Designing a Layout for Operation

Getting *The Salt Lake Route* from a dream to a full-size drawing

Chuck Thomas, NMRA Metro-North Division, Northeast Region

September 17, 2011

Designing a Layout for Operation

Topics

- Choosing a Theme
- Establishing Design Standards
- Making a Scale Drawing
- Making a Full-Size Floor Drawing

This is a story about how I'm doing it, not necessarily how you should do it. But hopefully you'll pick up an idea or two ….

Choosing a Theme

I decided to build the Union Pacific *Salt Lake Route* from East Los Angeles through Riverside and Cajon to Summit in 1955

I grew up near Los Angeles and this area and era have special meaning to me

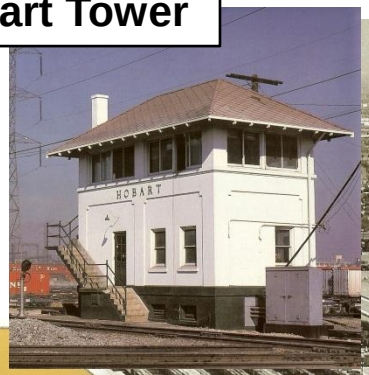
"The Arrowhead" near San Bernardino

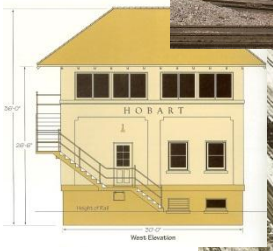
Short History of *The Salt Lake Route*

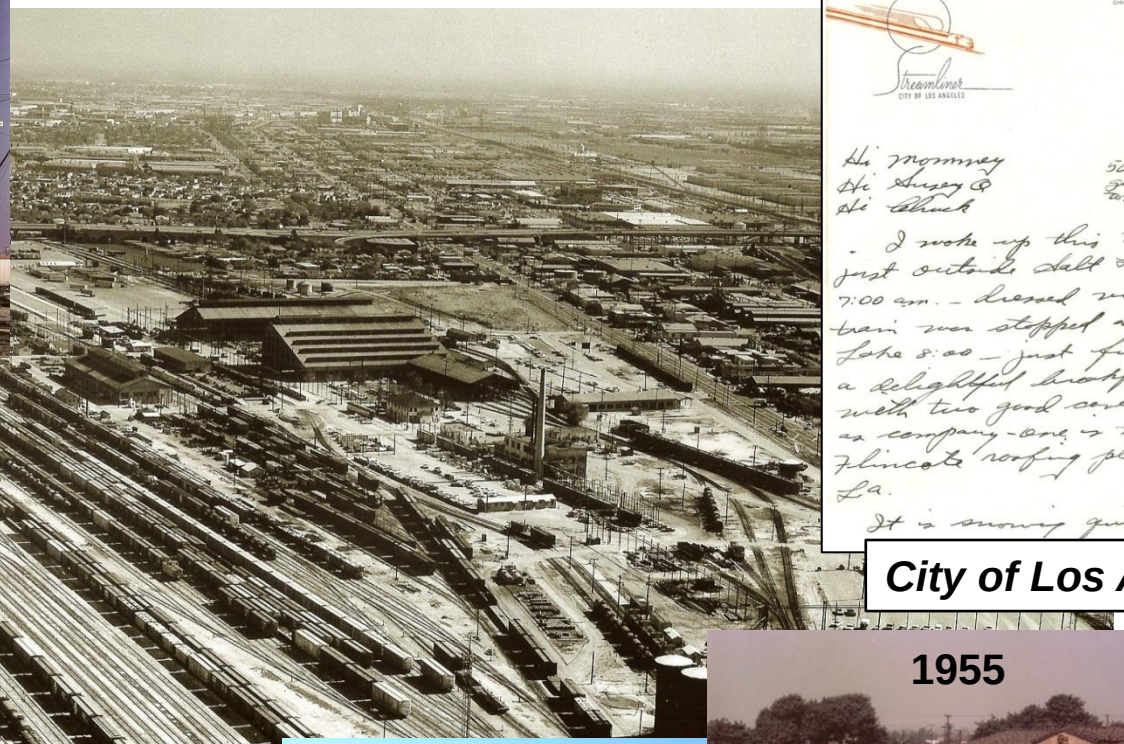
- **Railroad ran 780 miles from LA to Salt Lake City**
- **Senator William Clark acquired the Los Angeles Terminal Railroad, renamed it the San Pedro, Los Angeles and Salt Lake Railroad Company and began construction to Salt Lake City in 1901**
- **E. H. Harriman of the Union Pacific acquired half-interest in the railroad in 1902**
- **Name was shortened to the Los Angeles and Salt Lake Railroad (LA&SL) in 1916, and the UP acquired full interest in 1921**
- **Arrowhead emblem was chosen for the rock formation near San Bernardino at the base of Cajon Pass**

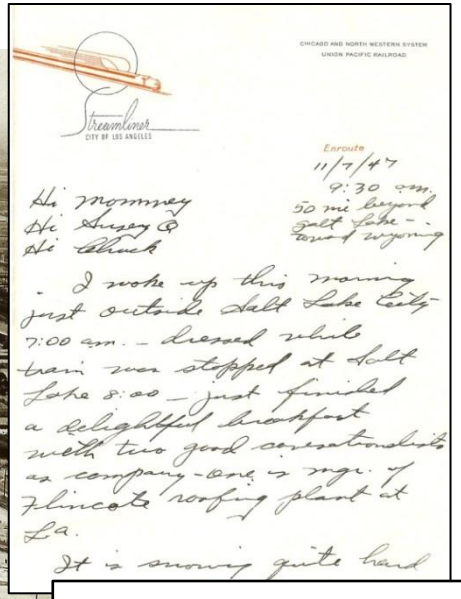
The Salt Lake Route – East LA Yard and Depot

Hobart Tower





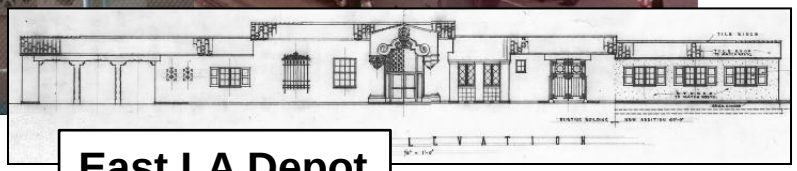




City of Los Angeles

1955

2006



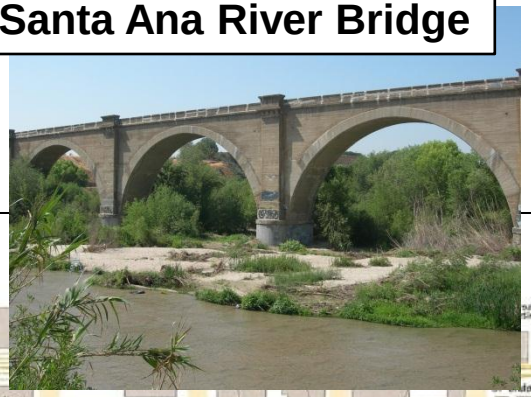
Icing Dock & TOFC Loading

East LA Depot

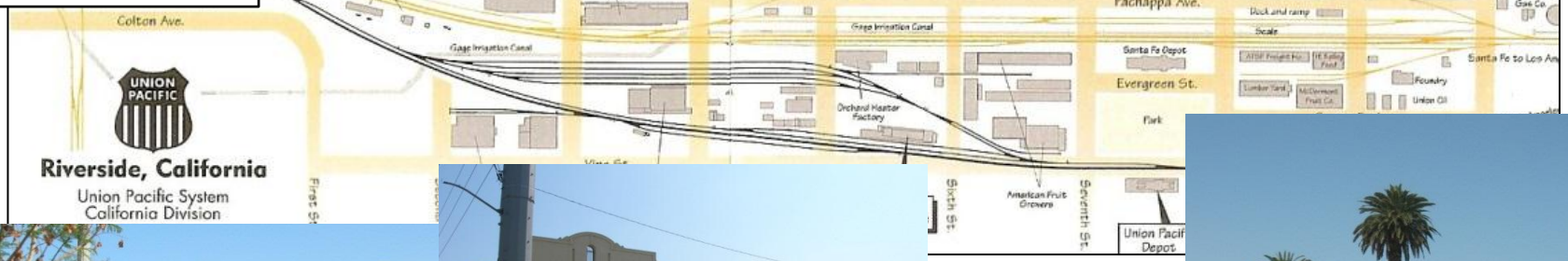
The Salt Lake Route – Riverside

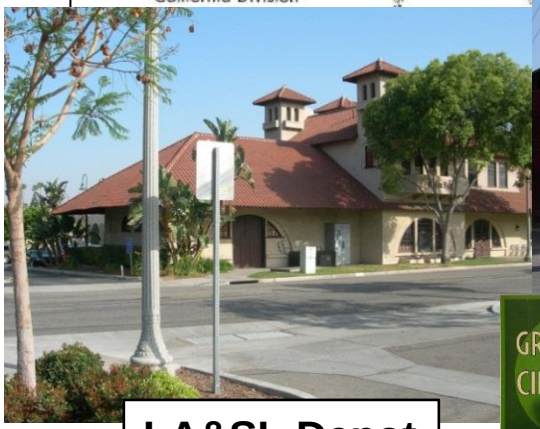
National Orange

Santa Ana River Bridge

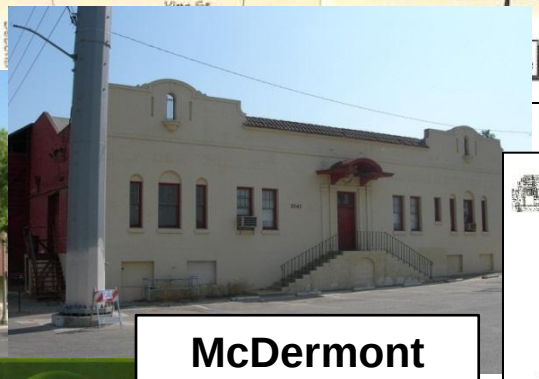


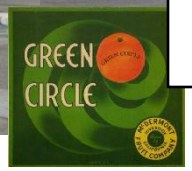
Riverside Jct.



