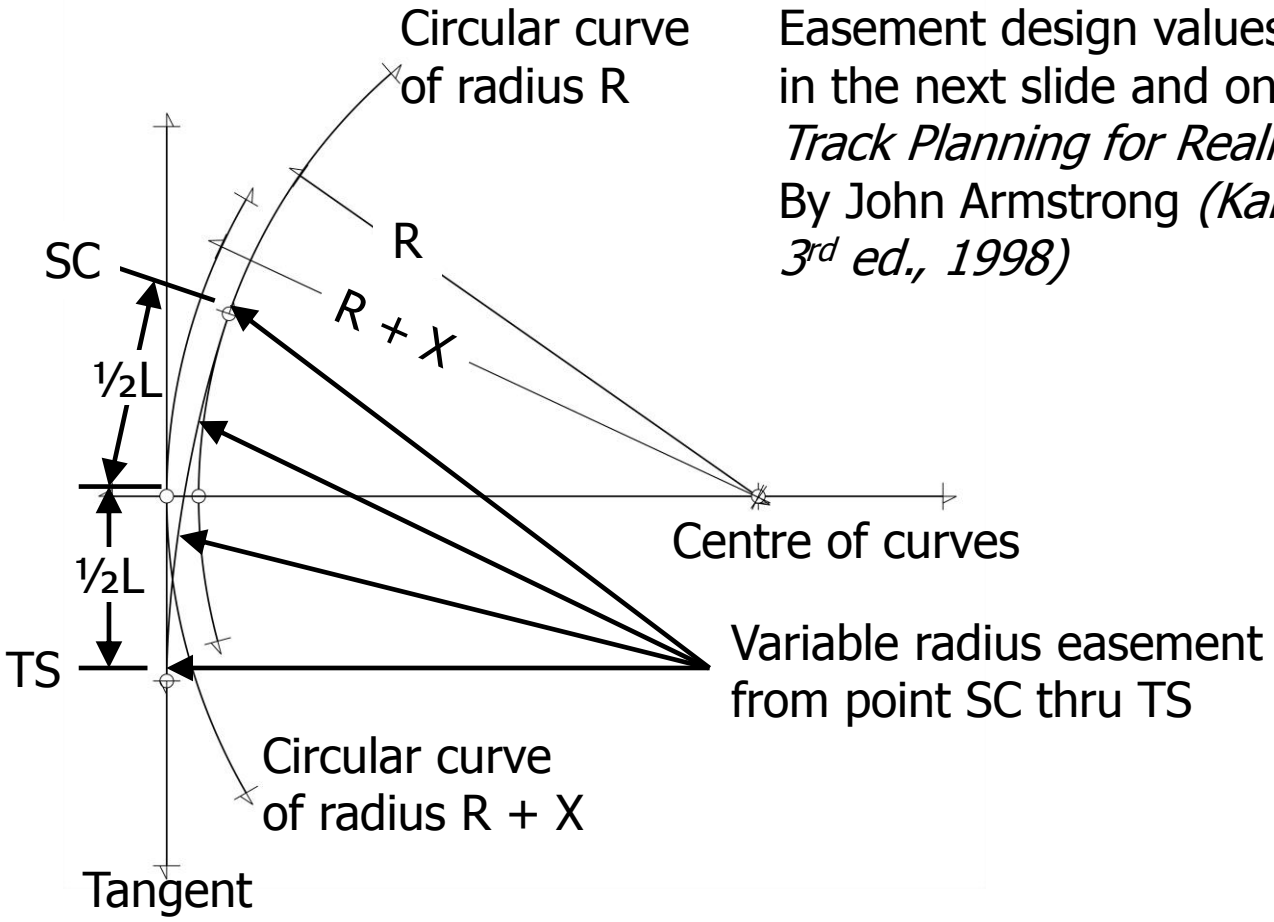
-Reduces length of straight between curves

Turnout diverging route is an easement

Simple easements for an HO 90º curve of 25¼" radius



Better curve easements



Easement design values are shown in the next slide and on *p. 116* of *Track Planning for Realistic Operation*, By John Armstrong *(Kalmbach, 3rd ed., 1998)*

Better curve easements

Dimensions in inches		N	HO	O
Sharp curves	**R**	**9¾**	**18**	**32**
	X	3/16	⅜	½
	L	6	12	20
Conventional curves	**R**	**13**	**24**	**42**
	X	¼	7/16	⅝
	L	8	16	25
Broad curves	**R**	**16**	**30**	**54**
	X	¼	½	¾
	L	10	18	30

Taken from *Track Planning for Realistic Operation, Page 116,*
By John Armstrong (*Kalmbach, 3rd ed., 1998*)

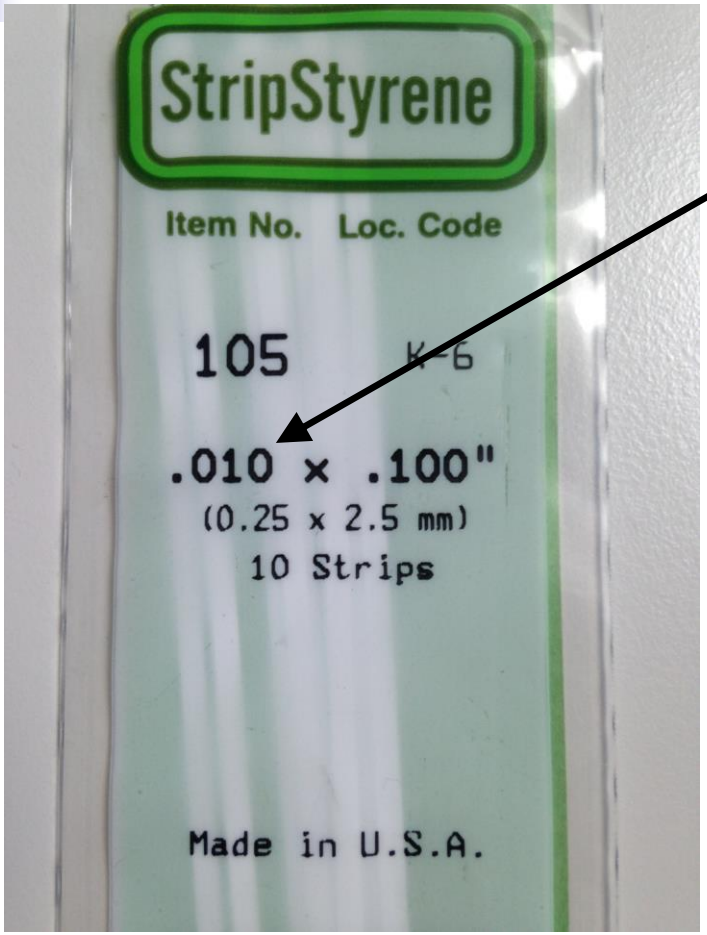
Superelevate (bank) the curves

Superelevation is easy to do, and adds a visually important railroad-like detail

-Attach strips to the top of the roadbed with white wood glue along the arc that the outside rail will lie long the curve

-Ideally start banking on the adjacent straight track segments, for HO about 12 actual inches from ends of the curves

Superelevate the curves



0.010” thick styrene strip
X 87:1 = 0.87” or roughly
one HO scale inch (1”)

Superelevate the curves

Build the strips up in layers, starting at one 0.010” thickness and rising to as many as four, and then taper down

-In HO one thickness can be added or eliminated every 12 to 18 actual inches

-The maximum superelevation (one, two, three or four strips) will be a function of the length of the curve’s arc

Aisle width

Aisle width should be consistent with the design criteria regarding crew size

-Even if you are currently a solo operator, your interests may evolve over time

Start plan with 27” to 30” wide aisles

-More (add 6” to 10”) near high traffic yards and layout entrances

-More for double deck layouts

Aisle width

Disperse the operating crowds

-Relocate overlapping towns to ease aisle congestion points

-Locate most industrial spurs in towns other than the one with main classification yard

High and shallow benchwork

Making track elevation roughly 1’ below owner eye level eases layout construction