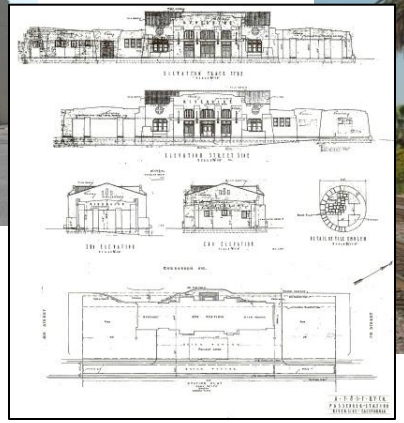


LA&SL Depot



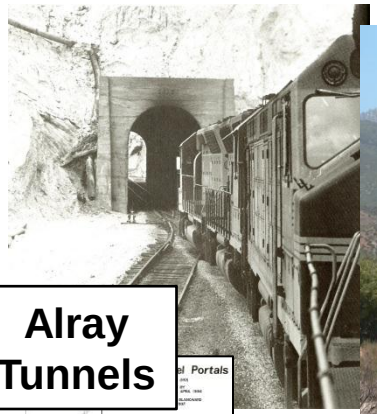


McDermont Fruit Company

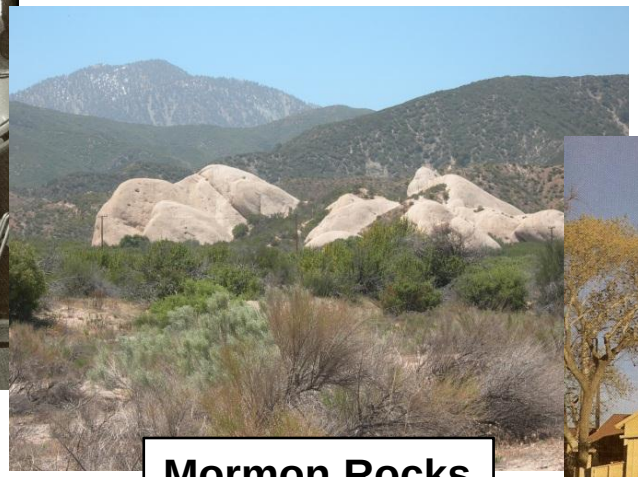


ATSF Depot

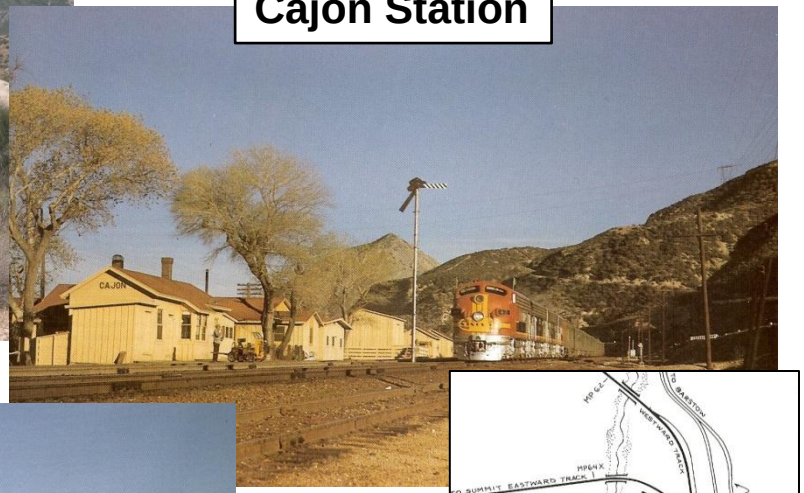
The Salt Lake Route – Cajon Pass and Summit



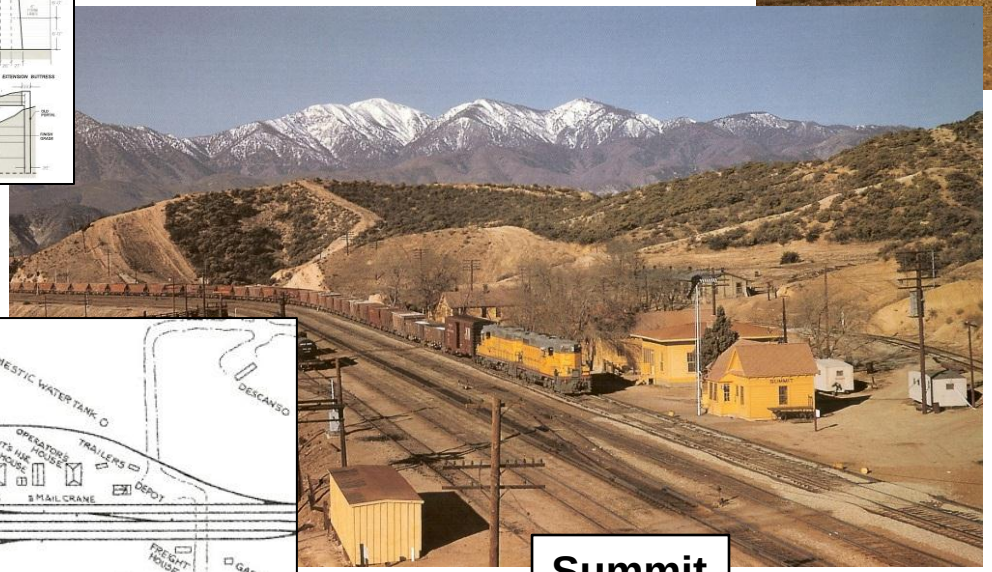
Alray Tunnels



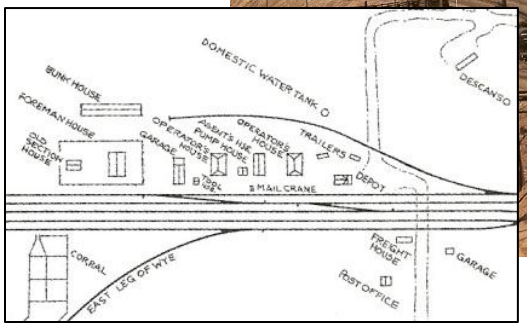
Mormon Rocks

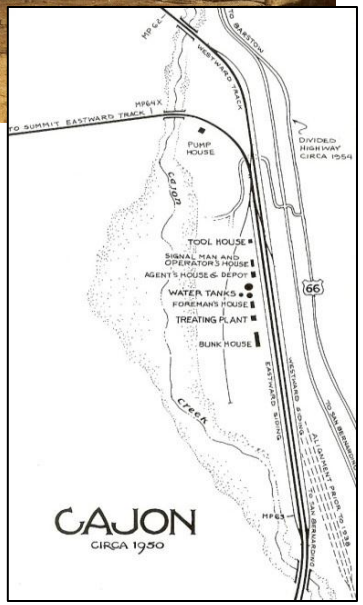


Cajon Station



Summit

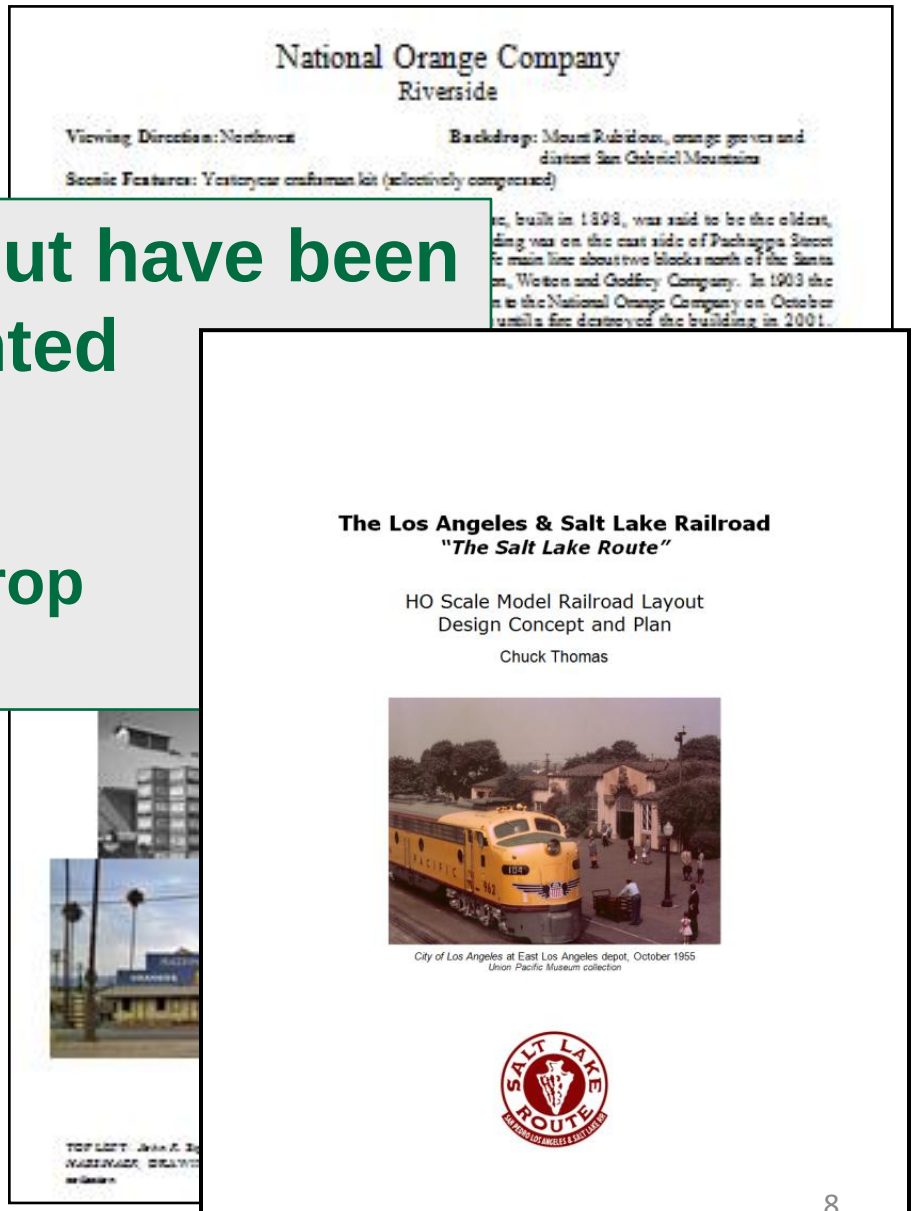




LA&SL Layout Design Concept and Plan

Key locations on the layout have been researched and documented

- History and significance
- Viewing direction
- Scenic features and backdrop
- Modeling plans



Primary Research & Design References

Books

Armstrong, John. Track Planning for Realistic Operation, Prototype Railroad Concepts for Your Model Railroad, Third Edition. Kalmbach Publishing, 1998.

Donat, Dick. Trackside Around Southern California 1954-1963. Morning Sun Books, 2010.

Hemphill, Mark W. Union Pacific Salt Lake Route. Boston Mills Press, 1995.

Ranks, Harold E. and Kratville, William W. The Union Pacific Streamlines. Kratville Publications, 1974.

First Printing, serial number 001625

Signo ute.
Go

Strack

_____

Thom
Sig

Walker, Chard. Cajon, Rail Passage to the Pacific. Signature Press, 1985.

I found design ideas in books, periodicals, historical societies, libraries, on the Internet and through field research

Periodicals

Model Railroader. (Kalmbach Publishing) 1986-2011.

The Streamliner. (Union Pacific Historical Society) 1985-2011.

The Warbonnet. (Santa Fe Historical & Modeling Society) Second quarter 2002 and First quarter 2008.

Other Sources

Colorado Railroad Museum, Golden, CO.

National Model Railroad Association, Standards and Recommended Practices.