-Track can be laid more accurately

-Easier to do wiring and scenery

Operation is more enjoyable

-Coupling/uncoupling cars is easier

-Details of track & trains can be appreciated

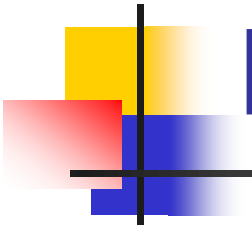
-Sharpness of curves is disguised

High and shallow benchwork

If trains can be operated without stooping, aisles can be narrower

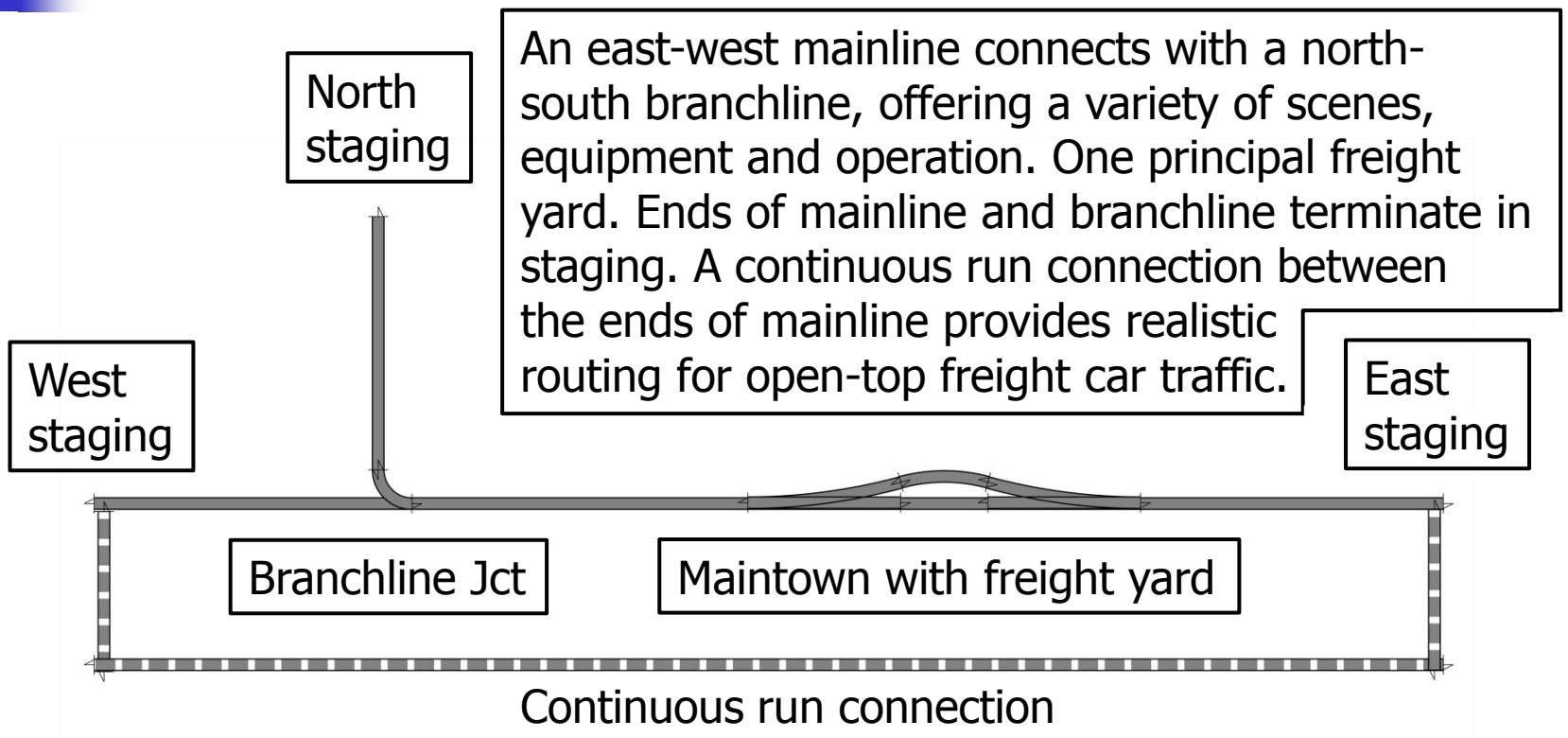
-Potentially a longer mainline can be fitted

Layout maintenance more enjoyable if benchwork is at chest, not waist, level



Mainline design

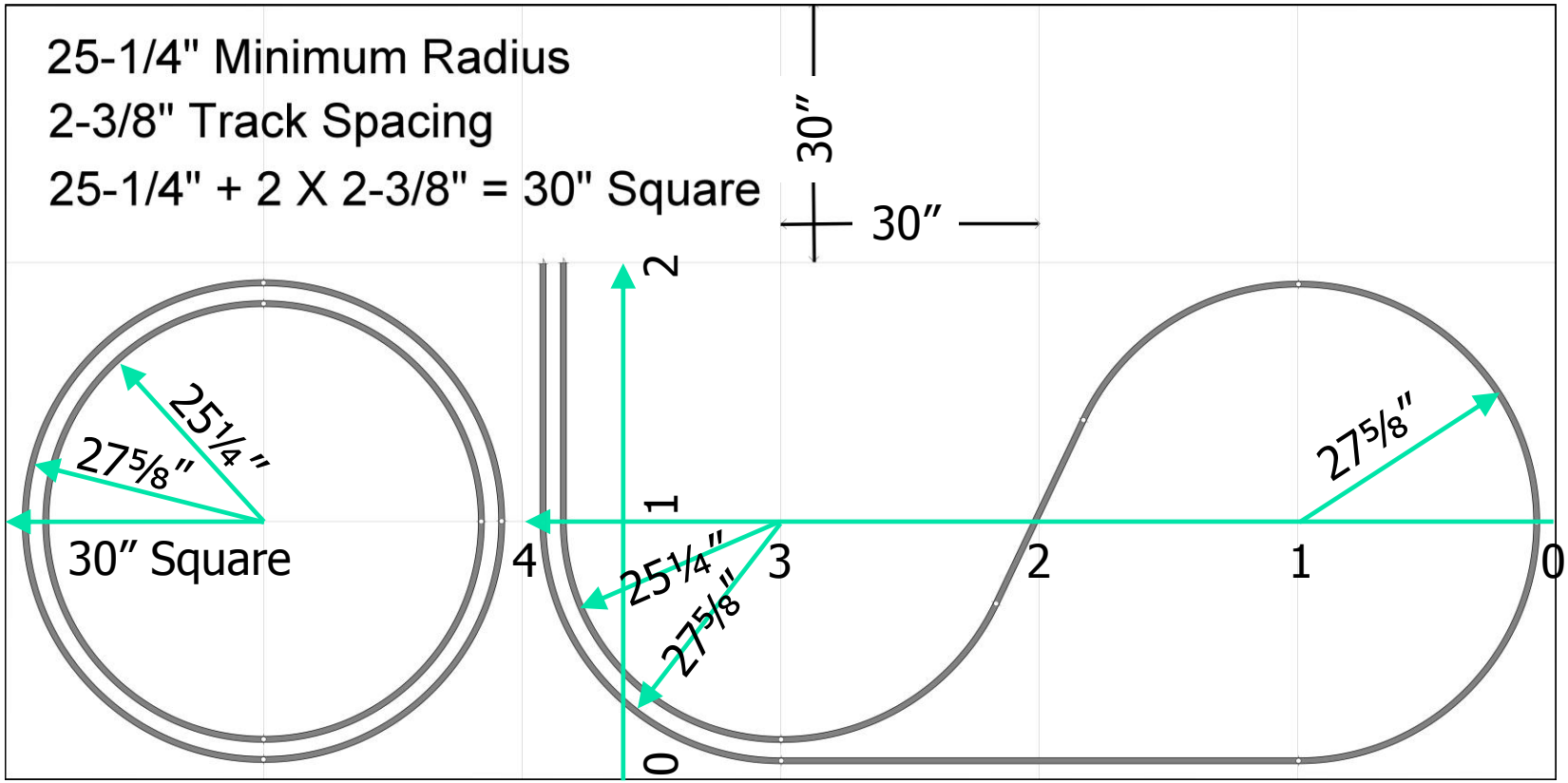
Good generic track schematic



Armstrong's square

Dimensions in inches	N	HO	O
1. Minimum curve radius	13⅝	25¼	45⅝
2. Horizontal track spacing (centre-to-centre for adjacent tracks)	1⅜	2⅜	4 3/16
3. Next concentric curve radius = 1 + 2	15	27⅝	49 13/16
4. Track spacing (Line 2.) x 2	2¾	4¾	8⅜
5. Length of square = 1 + 4	16⅜	30	54

What fits into a square?

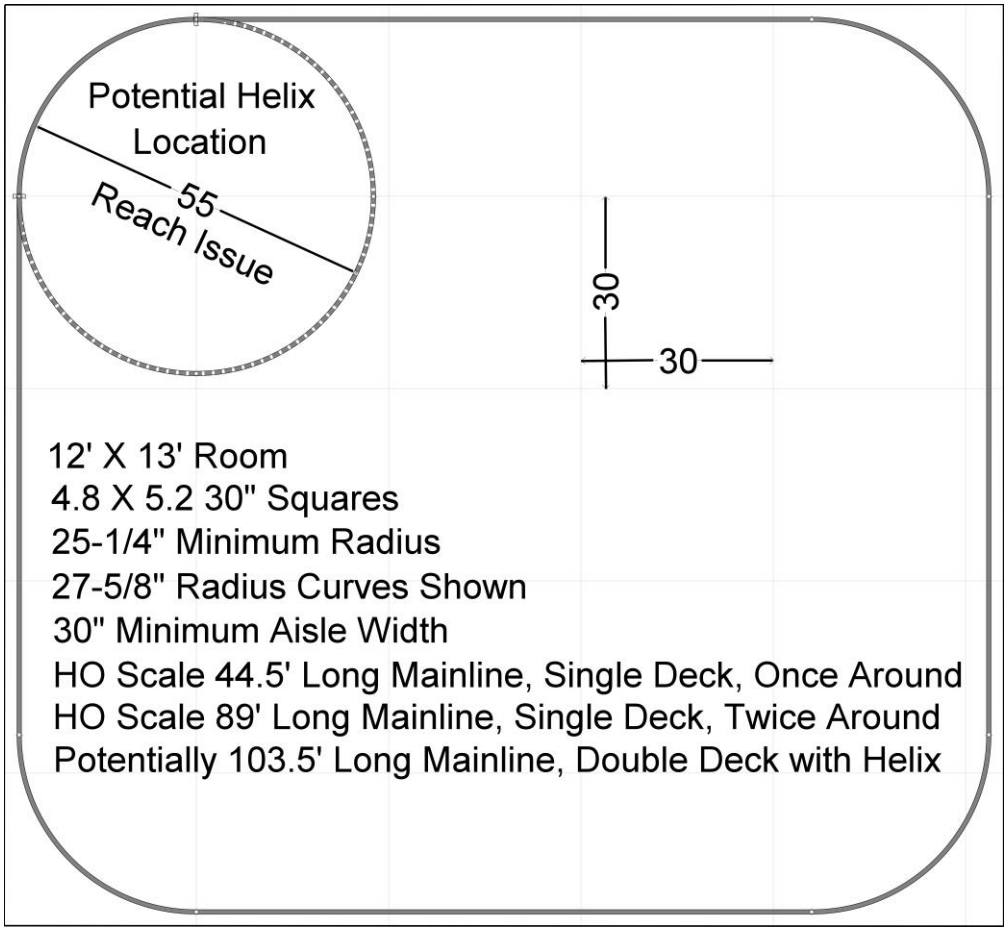


Aisles take more squares in smaller scales

Dimensions in inches	N	HO	O
1. Sample aisle width	30	30	30
2. Length of square	16⅜	30	54
3. Length of square = Line 1 / Line 2	1.8	1.0	0.6