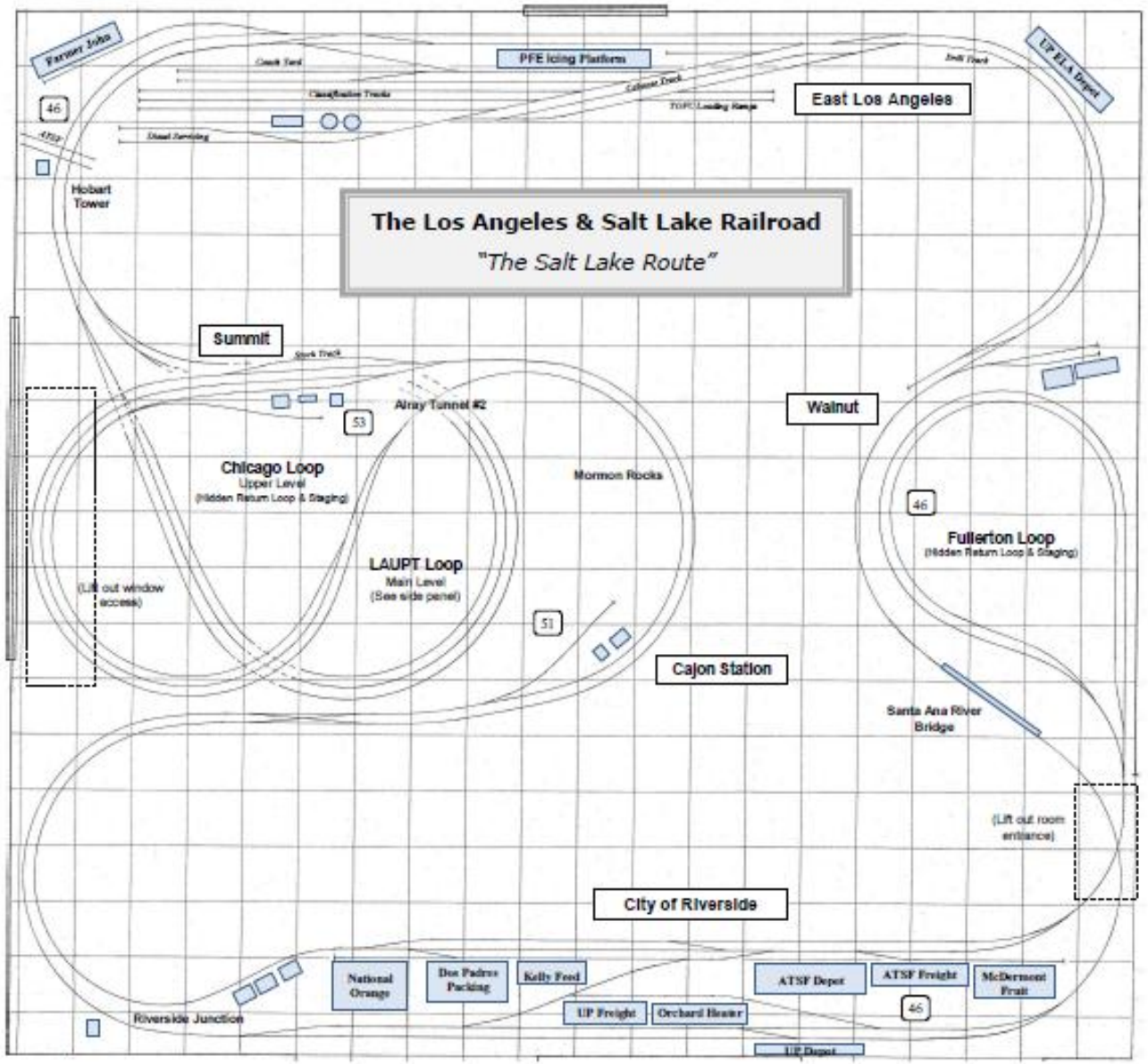
The Library of Congress. Built in America, American Memory Project.

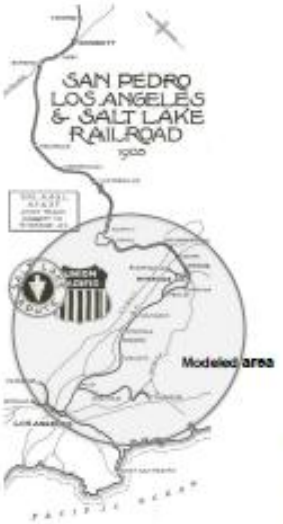
The Union Pacific Museum, Omaha, NE.

Field Research

2006-2008

The Salt Lake Route – Track Plan





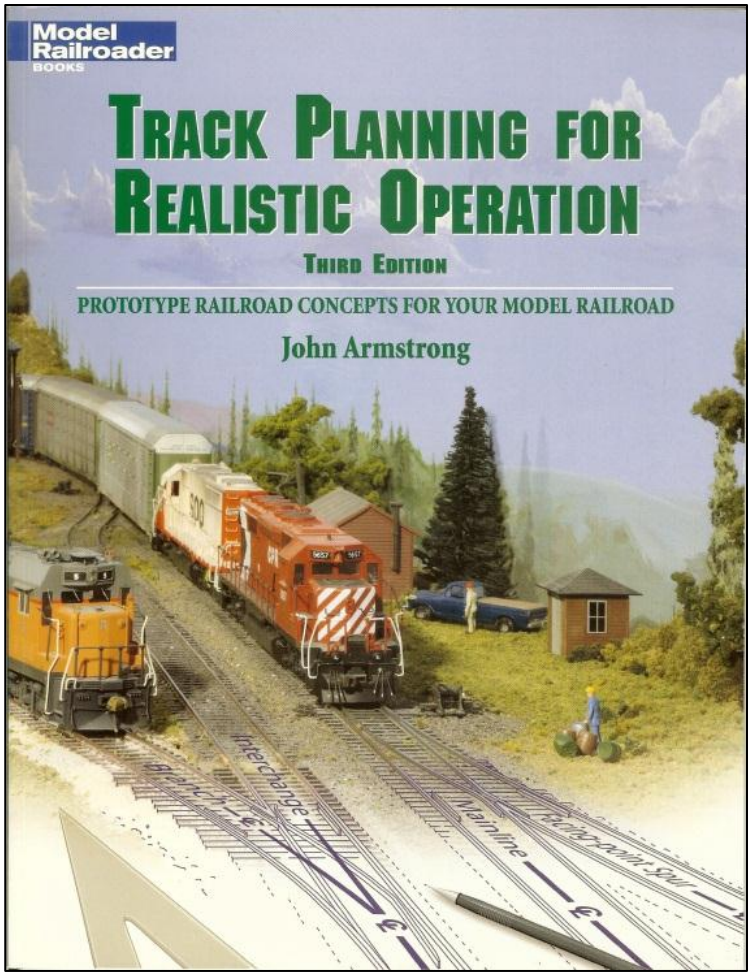
HO scale (1:87.1)
Room size: 20' x 19'
12" grid
Numbered boxes indicate inches above floor

LAYOUT DRAWING: *Charles C. Thomas;* MAP: *John R. Signor*

Establishing Design Standards

Getting it to fit (and work!)

Step 1: Read this book

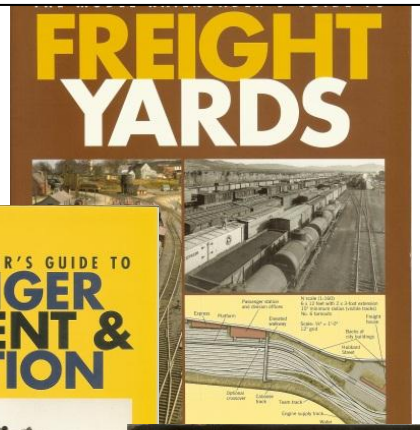


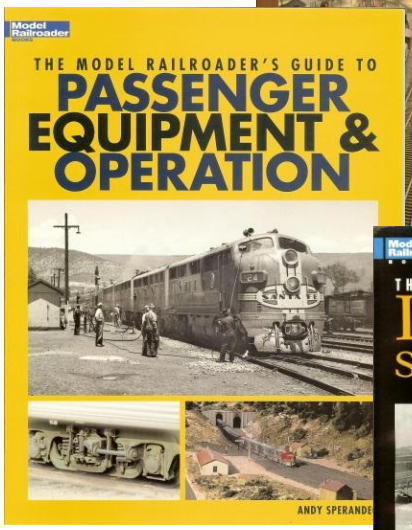
Almost everything you need to know about designing a layout from John Armstrong, the Dean of Model Railroad Layout Design

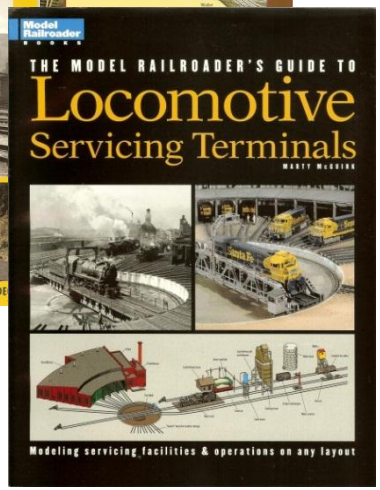
Step 2: Read this book again!

Other Useful References

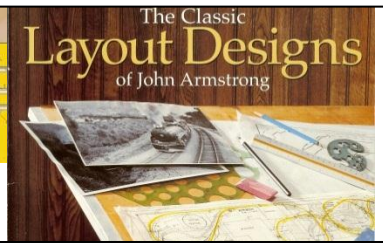
Great prototype design ideas







Excellent operations-oriented ideas for single and multi-deck layouts



More ideas from John Armstrong

Layout Design BOOTCAMP

by Byron Henderson for the Layout Design SIG

www.x2011west.org/handouts/ldBootcamp.pdf

Online sources

And there are lots of other resources in print and online ….

Layout Overview

Scale
Room size _____
Prototype _____
Locale _____
Period _____
Layout style _____
Layout h
Benchw
Roadbe
Main lin
Track
Turnout
Minimu
Track ce
Return loops _____
Maximum grade _____
Scenery & backdrop _____
Train Control _____
Turnout control _____
etc., etc. _____

- ✓ I started with a blank "Layout Overview" and filled it in as my ideas and designs grew.
- ✓ Some items are aesthetics and some have real impact on operations.

The Salt lake Route Layout Overview

Scale	HO
Room size	20 x 19 feet
Prototype	Union Pacific and Santa Fe Railroads
Layout style	Walk around
Layout height	46” main level rising to 53” at Summit
Benchwork	Open grid and L-girder
Roadbed	Homabed on ¾” birch plywood & ½” homasote
Main line	162 feet UP; 77 feet Santa Fe; 50 feet joint track
Track	Code 83 mainline & staging, 70 yards & sidings
Turnout min.	#8 passenger mainline, #6 freight mainline and ds
Minimum radius	34” passenger, 26” freight; curves eased and super-elevated
Track centers	2” tangent; 2 ¼ to 2 ½” double-track curves
Maximum grade	2.5 percent
Train Control	North Coast Engineering (NCE) DCC
Turnout control	Tortoise switch machines and ground throws
etc.	
etc.	

Key Design Considerations

The Salt Lake Route "Givens & Druthers"

Givens (things you must have, or can't change)

- ✓ Ability to operate and showcase the *City of Los Angeles*
- ✓ Continuous running, plus switching for interesting operations
- ✓ A sense of going somewhere w/staging at each end
- ✓ Single deck design with possible upper/lower-level staging
- ✓ The "feel" of Southern California w/enough detail for interest but uncluttered and with a uniform color palette
- ✓ Around the room design with "arm-reach" accessibility
- ✓ DCC wireless cab control

More Design Considerations

The Salt Lake Route "Givens & Druthers"

Druthers (things you want, but are willing to compromise)

- ✓ Prototypical accuracy, but with reasonable artistic license
- ✓ The citrus groves, packing houses and a PFE icing facility
- ✓ The Santa Ana River railroad bridge
- ✓ Piggyback service (TOFC) loading ramps
- ✓ Interchange with the Santa Fe and possibly Southern Pacific
- ✓ At least a portion of Cajon Pass & San Gabriel Mountains
- ✓ Benchwork designed for eventually needing to move and downsize

More Design Considerations

More things to think about

Physical Space Considerations

- Room shape, square footage, doors and stairs
- Wall height, window locations
- Access to appliances, heating and A/C
- Existing and future lighting
- Other room activities

And more things to think about

Construction Considerations

- Shelf, along-the-wall, around-the-room, mushroom, island, etc.
- Single deck, multi-deck
- L-girder, open grid, tabletop
- Duckunders and lift-out sections

Operating Considerations

- Aisle width and potential congestion points
- Layout height
- Train lengths and staging
- Train and turnout control
- Passing, trailing and facing sidings
- Grades and vertical clearances
- Access for construction and maintenance

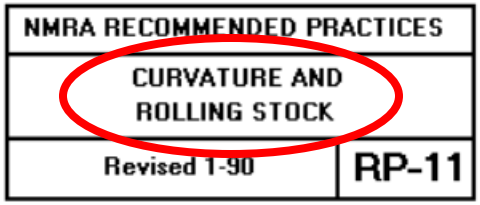
Determining Minimum Curve Radius, Turnouts, Track Centers, etc.

Where to look for guidance:

✓ NMRA Standards and Recommended Practices (RPs)
http://www.nmra.org/standards/sandrp/consist.html

- Publications
- Experience operating other layouts
- Expert advice from other operators

✓ Test your actual equipment



Using NMRA Standards & RPs

Complied by Hill, Hazen, Bradley

Equipment should be designed and built to operate satisfactorily at restricted speeds through the minimum turnouts and minimum radius curvature specified below. For operation at typical main line scale speeds (see DATA SHEET D4d) specifications for one or more higher classes should be used.

Layouts should be designed and built with not less than the specified minimum radii and turnouts for the equipment listed. Use of the largest radius curves, properly eased (see DATA SHEET D3b, D3c, D3c.1), consistent with the design limitations of the individual layout, is strongly recommended for best operation.

CLASSIFICATION OF EQUIPMENT

Class	Key	Motive Power	Passenger	Freight
Standard Trunk Lines	M	Steam locos to 17' rigid wheel-base. Diesel locos to 60' long with two 4-wheel trucks.	Suburban, postal and baggage cars to 60' with diaphragms.	Standard cars to 50' long with regular couplers or with cushion underframes and regular couplers.
	N	Steam locos to 20' rigid wheel-base Diesel locos to 60' long with two 6-wheel trucks.	Suburban, postal and baggage cars to 70' long with diaphragms.	Standard cars to 62' long with or without cushion undergrames and regular couplers.
	O	Steam locos to 24' rigid wheel-base. Diesel and electric locos to 70' long with two 6-wheel trucks.	All cars to 80' long with diaphragms.	Cars to 85' long if not over 9' wide with or without cushion under-frames and regular couplers. Plate C cars.
	P	Steam locos to 28' rigid wheel-base. All Diesel locos. All Electric locos.	All passenger cars.	All freight cars

NMRA RECOMMENDED PRACTICES	
CURVATURE AND ROLLING STOCK	
Revised 1-90	RP-11

Using NMRA Standards & RPs

Classification Key	A	B	C	D	E/J	F/K	G/L	H/M	N	O	P
Min. Turnout No.	2.5	3	3	4	4	5	5	6	6	6	7
Minimum Curve (In Degrees)		180	100	80	60	50	40	35	30	25	20
Prototype Radius	36'	50'	65'	78'	100'	118'	146'	166'	193'	231'	288'
O Scale	9"	12.5"	16"	19.5"	25"	30"	36.5"	41.5"	48"	58"	72"
S Scale	7"	9.5"	12"	14.5"	19"	22.5"	27.5"	31"	36"	43.5"	54"
OO Scale	5.5"	8"	10.5"	12.5"	16"	18.5"	23"	26"	30.5"	36.5"	45.5"
HO Scale	5"	7"	9"	11"	14"	16.5"	20"	23""	26.5"	32"	40"
TT Scale	3.5"	5""	6.5"	8"	10"	12"	14.5"	16.5"	19.5"	23"	29"
N Scale	2.75""	3.75"	4.875"	5.875"	7.5"	8.875"	11"	12.5"	14.5"	17.375"	21.5"

Note 1. For classes O and P, minimum high speed turnout and crossover should be No. 8. However, for 3-rail systems, No 6 is the recommended maximum because of the length of the gap in the third rail.

Using NMRA Standards & RPs

NMRA STANDARDS

TRACK CENTERS

Revised: July 2002 | Sheet No. S-8

This STANDARD lists Track Center Distances and provides for Side Clearances required for various curvatures with three size categories of models.

Class II Includes small four-wheel truck diesels, geared and other small steam locomotives with short end overhangs typical of old-time, logging and branch lines and equivalent rolling stock.

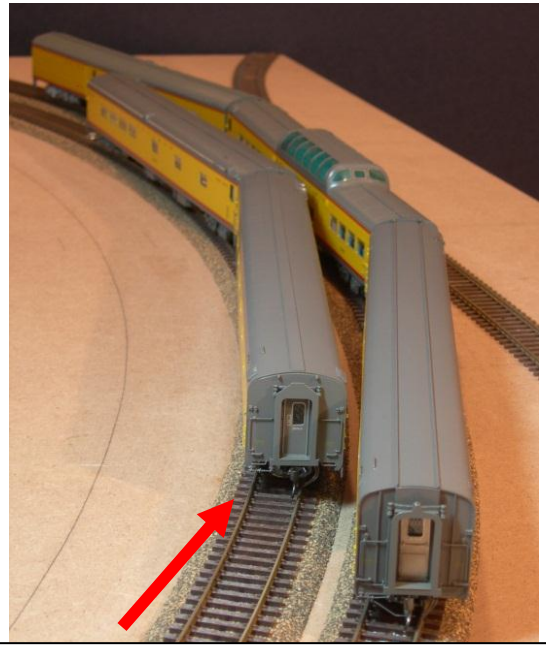
Class I Includes longer steam locomotives typically with two-wheel trailing trucks, larger four and six-wheel truck diesels and equivalent rolling stock.

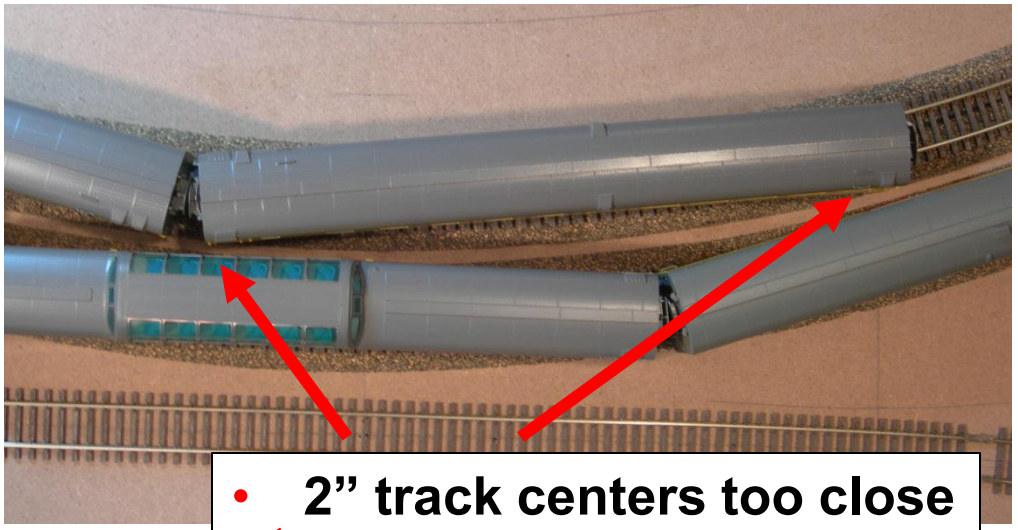
Class Ia Includes the largest steam locomotives with four-wheel trailing trucks, articulated locomotives, those with rigid wheelbases in excess of 20 feet, full length passenger cars and other long rolling stock.

Layouts constructed to one of these classes should accept models of its own and smaller classes, but larger models can expect clearance problems on a layout built to a smaller classification. See STANDARD S-7 and RP-11.

Degrees	M	0	5	10	15	20	25	30	35	40	45
Radius		Tang.	1146	574	383	288	231	193	166	146	131
HO SCALE:											
Radius-inches		Tang.	158	79	53	40	32	26 1/2	23	20	18
Centers											
Class II	2 1/16	1 13/16	1 13/16	1 13/16	1 1/8	1 15/16	2	2 1/16	2 1/32	2 1/8	2 3/16
Class I	2 1/16	1 13/16	1 1/8	1 15/16	2	2 1/16	2 1/8	2 1/16	2 1/16	note 8	
Class Ia	2 1/16	1 13/16	1 31/32	2 1/8	2 1/4	2 1/8	2 1/2		note 8		

When in doubt, test it out





- 2” track centers too close

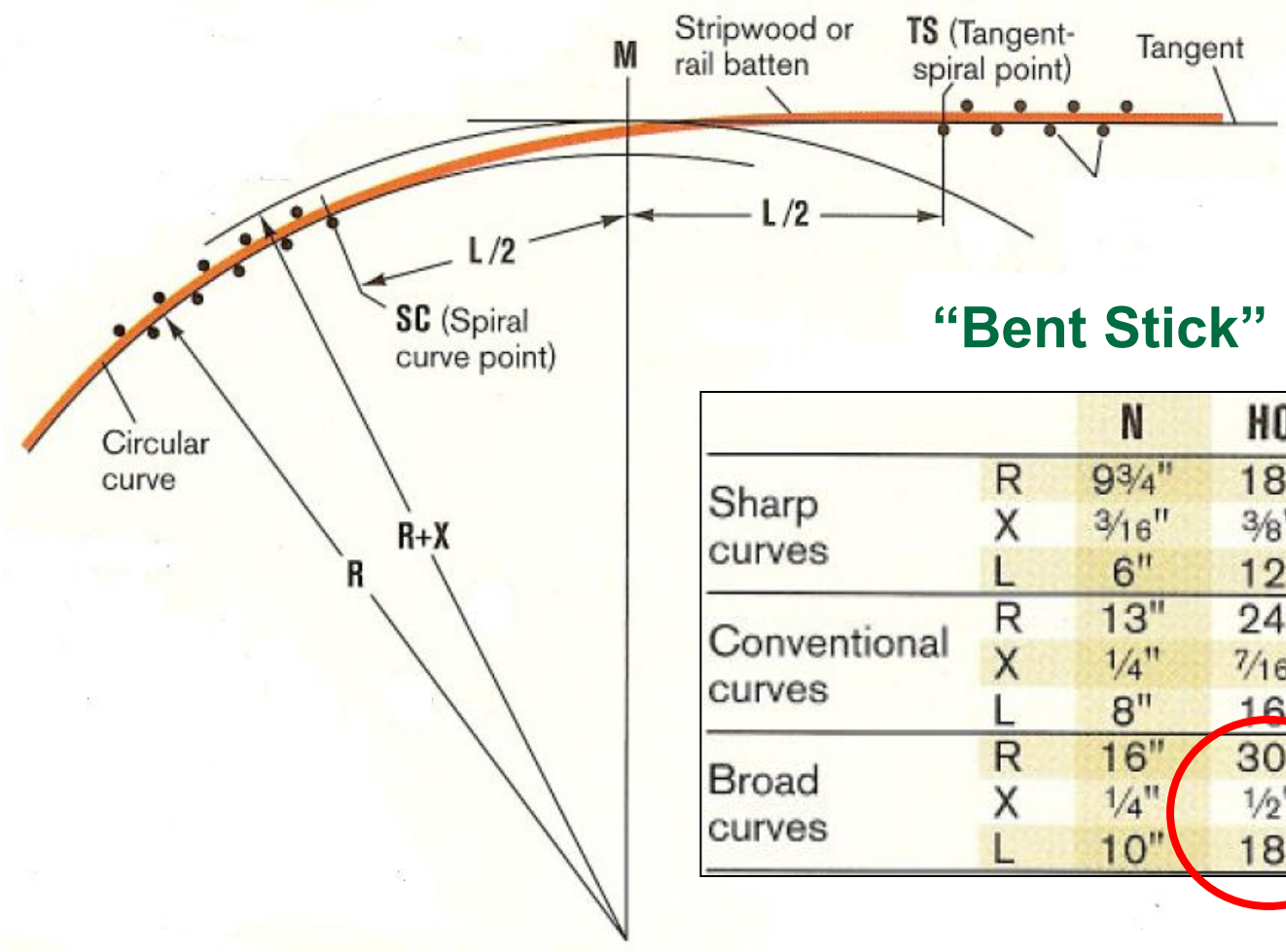
✓ Increase to 2 ½”

✓ 34” minimum radius
(Not visually perfect, but operable)