HO Plan #1
Around the walls mainline

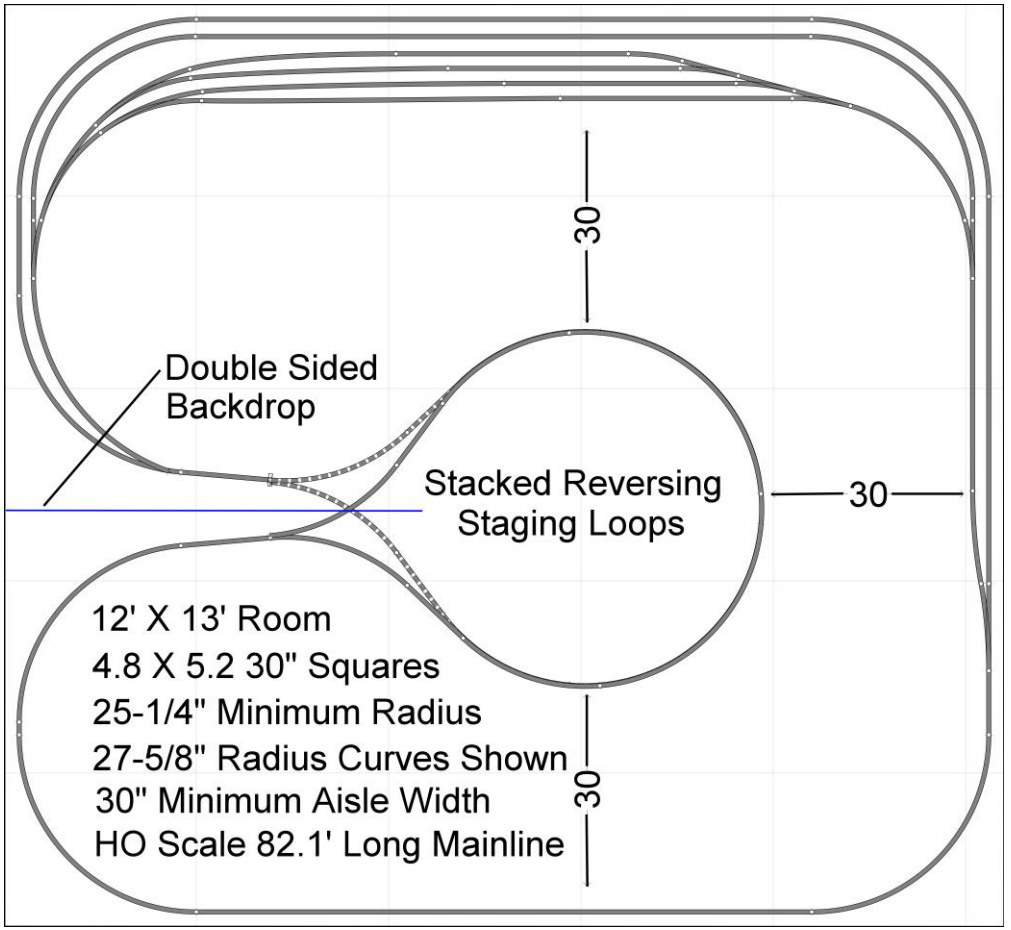
Each additional foot of room length will add 2’ to the Length of mainline for a once around, single deck layout (2:1 leverage)



HO Plan #2
Minimum peninsula mainline

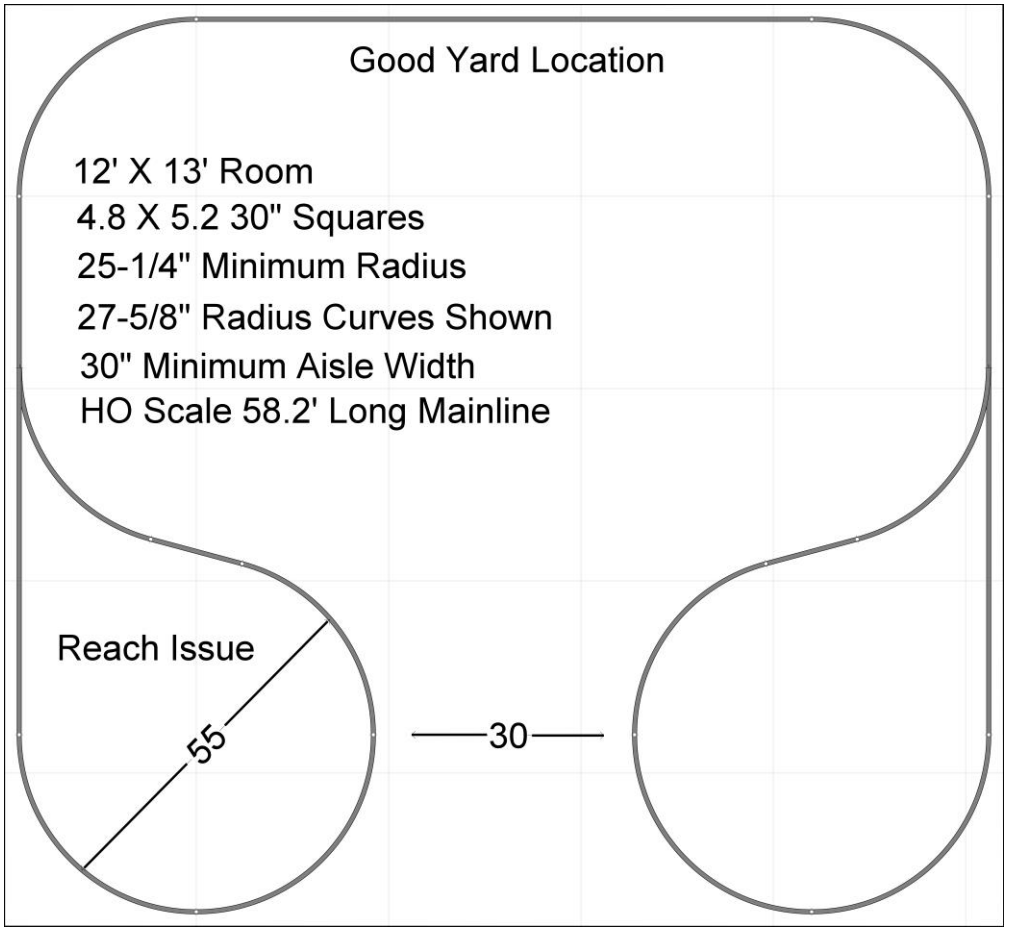
Each additional foot of room length will add 4′ to the length of mainline
(4:1 leverage)

Locate duckunder away from busy yard. Narrow bench-work allows duckunder to be short; aisle can be 40+″ wide; 2% graded mainline can be 3-½″ higher than yard – e.g., a 51-½″ high yard permits a 55″ high duckunder.



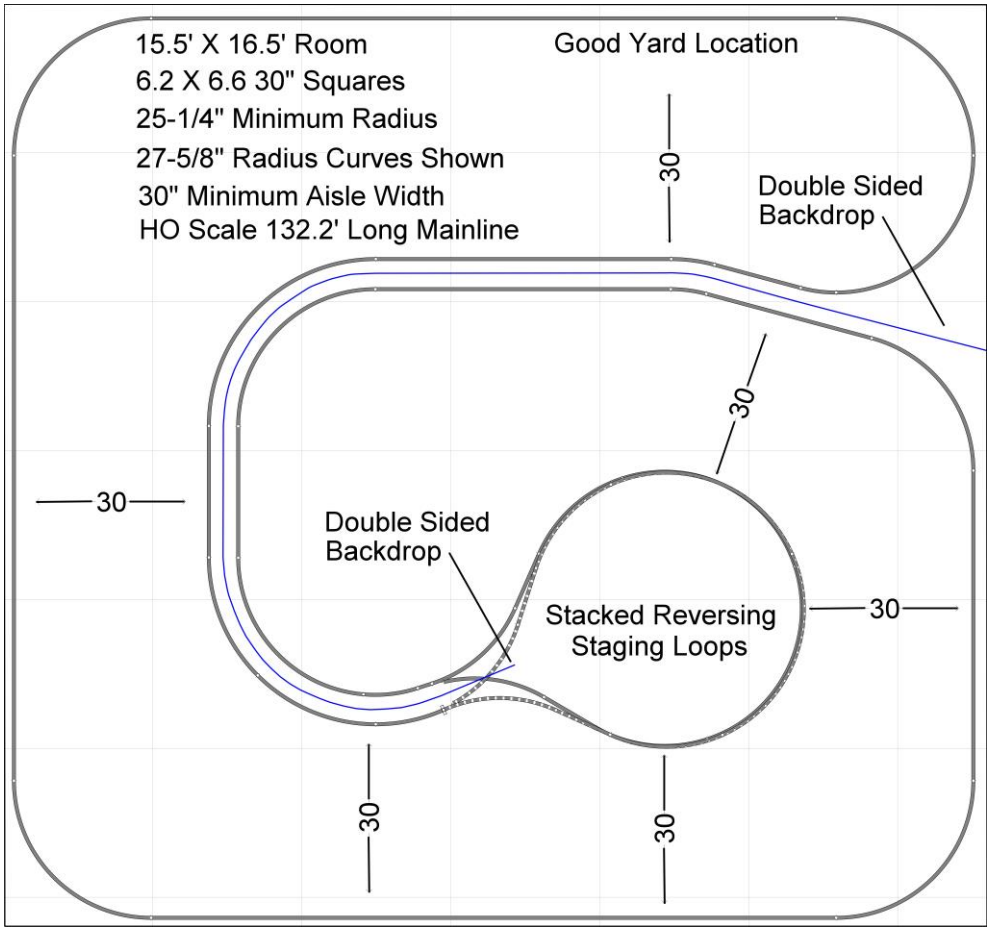
HO Plan #3
No stoop entrance

29% or 24’ of the mainline in the previous plan is lost in this no stoop plan due to only partial use of the run along-the-room-perimeter and (2) need for a second reversing loop “blob” since loops are no longer stacked



HO Plan #4
Minimum spiraling peninsula

Each additional foot of room length will add 6’ to the Length of mainline
(6:1 leverage)

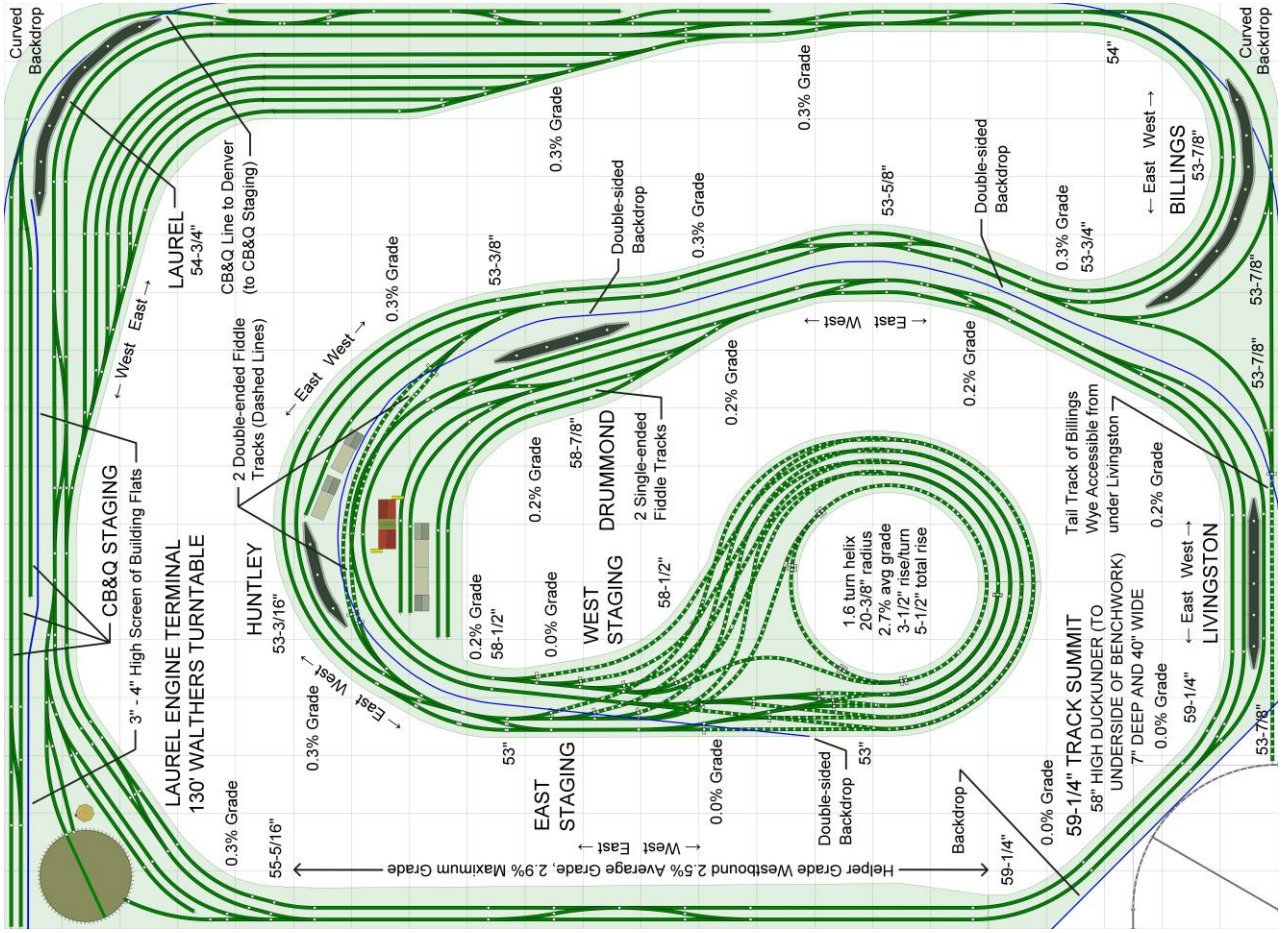


HO Illustrative
16’ x 22’ spiraling peninsula

1’ x 1’ grid

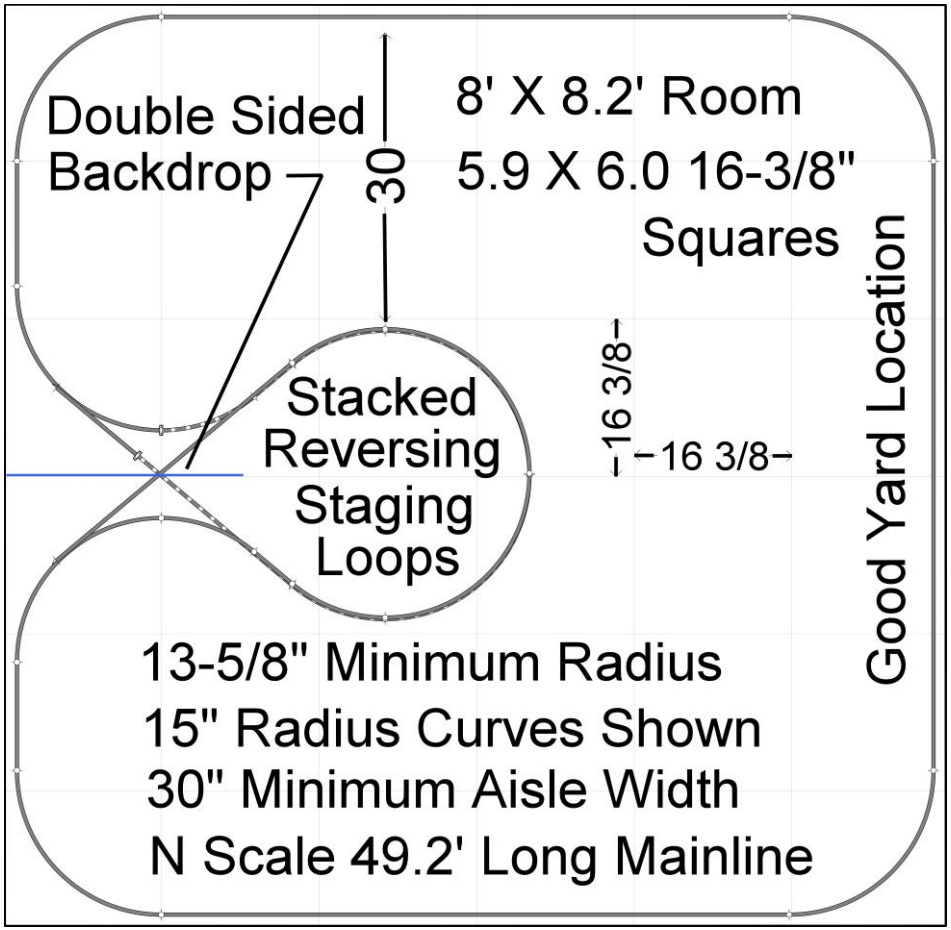
154’ long mainline
(2½ scale miles)

27⅝” min. radius
#5½ min. turnout
30” min. aisles
40” aisle by yard



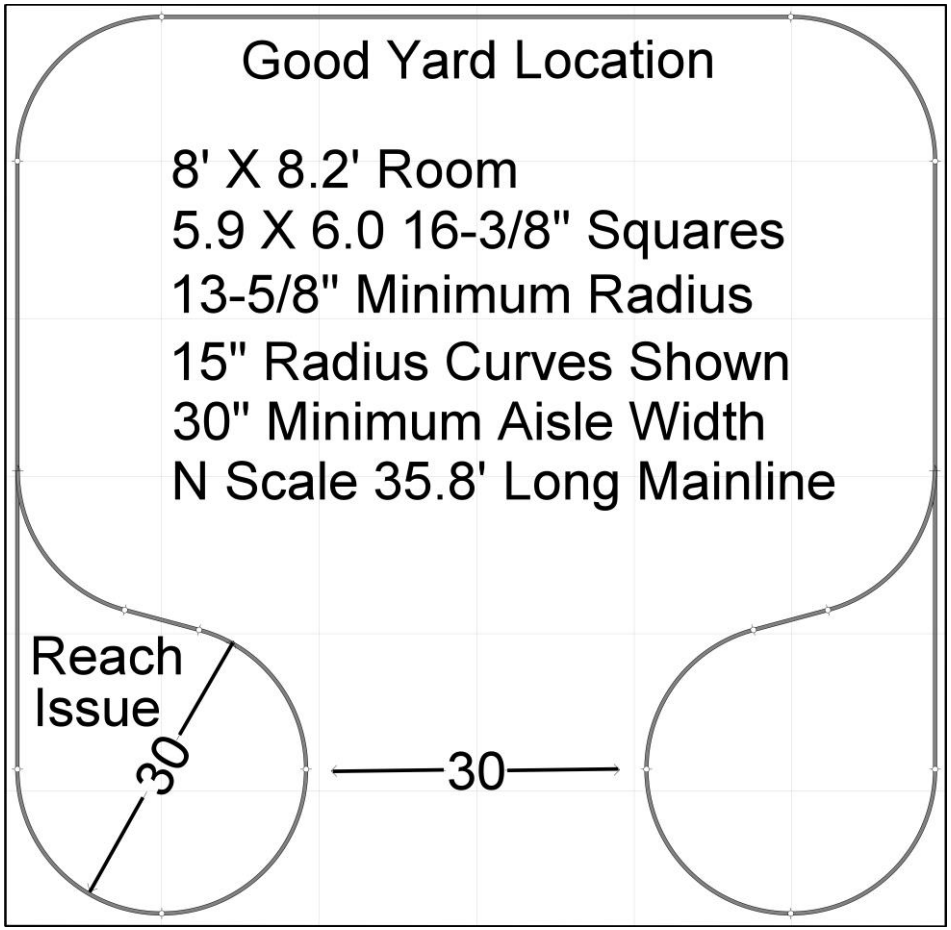
N Plan #1
Minimum peninsula mainline

Each additional foot of room length will add 4’ to the length of mainline (4:1 leverage)