✓ #6 turnout on 12 degree angle

Easements

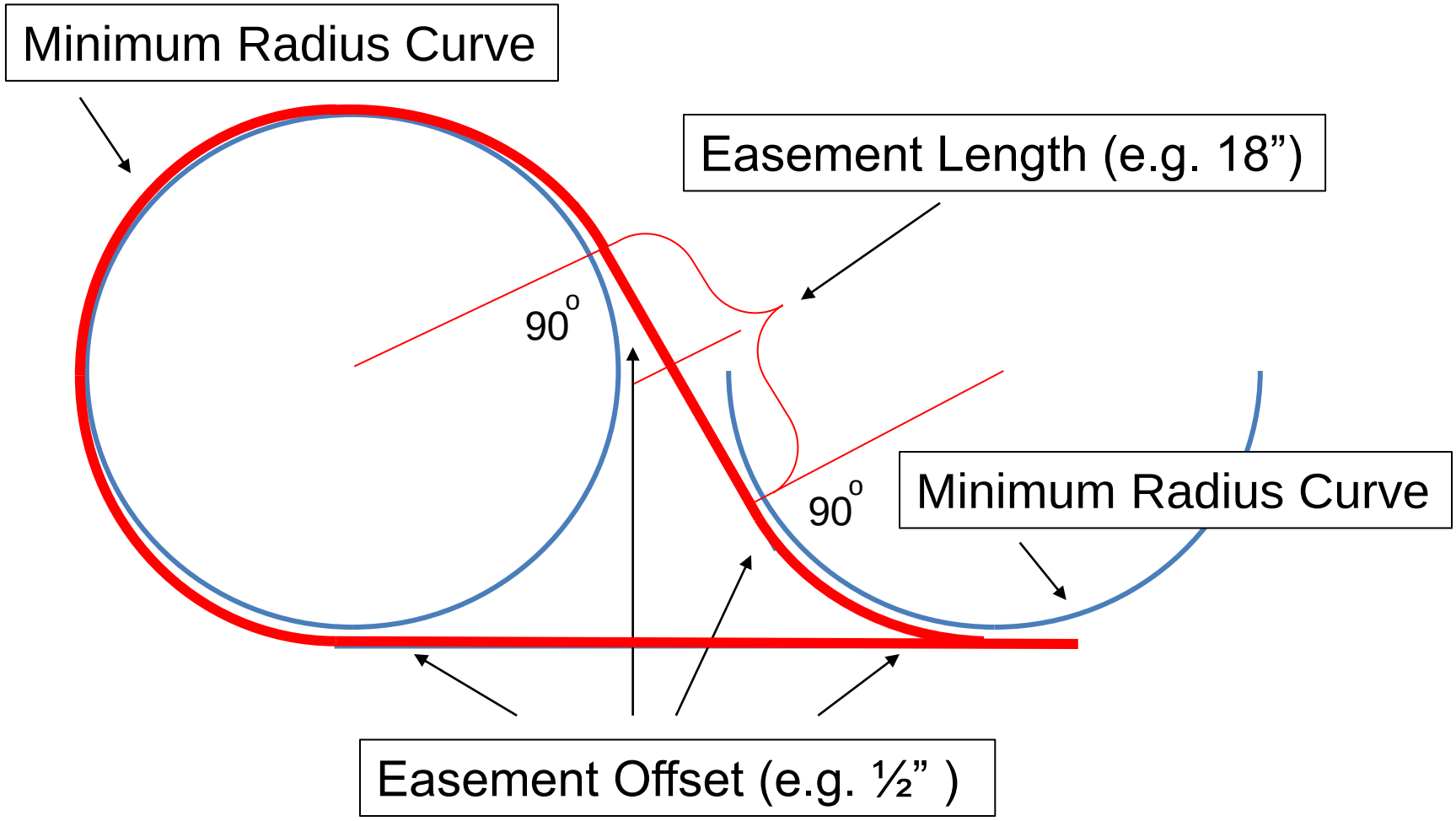
Easements are transition curves with gradually increasing radius inserted between a tangent (straight track) and a circular curve which greatly improve the appearance of trains as they enter curves.



"Bent Stick" Method

		N	HO	S	O
Sharp curves	R	9¾"	18"	24"	32"
	X	3/16"	3/8"	7/16"	½"
	L	6"	12"	16"	20"
Conventional curves	R	13"	24"	32"	42"
	X	¼"	7/16"	½"	5/8"
	L	8"	16"	20"	25"
Broad curves	R	16"	30"	42"	54"
	X	¼"	½"	5/8"	¾"
	L	10"	18"	25"	30"

Calculating a Minimum Reverse Loop

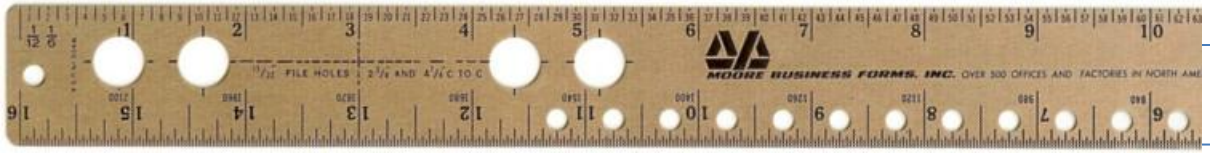


Making a Scale Drawing

Getting it on paper

Scale Drawing Tools

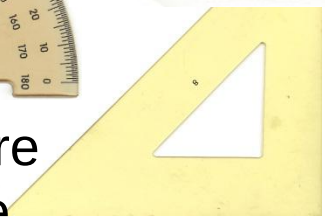
12 to the inch business forms ruler



Flip chart paper with 1” square grid

Tracing Paper

Wire for measuring distances
(22 AWG Solid works well)

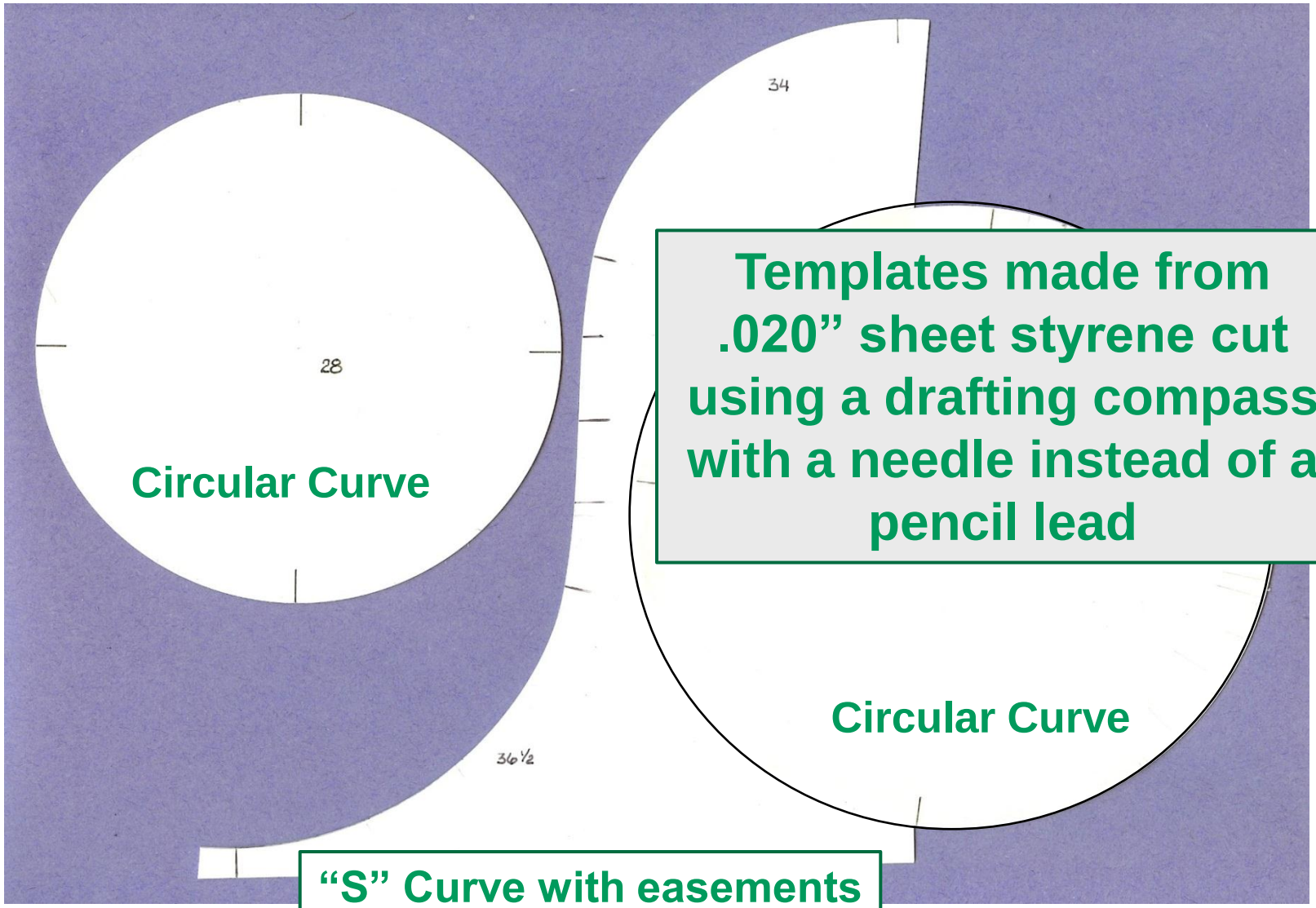


Protractor, Square & French Curve

Good mechanical pencil

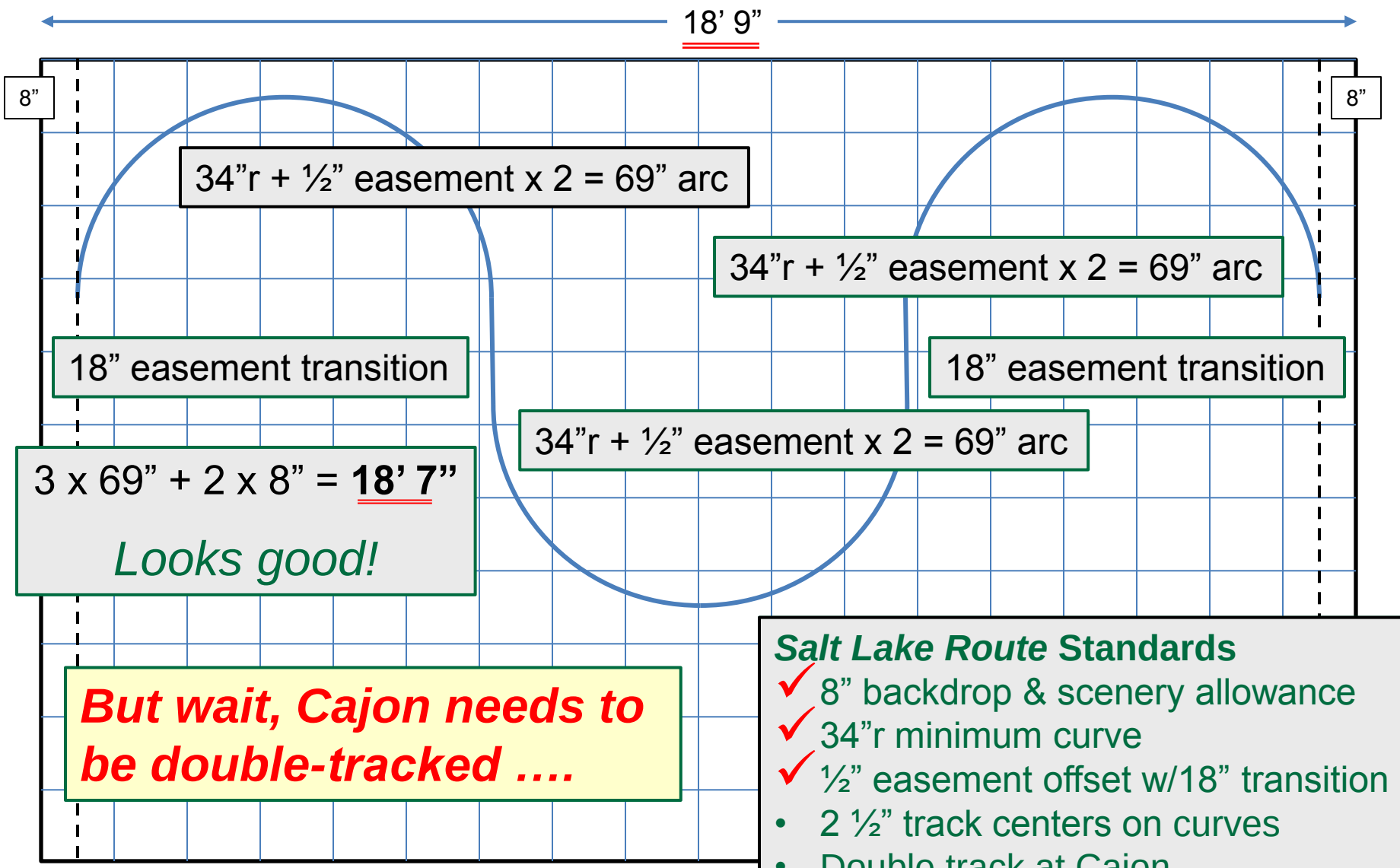
Eraser
(large size!)