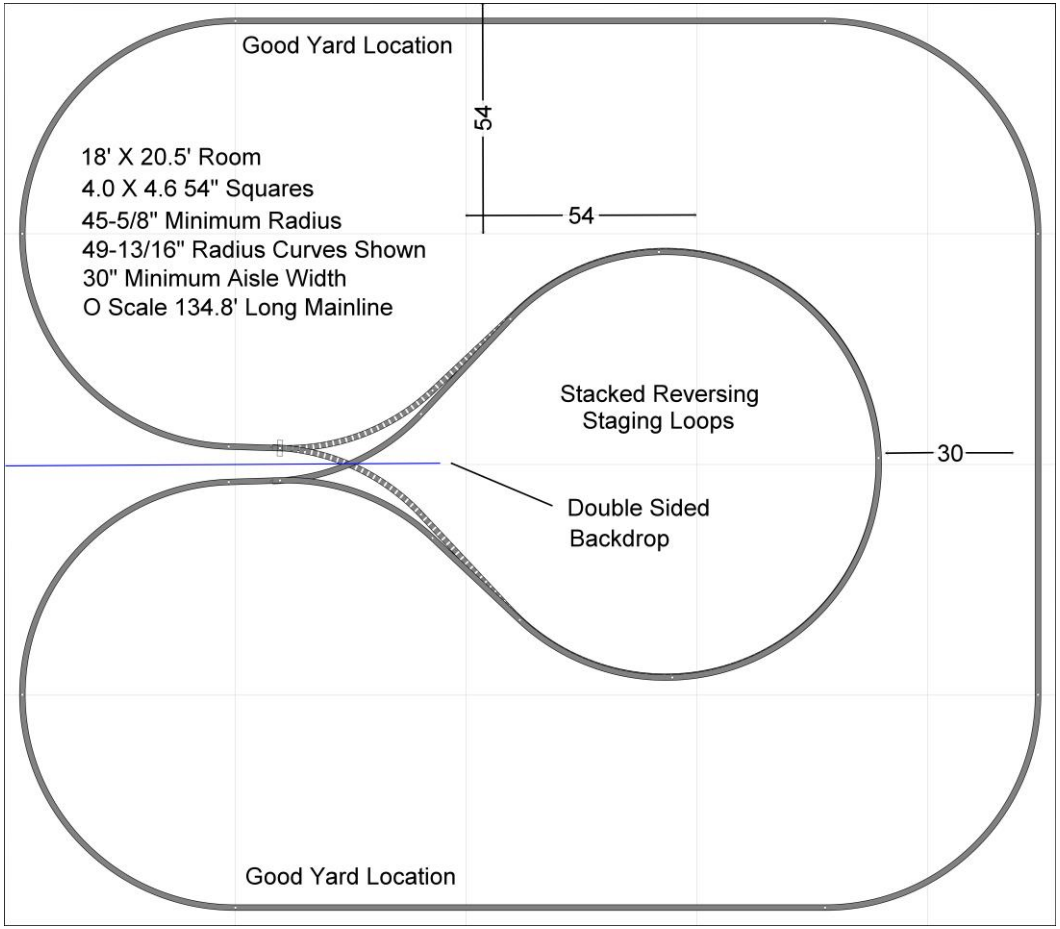
N Plan #2
No stoop entrance

27% or 13’ of the mainline in the previous plan is lost in this no stoop plan



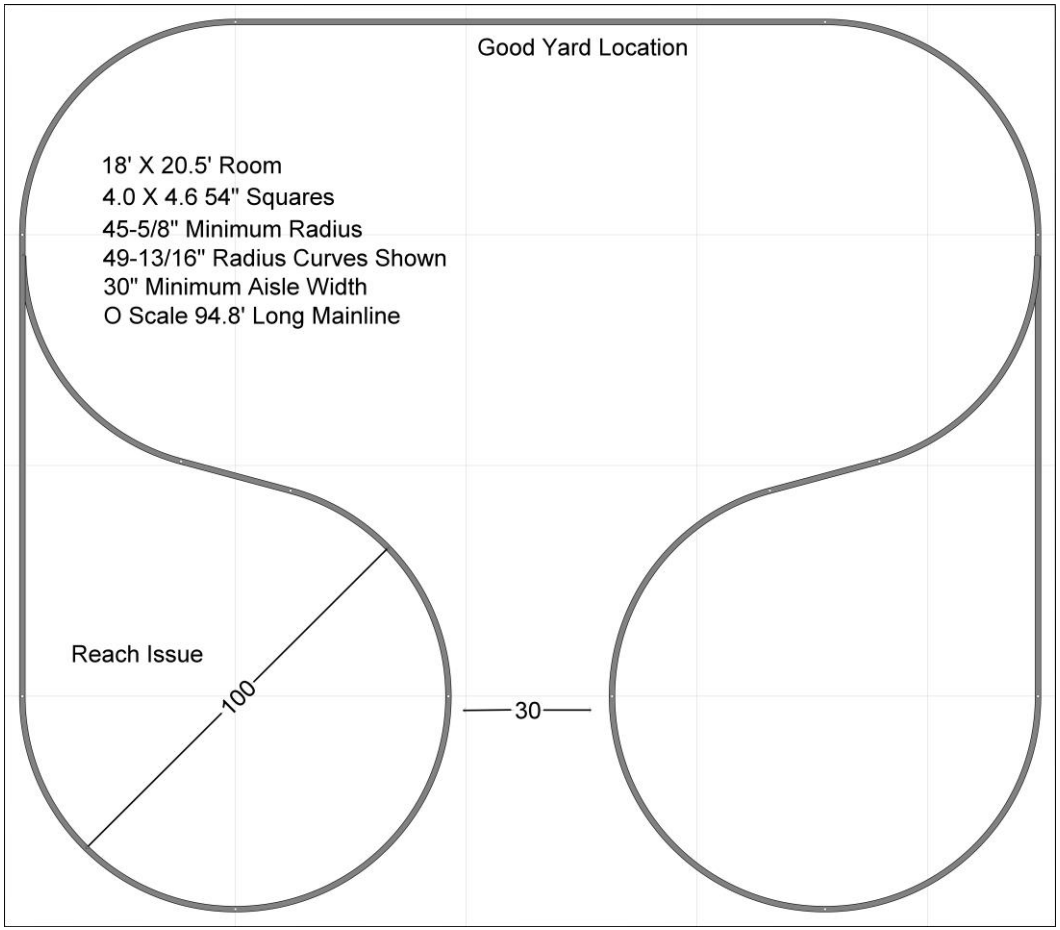
O Plan #1
Minimum peninsula mainline

Each additional foot of room length will add 4’ to the length of mainline (4:1 leverage)



O Plan #2
No stoop entrance

30% or 40’ of the mainline in the previous plan is lost in this no stoop plan



Staging design

Double ended reversing staging loops

-Turn and hold trains for return trip

Double ended non-reversing tracks

-Hold without turning–open-top freight cars

Single ended tracks

-Trains head in/back out, or the opposite

-Add escape crossover so loco can run around train, re-couple to other end

Staging design

-Add reverted loop or wye to turn trains

Fiddle yard with off layout storage

-Under the layout or wall storage racks

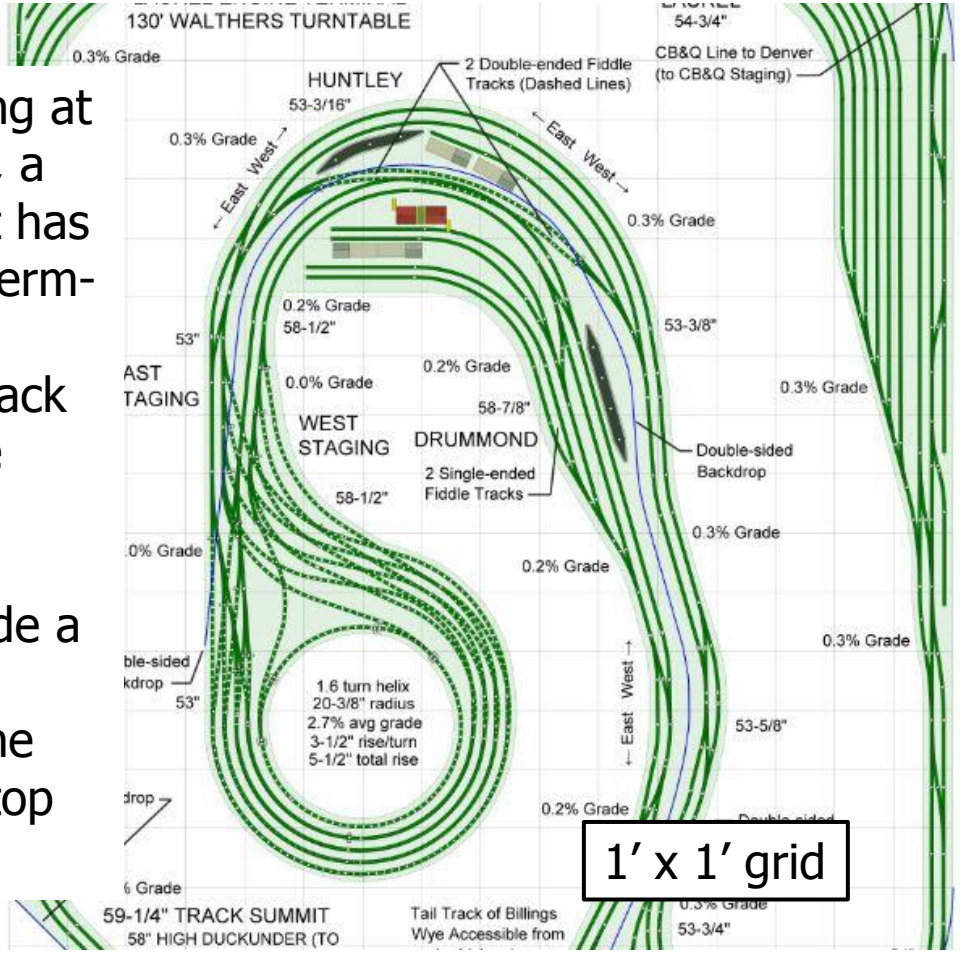
-Storage cassettes, car ferries, boxes

Best solution may be a combination design, tailored to desired operations and available space

Stack the staging

If you intend to have staging at both ends of your mainline, a good idea, seek a plan that has both ends of the mainline terminating in the same general area of the layout room. Stack the staging yards to reduce their footprint.

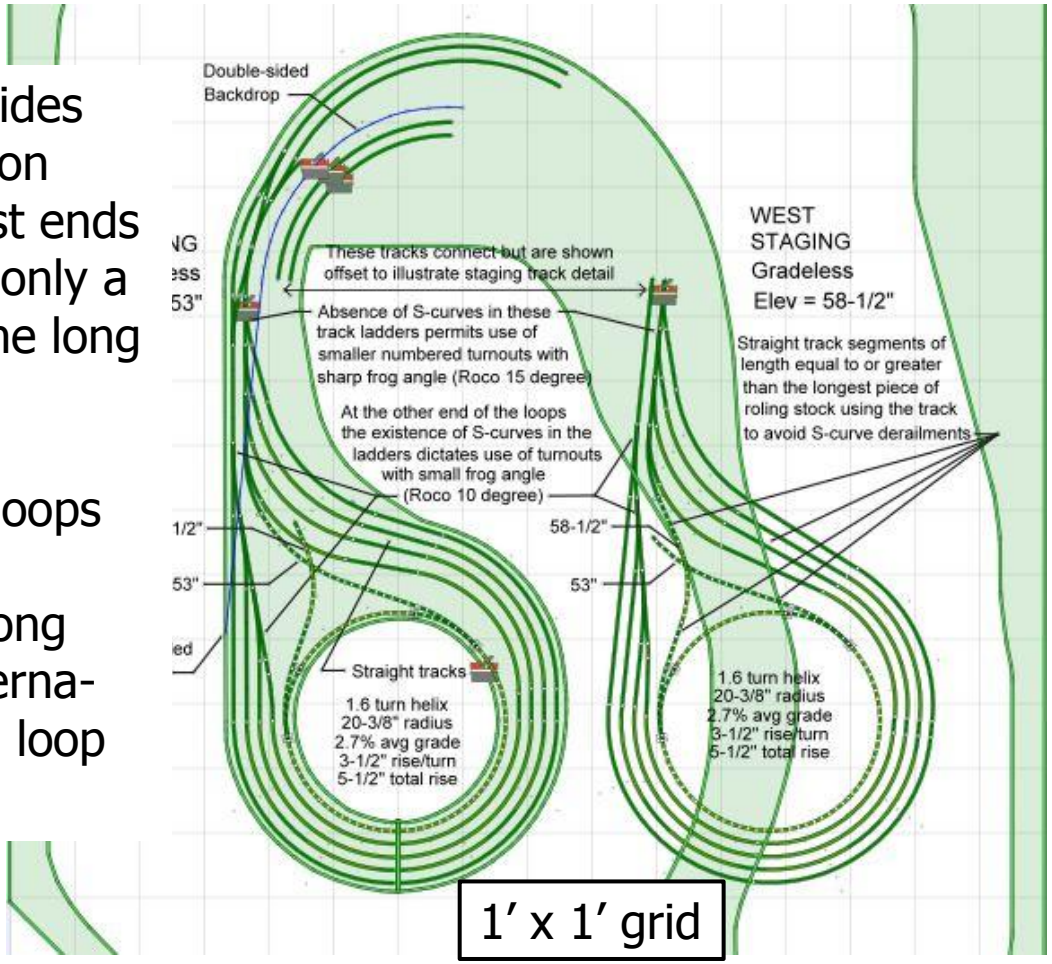
It may be possible to provide a continuous run connection between the two ends of the mainline for realistic open-top freight car traffic.



Stack the staging

The helix in this plan provides a continuous run connection between the east and west ends of the mainline. Although only a single track it can store one long or two shorter trains.

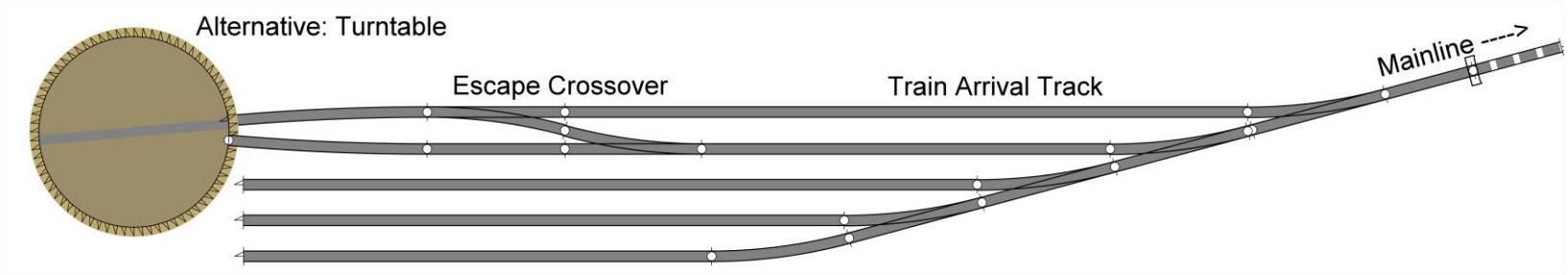
Nested reversing staging loops have a large footprint and consume an undesirably long length of mainline. An alternative design is the reverted loop which will be shown later.



Single ended staging yard

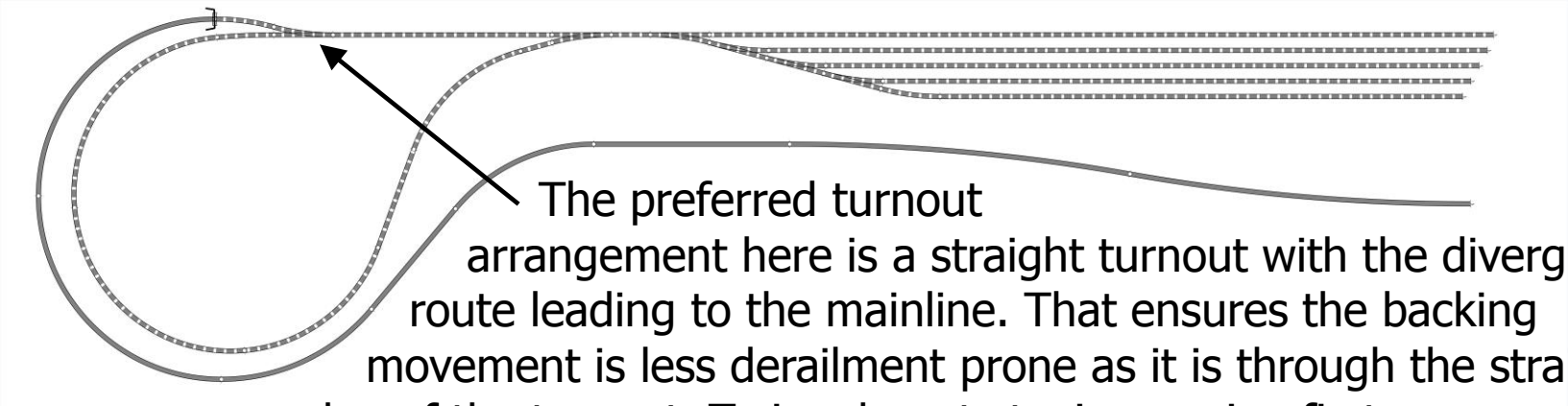
Only one escape crossover is required to allow engines of all arriving trains to run around their trains. The track arrangement below maximizes the length of train that can be run around before the road engine and train is stored on one of the adjacent single ended tracks. The stored train is ready to depart, engine first. If possible the run around tracks should be left vacant for other arriving trains.

If using steam or single ended diesel engines, a turntable connected to two of the stub tracks can be substituted for the crossover. After turning the engines they are stored on the stub tracks with their trains. Because of space limitations the usual roundhouse and or diesel storage tracks are eliminated in this plan.



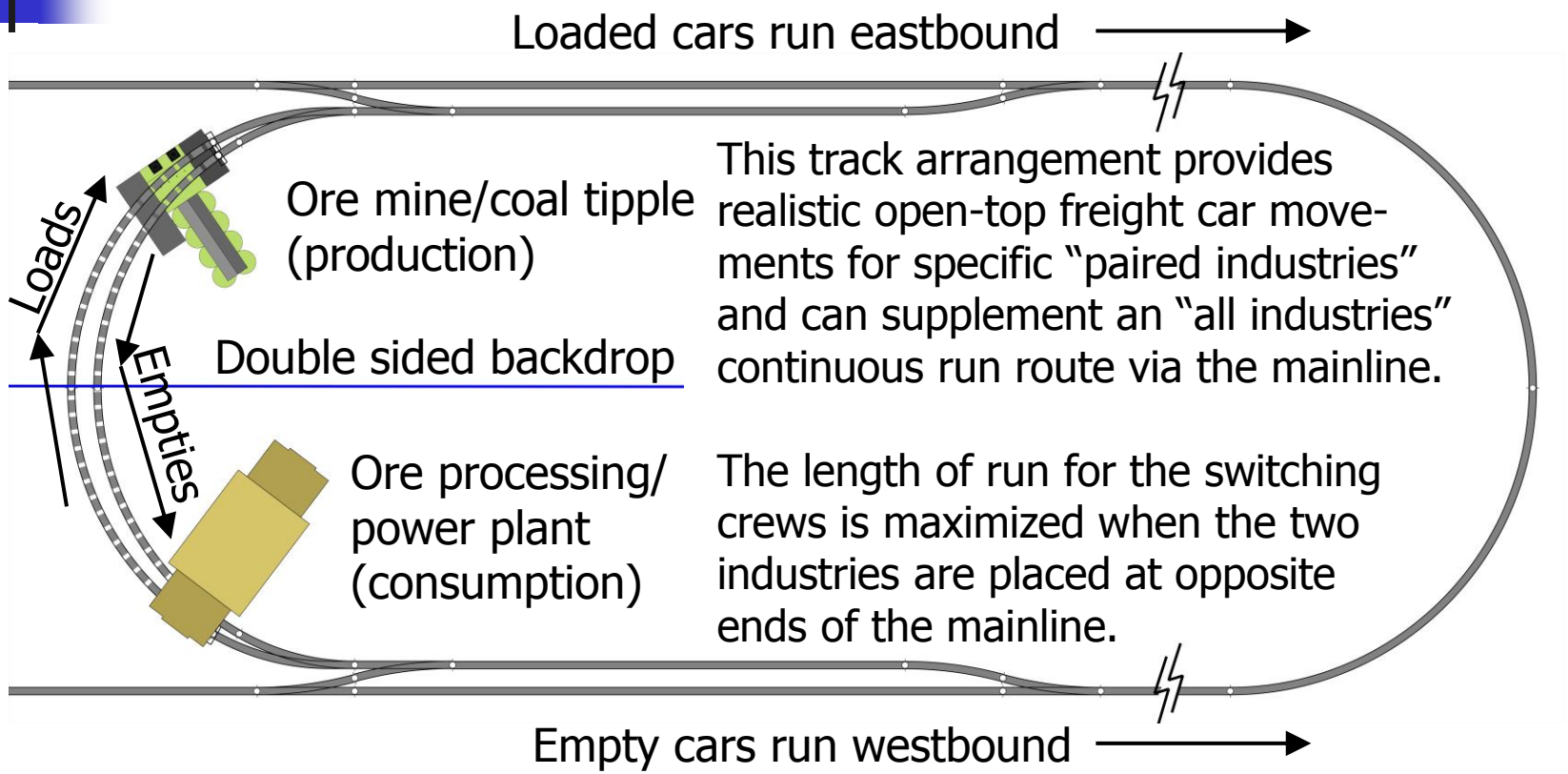
The reverted loop

The reverted loop permits more of the mainline to be visible. Having a generous number of long staging tracks does not require the oversized footprint that equivalent nested reversing loops demand. The turning of trains is slower than with conventional reversing loops since trains must be stopped, backed counter-clockwise around the reverted loop and into a single ended staging yard. For the operation to be derailment free trackwork and rolling stock must be finely tuned.