Styrene Curve Templates

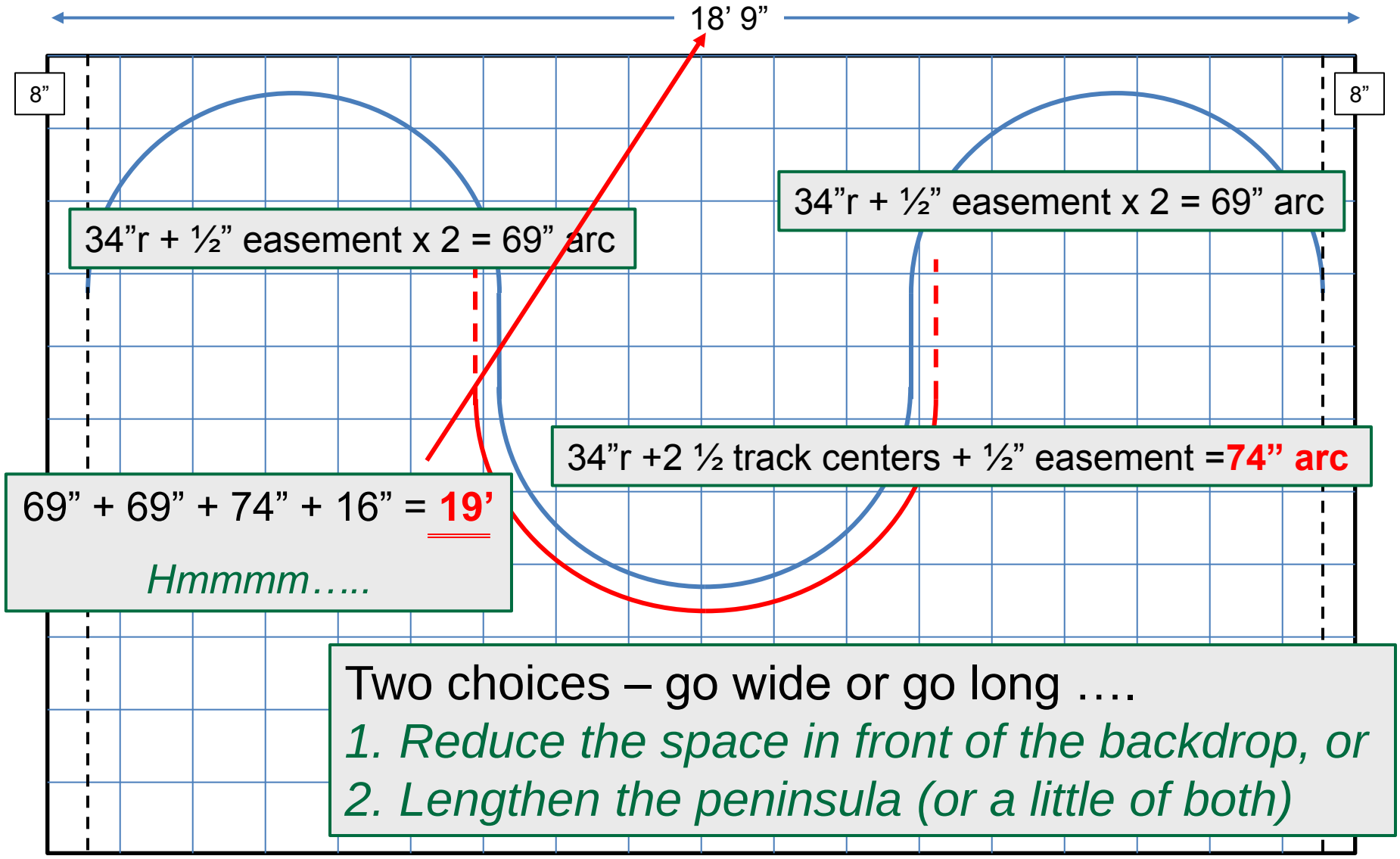


A blank sheet of paper

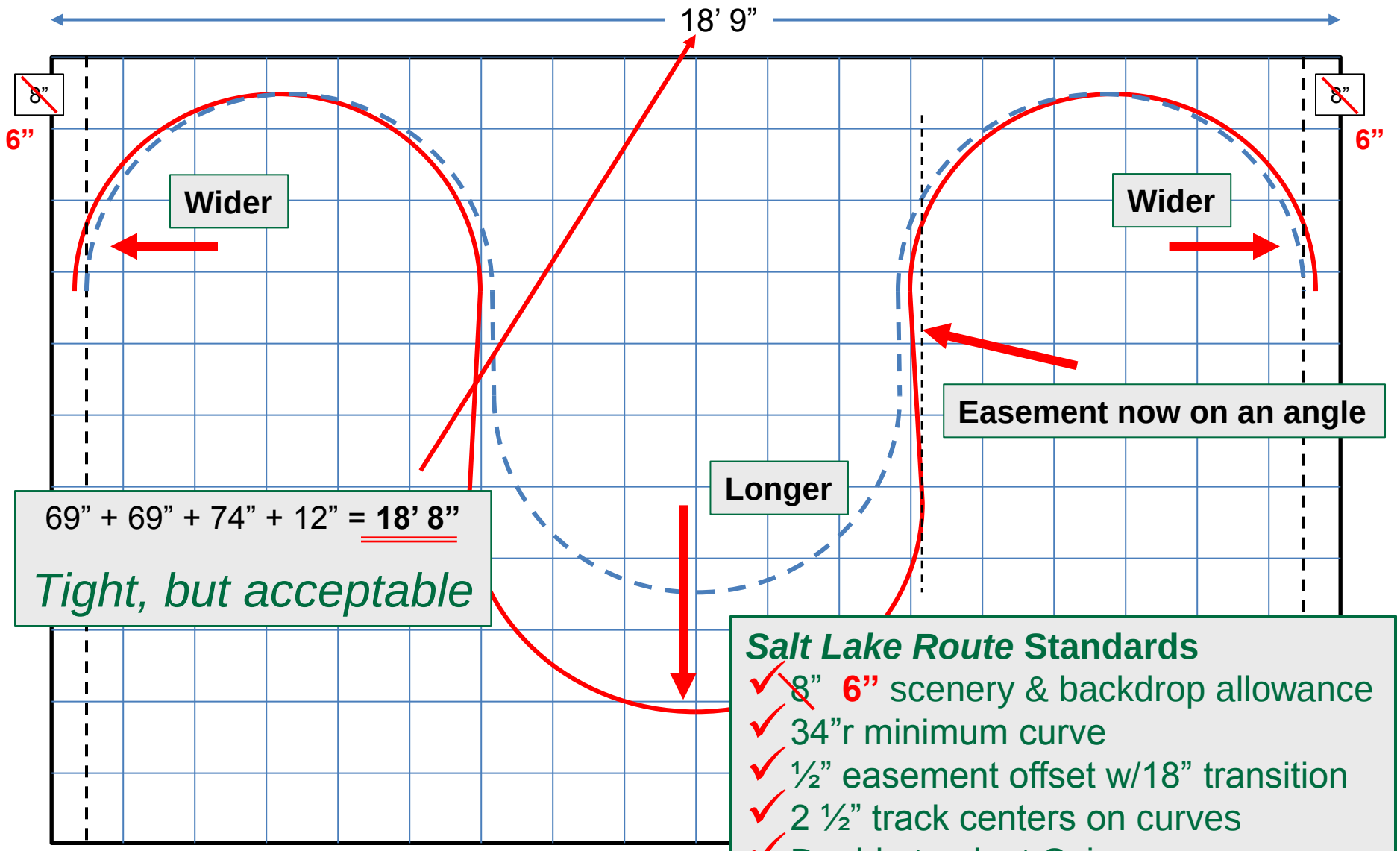
or, How to put 10 pounds of layout in a 5 pound room ….



Getting it all to fit ….



Getting it all to fit ….



Calculating Heights & Grades

Length of run x Grade % = Rise — e.g. 139” x 2.5% = 3 ½”

or

Rise/Length = Grade % — e.g. 3 ½”/139” = 2.5%

Location		Grade Marker	Height	Approximate Distance Btw Levels		Grade: Run: Pt. to Pt.	Grade: Run: Inches	Grade: Run: Feet	Grade: Rise: Inches	Grade: Rise: %	Backdrop Height	Total Height
LAUPT Loop and ELA	A		46									
Walnut / Fullerton Loop	B	G1	46								18 11/16	64 11/16
											18 11/16	64 11/16
											18 11/16	64 11/16
											7 8/16	53 8/16
											18 11/16	64 11/16
						4-G4a	6	1/2	1/16	1.00%		
Riverside Junction Transition 2		G4b	46 3/16			G4a-G4b	6	1/2	2/16	2.00%		
Devore	F		49 10/16	F-A	3 3/4	G4b-G5b	139	11 1/2	3 8/16	2.50%		
Cajon Transition West 2		G5b	49 13/16			G5b-G5a	6	1/2	2/16	2.15%		
Cajon Transition West 1		G5a	50			G5b-G5	12	1	3/16	1.80%		
Cajon	G	G5	50 8/16	G-A	4 2/4	G5-G6b	33	3	8/16	1.50%	14 3/16	64 11/16
Cajon T								1/2	2/16	1.80%		
Cajon T								1/2	2/16	2.15%		
Mormon Rocks	H	G6	52 9/16	H-A	6 2/4	G6-G7b	72	6	1 13/16	2.50%		
Summit Transition 2												
Summit Transition 1		G7a	52 11/16			G7a-G7	6	1/2	1/16	1.00%		
Summit Station & Chicago Loop	I	G7	52 11/16	I-A	6 3/4						12	64 11/16

Distance between levels at track crossing
(Actual clearance = 4 1/2”, minus 1/2” sub-roadbed, minus 3/8” roadbed and track = 3 5/8”)

“Vertical easements” to begin and end grades

Backdrop will remain constant height above floor

✓ Record curve centers and turnout locations to facilitate full-size drawing and/or trackwork

Location		Track	Radius	Inches from Wall		
				Windows	Back	Stairs
LAUPT Loop	C1	Mainline (outer track)	36 1/2	74	111 1/2	
		Staging (middle track)	34			
		Staging (inner track)	31 3/4			
Hobart	C2	Westbound main	36 1/2	44 1/2	42	

Curve Centers

#	Location	Coordinates	Code 83					
			8 RH	8 LH	6 RH	6 LH	Curved	Dbl X
	LAUPT Loop							
1	Staging track 1 (middle) entrance (westbound)	69B, 15 7/8W		1				
2	Staging track 2 (inner) entrance (westbound)	81B, 22 5/8W	1					
3	Staging track 2 (inner) exit (eastbound)	69B, 21W					8LH 50/35r	
4	Staging track 1 (middle) exit (eastbound)	57 3/8B, 14 1/8W					8LH 50/35r	
	Hobart							
5	Farmer John track	5B, 53 5/8W		1				
	ELA Yard							
	West End (Hobart)							
6	Departure track crossover west	7B, 58 3/4W		1				
7	Arrival track crossover west	5B, 74 1/4W		1				
8	Arrival track crossover east	5B, 83 1/2W	1					
9	Departuretrack crossover east	7B, 99 1/8W	1					
10	West yard entrance	7 7/8B, 41 1/4W					8RH 50/35r	
11	Switcher pocket	11B, 61 3/4W						
15	Coach yard track 2	23B, 78 1/8W						

ELA Depot
Walnut
Fullerton Loop
Pachappa
Riverside Jct.