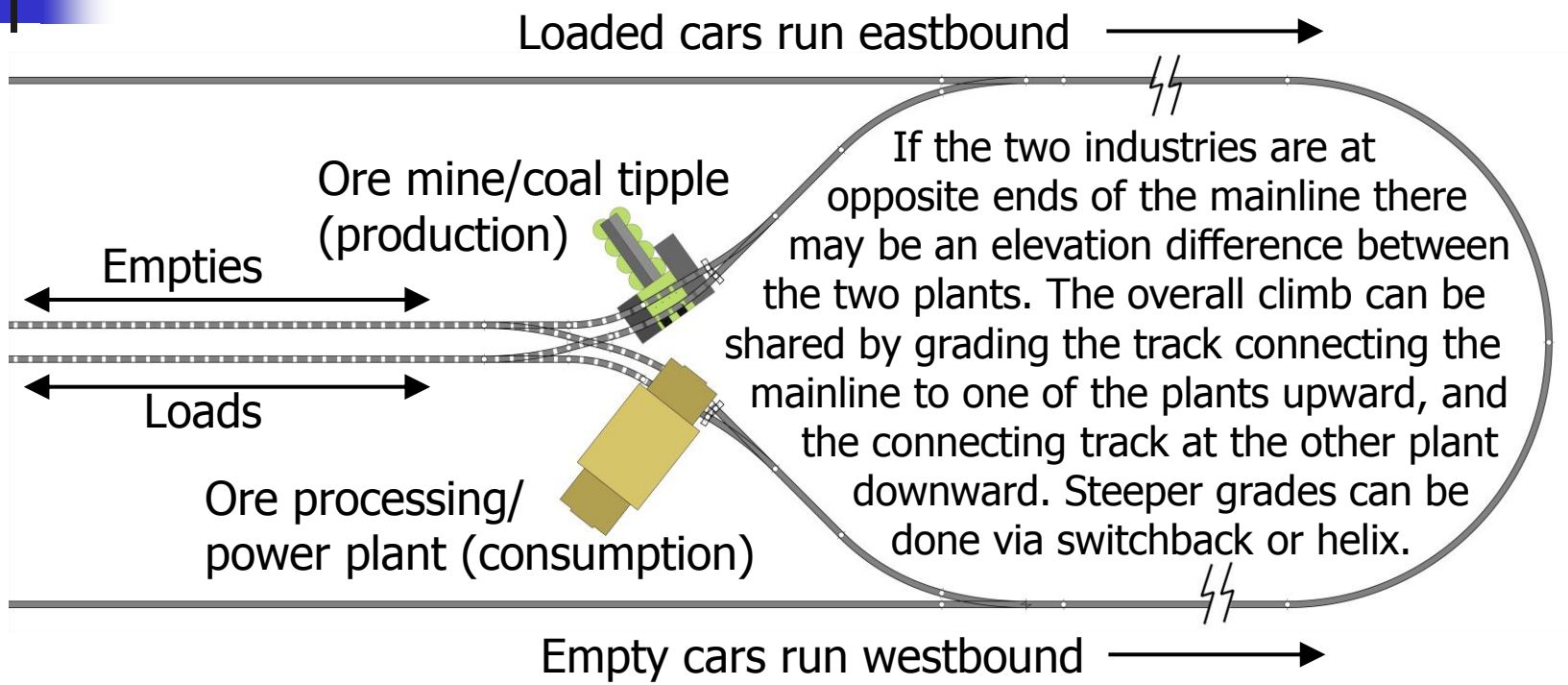
The preferred turnout arrangement here is a straight turnout with the diverging route leading to the mainline. That ensures the backing movement is less derailment prone as it is through the straight leg of the turnout. Trains depart staging engine first.

Loads-in/empties-out #1

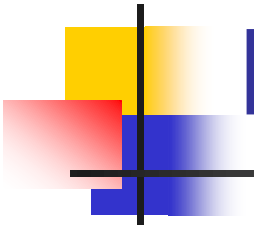


If the empties and loads tracks are oriented to run across a benchwork peninsula the width of the peninsula may limit the number of cars that can be staged here.

Loads-in/empties-out #2



If the empties and loads tracks are oriented parallel to the edge of the benchwork it may allow the two tracks to be long enough to stage two train-length cuts of cars (each 15 – 30 cars long), one empty, one loaded, for unit train operations.



Freight yard design

Freight yard design

The freight yard is a core component of a model railroad and warrants thoughtful consideration in the design effort

-Unlike mainline train running, yard switching on a model is prototypically slow–closer to a 1:1 fast clock ratio

-A yard must have sufficient *capacity* and the crew be able to classify cars *efficiently* or mainline train crews will become frustrated

Track and aisle space needed

Efficient switching demands wide aisles in the vicinity of the yard–perhaps 36″ to 48″–so yard crews can work unimpeded

- -Excluding really big layouts, a single larger yard is likely better than two smaller yards

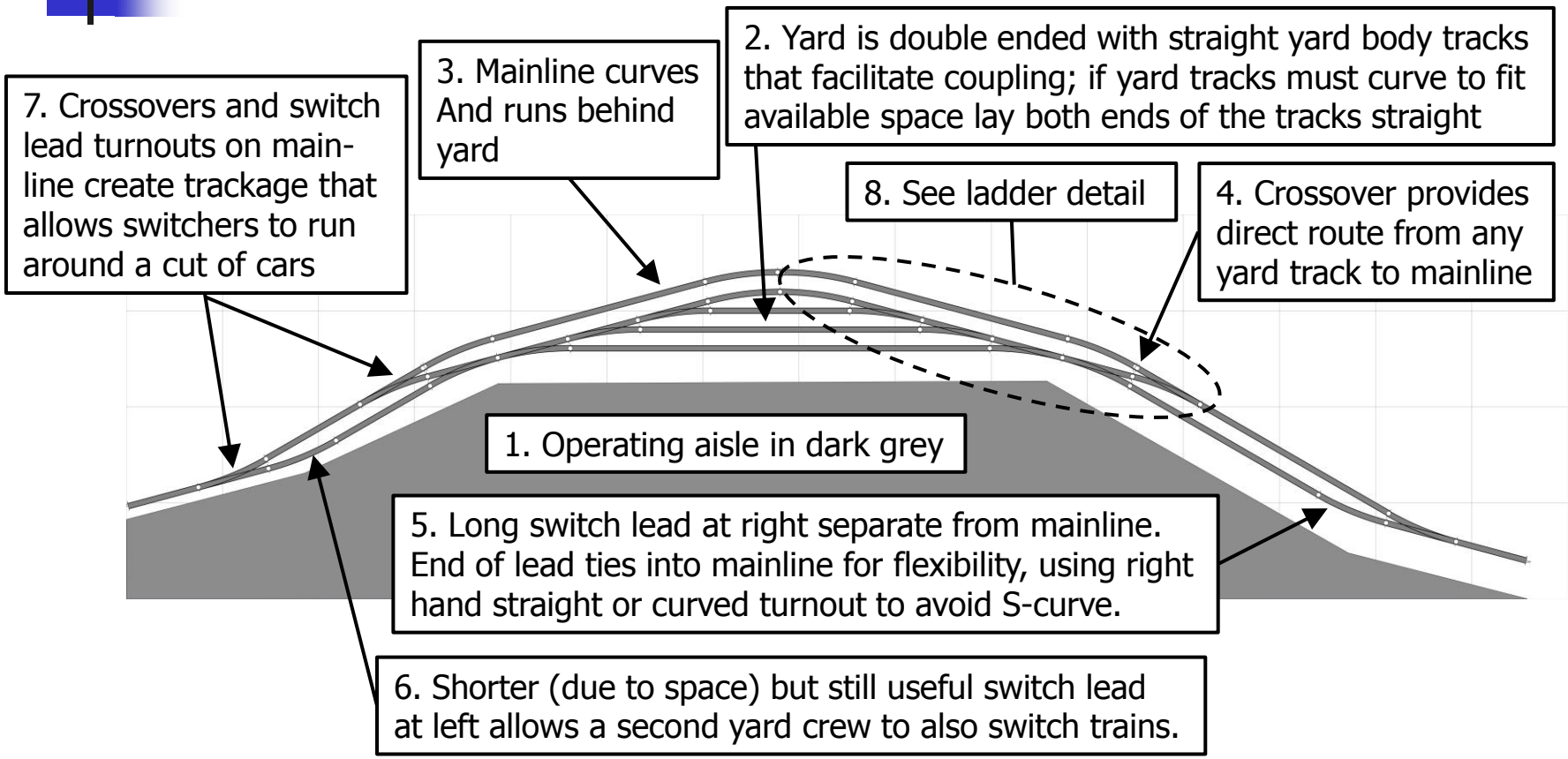
Finding adequate yard space may require a few iterations of the mainline/staging/ yard design process

Placement of the freight yard

Obtaining sufficient length of right of way for a yard may require curved yard tracks nestled in one corner of the layout room

An asymmetrical placement of the yard closer to one end of the mainline might offer greater operational variety

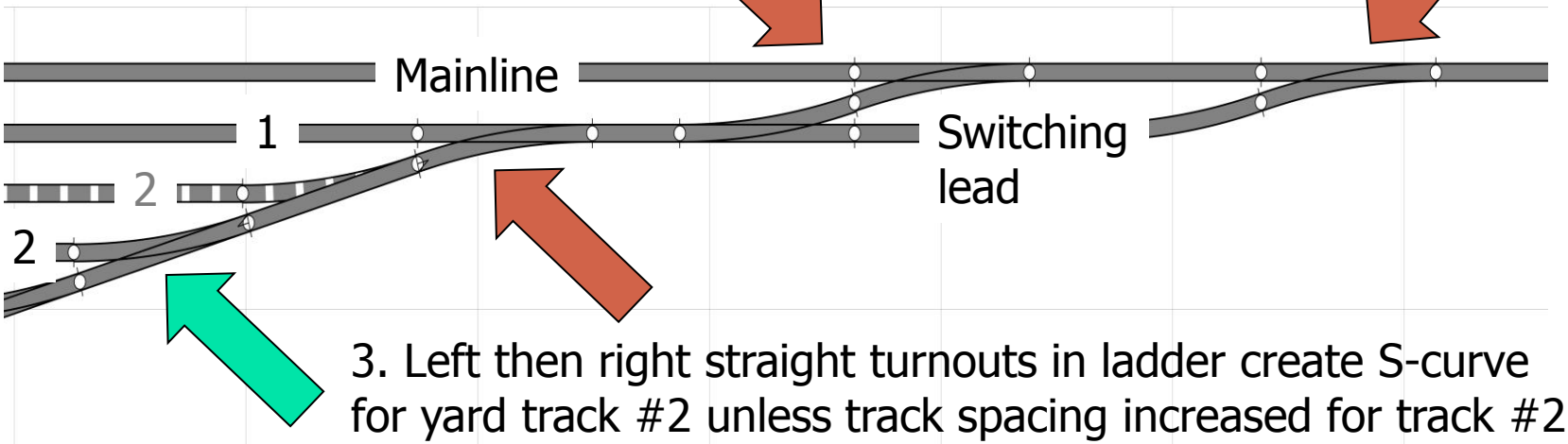
Thoughtful freight yard design



Typical yard with S-curves

1. Crossovers with a pair of left or right straight turnouts contain S-curves

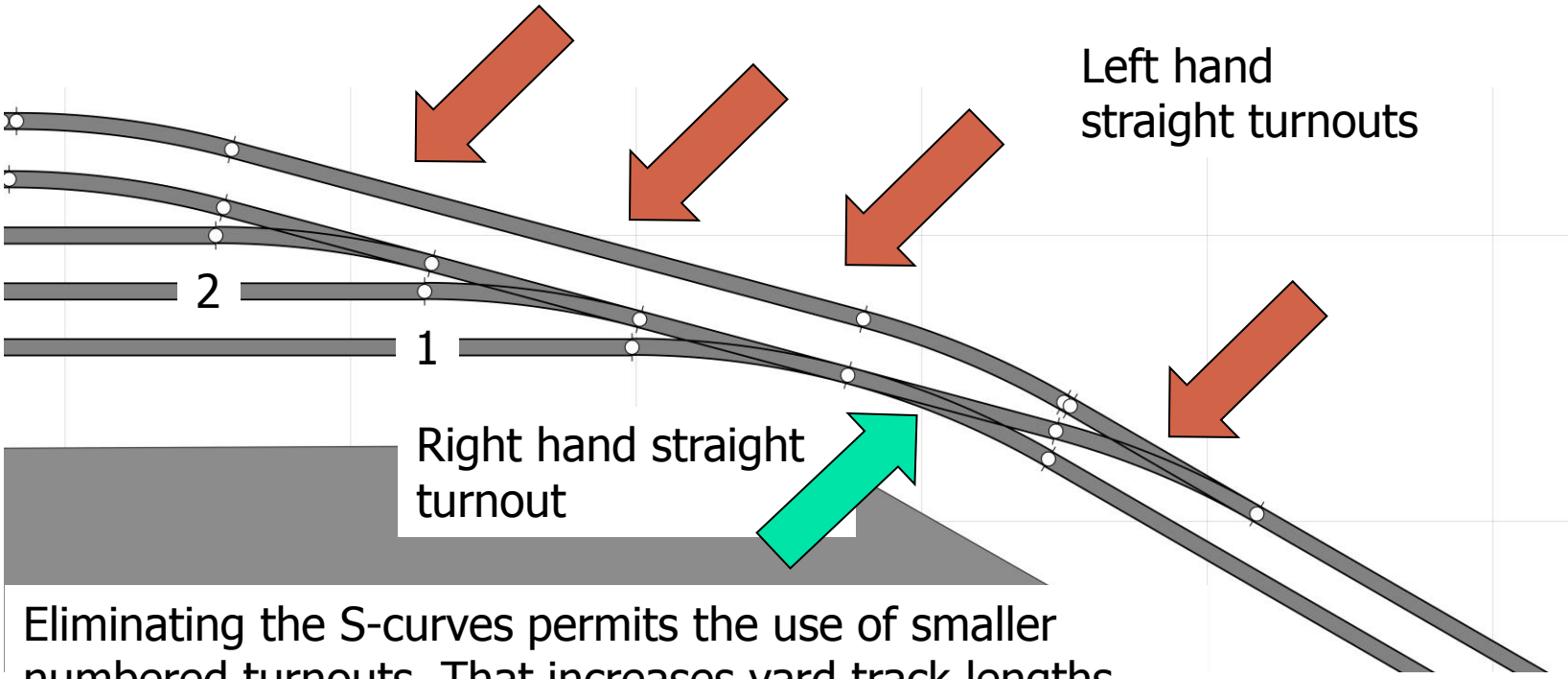
2. S-curve where switch lead joins mainline via left straight turnout



3. Left then right straight turnouts in ladder create S-curve for yard track #2 unless track spacing increased for track #2

If S-curves present we must use space consuming larger turnouts and/or limit the length and variability of lengths of the rolling stock

Ladder detail–no S-curves

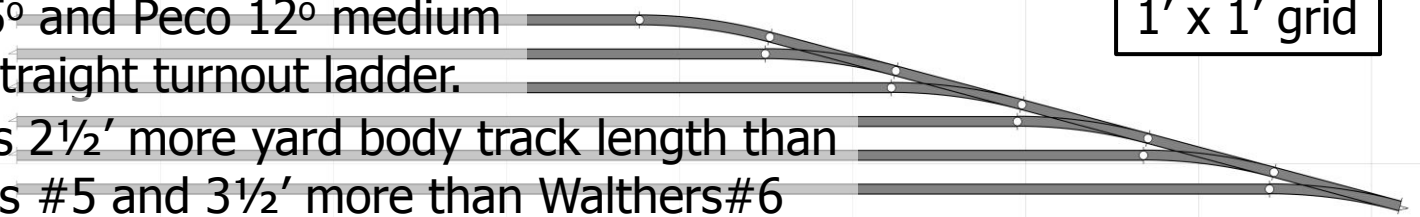


Eliminating the S-curves permits the use of smaller numbered turnouts. That increases yard track lengths and allows rolling stock with even larger differences in car lengths, to couple and run together reliably.

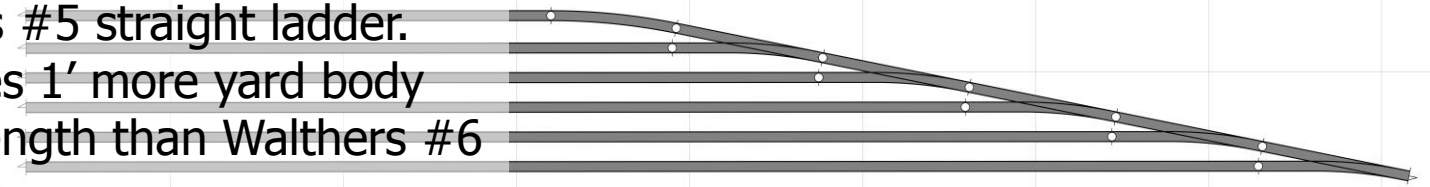
Smart HO turnout choices

1’ x 1’ grid

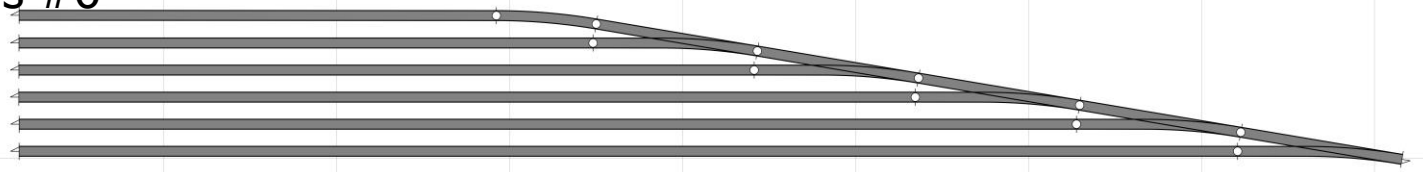
Roco 15º and Peco 12º medium radius straight turnout ladder.
Provides 2½’ more yard body track length than Walthers #5 and 3½’ more than Walthers#6



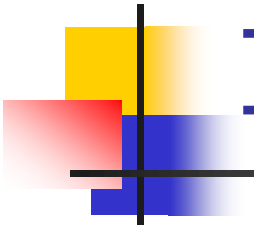
Walters #5 straight ladder.
Provides 1’ more yard body track length than Walthers #6



Walthers #6 straight ladder



Turnouts are HO code 83, except the Pecos which are code 75 / code 100.
Capacity impacts are double those shown above for a double ended yard.



Industrial and other trackage

Industrial and other trackage

Industry spurs–usually design after mainline, staging and freight yard

Engine terminal/loco servicing

-"Store" engines with trains in staging

-Diesel/coal/sand/roundhouse facilities provide sources of local freight traffic

Branchline locations–top of helix, hallway

References

Any book or article by John Armstrong including:

1. Track Planning for Realistic Operation (Kalmbach 1979 or 1998)
2. 18 Tailor-Made Model Railroad Track Plans (Kalmbach 1983)
3. 20 Custom Designed Track Plans (Kalmbach 1994)
4. Creative Model Railroad Design (Kalmbach 1978)
5. The Classic Layout Designs of John Armstrong (Kalmbach 2001)

Other authors/references

6. Layout Design (LDSIG) and Operations Special Interest Group (OpSIG)
7. A Compendium of Model Railroad Operations (book from OpSIG 2017)
8. How to Operate Your Model Railroad (Bruce Chubb / Kalmbach 1977)
9. Realistic Model Railroad Operation (Tony Koester / Kalmbach 2003 or 2013)
10. Designing & Building Multi-Deck Model Railroads (T. Koester / Kalmbach 2008)
11. Edmonton Model Railroad Association (EMRA) – Ops-oriented club layout