Turnouts and Location Coordinates

Making a Full-Size Drawing

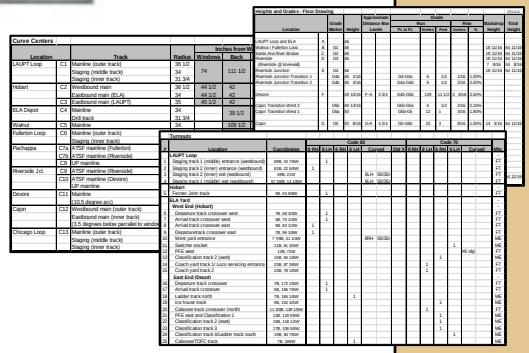
Getting it on the floor

Full-Size Drawing Tools

Carpenter's squares

Bosch Laser Distance Measurer

Roll of brown paper



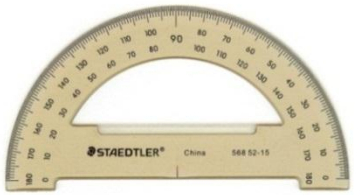
Scale drawing records

Yardsticks

String for measuring distances

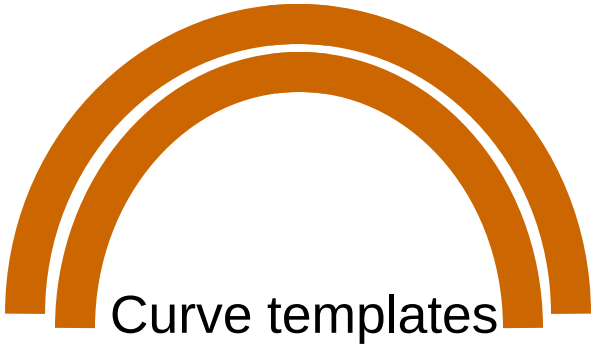
Eraser

Fine tip marking pens



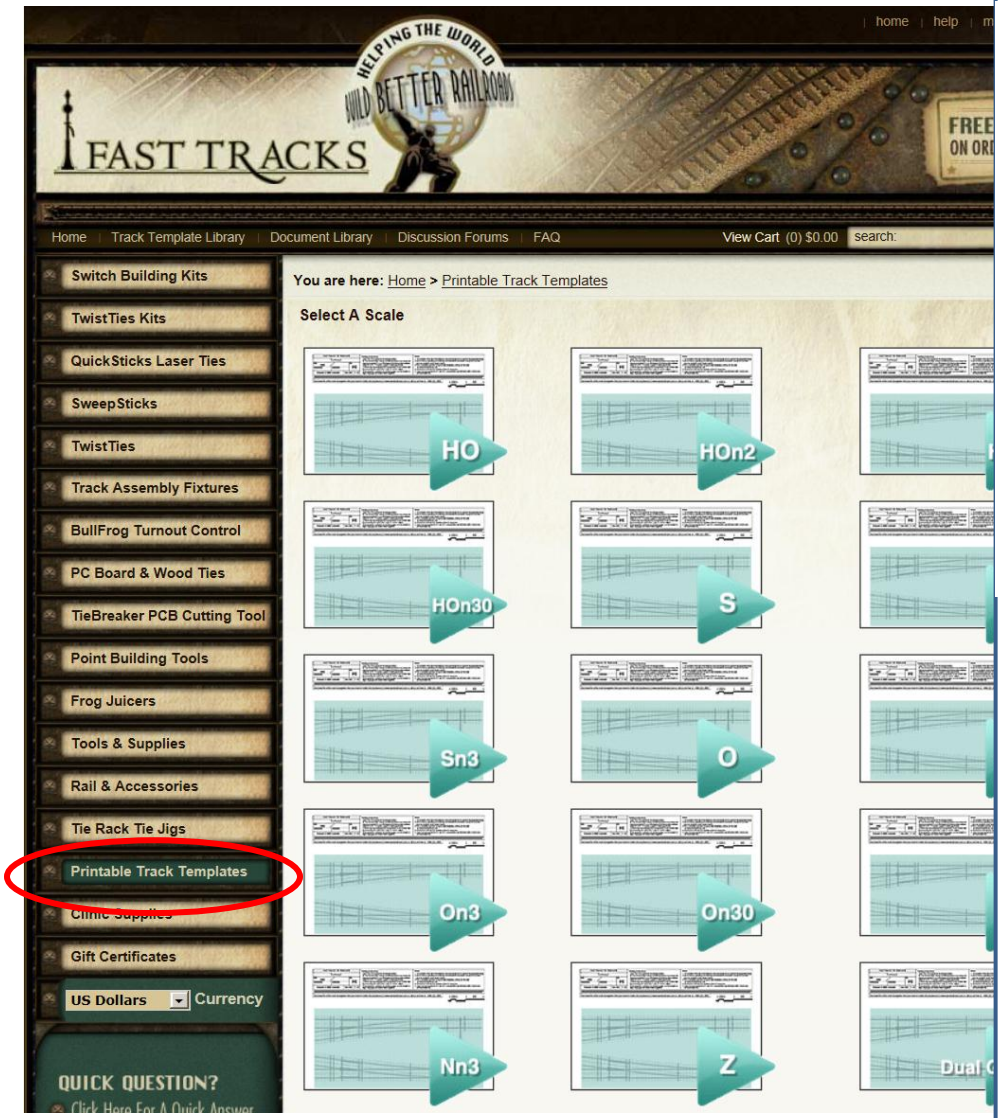
Protractor
(bigger the better)

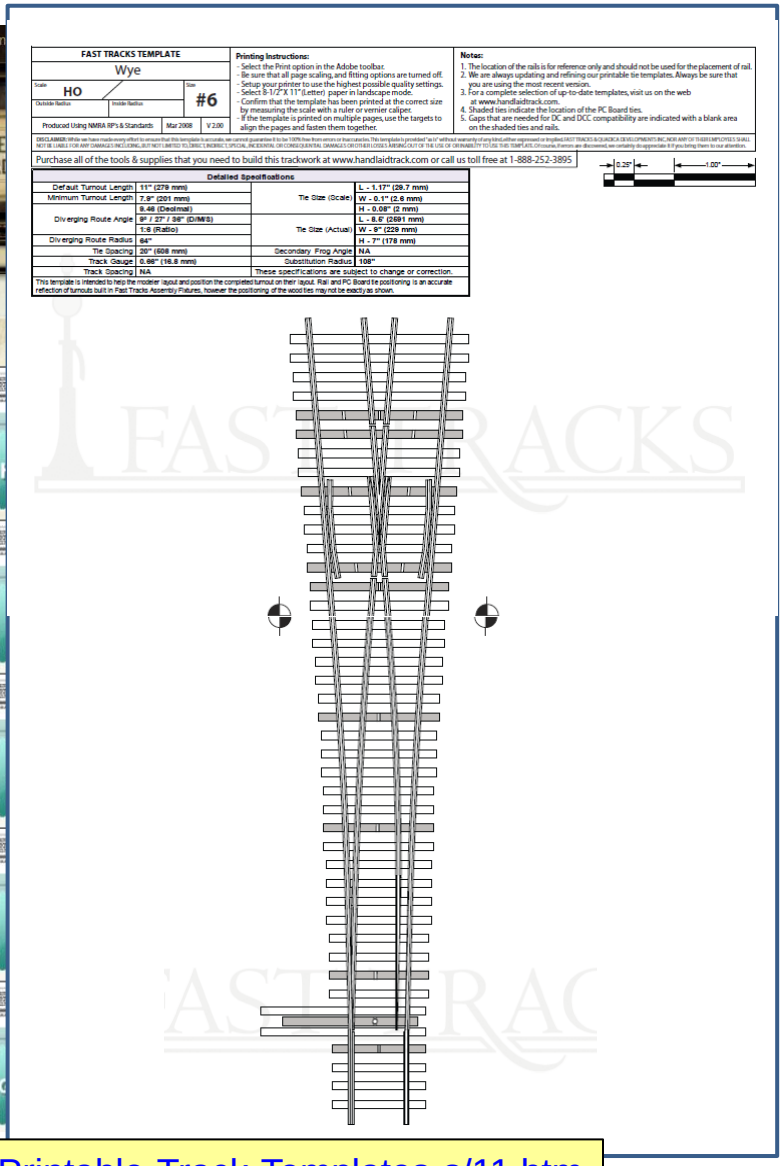
Turnout templates



Curve templates

Turnout Templates – *Fast Tracks*

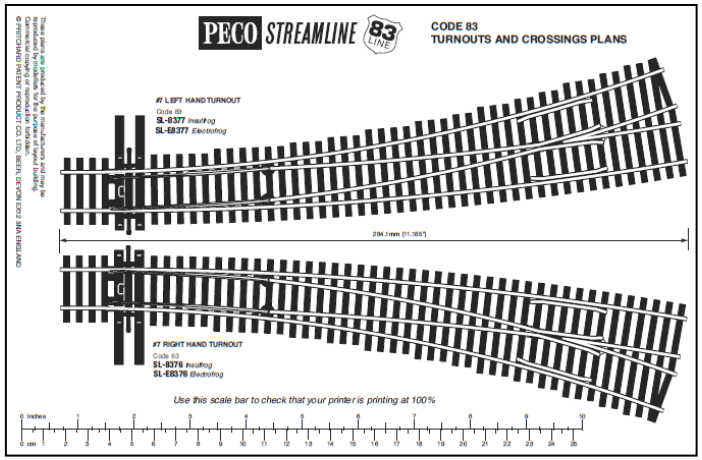




http://www.handlaidtrack.com/Fast-Tracks-Printable-Track-Templates-s/11.htm

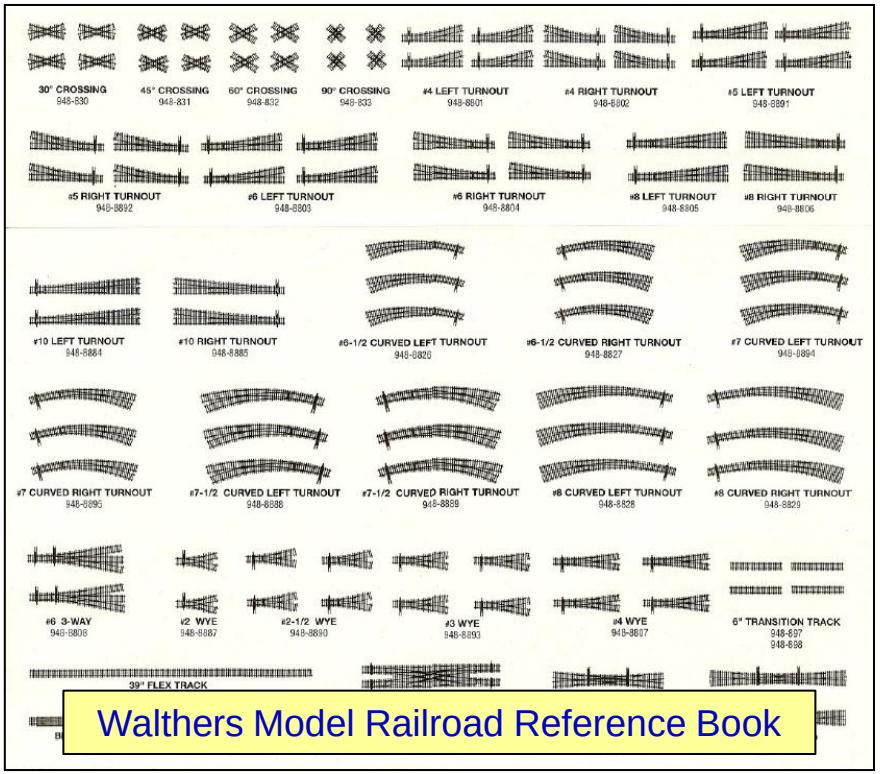
Turnout Templates

PECO



http://www.peco-uk.com/page.asp?id=pointplans

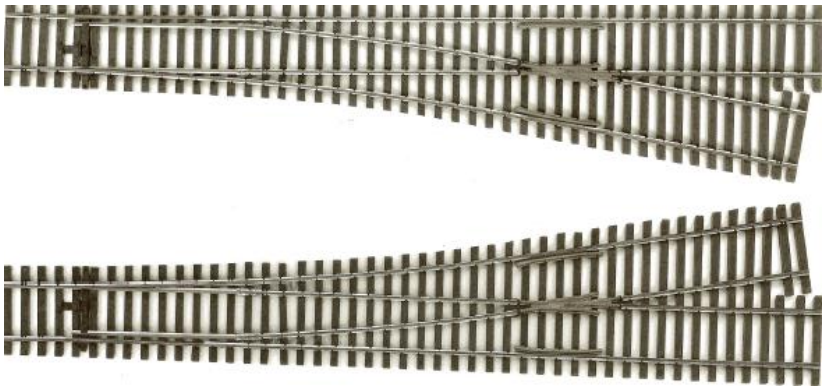
Walthers



Walthers Model Railroad Reference Book

(¾" : 1' scale)

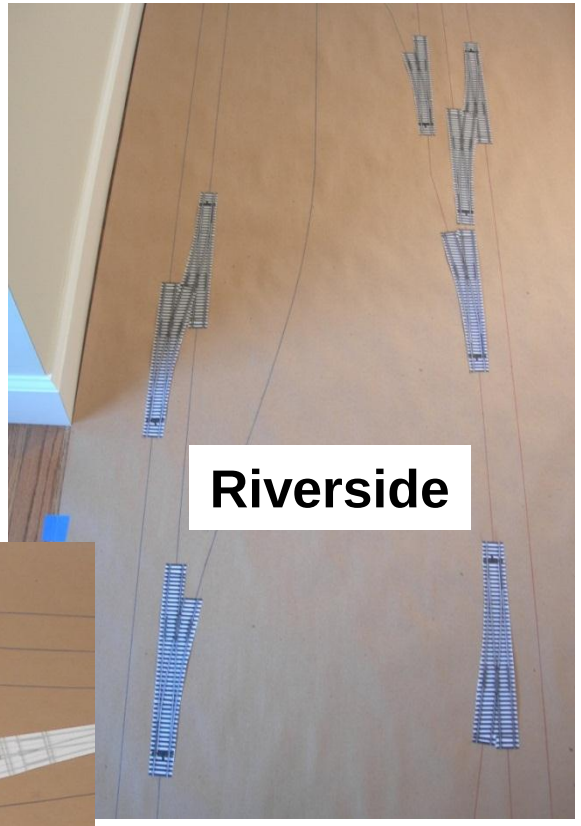
Micro Engineering



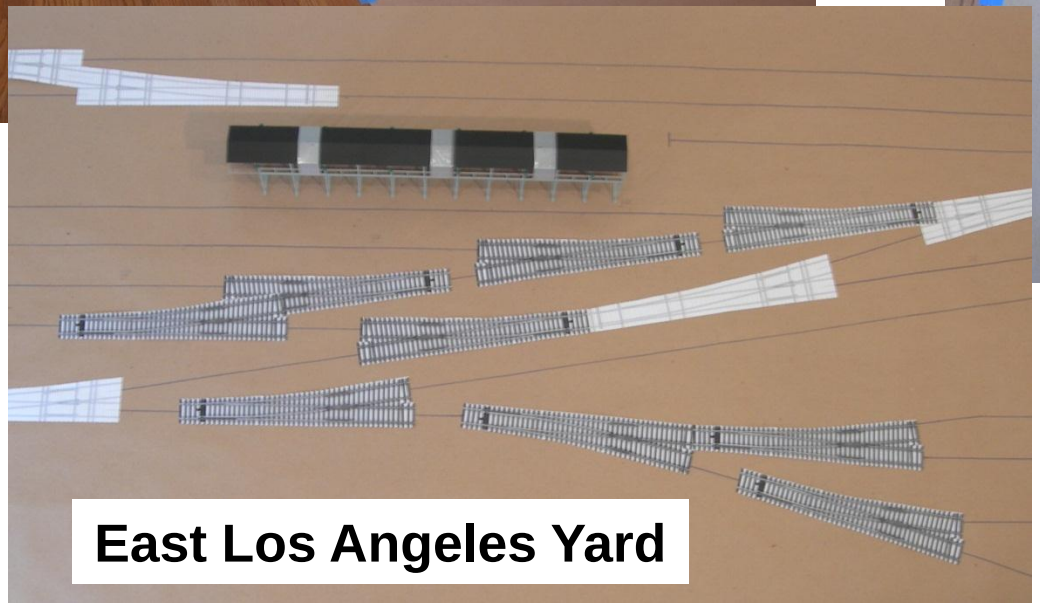
Photocopy of actual turnout
Top is a regular copy; Bottom is a "mirror image" copy

Scenes from the “Floor Show”

Cajon Pass, Summit and the LAUPT & Chicago Loops

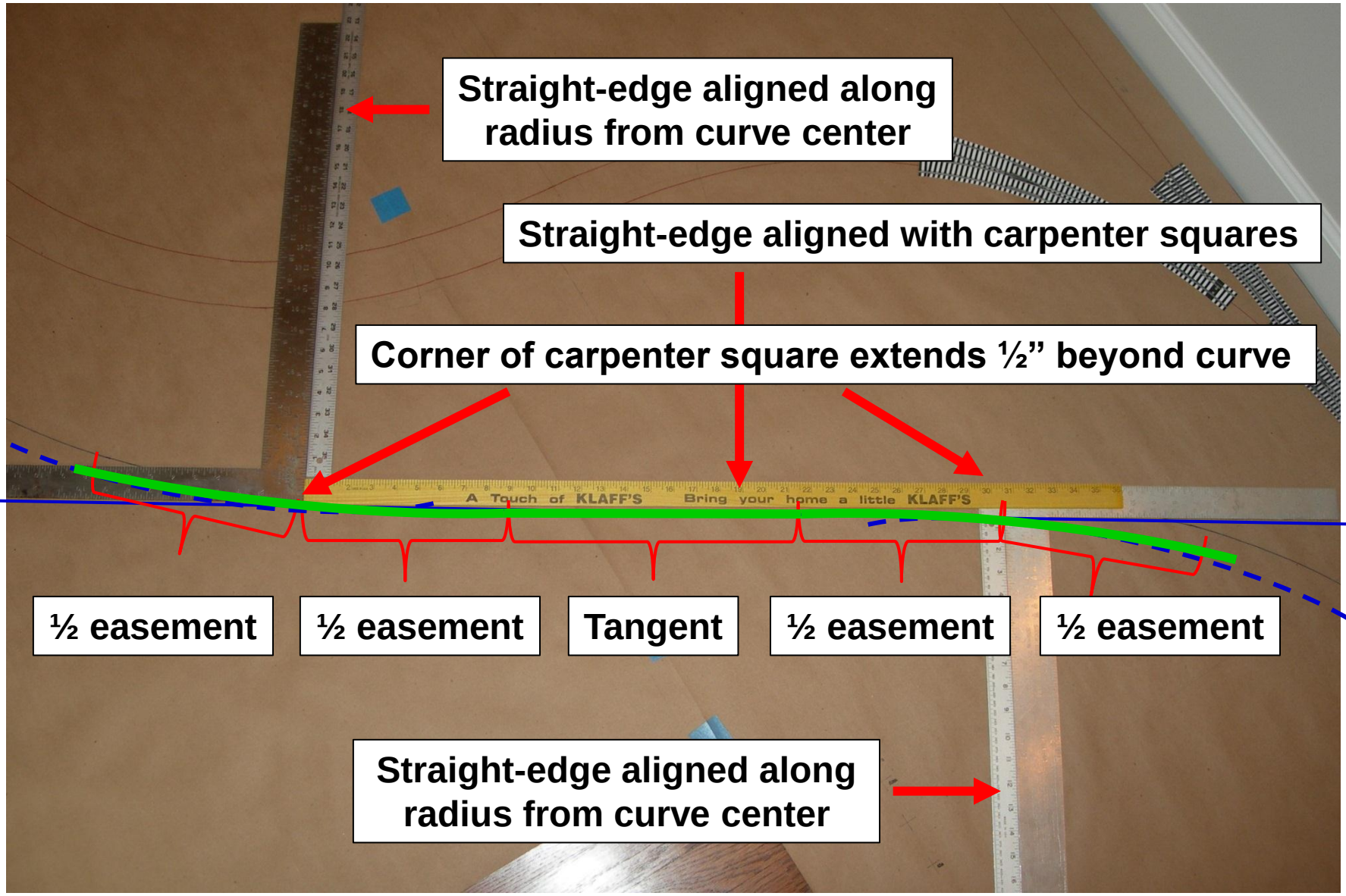


Riverside



East Los Angeles Yard

Laying Out a Full-Size “S” Curve



The Salt Lake Route – Now What?

Next Steps:

- ✓ **Position structure footprints and confirm clearances**
- ✓ **Determine distance to fascia, curvature and aisle width**
- ✓ **Locate switch motor and uncoupling magnet positions**
- ✓ **Mark benchwork and support joists on floor plan**
- ✓ **Determine and mark DCC power districts, circuit breakers, reversing points, cab bus panels, etc.**
- ✓ **Begin construction!**

To be continued ….

Questions??

"*On the green light you go and on the red light you stop, because no engineer would ever run a red light.*"

"Engineer Bill" Stulla, KHJ-TV Cartoon Express, Los Angeles, 1954

Photo, Drawing and Image Credits

NOTICE: This Designing a Layout for Operations presentation was created by the author, Charles C. Thomas, for his personal use and as an instructional aid for model railroad clinics for members of the National Model Railroad Association. All photos, drawings and images are property of the author except as noted below. The author does not have, nor can he confer, rights to the photos, drawings and images which are the property of others.

Chart	Image	Source
1	City of Los Angeles	Union Pacific Museum Collection
5	East Los Angeles Yard	Union Pacific Museum Collection
5	Hobart Tower (photo)	Alan Miller
5	Hobart Tower (drawing)	Matt Zebrowski for The Streamliner
5	City of Los Angeles	(as noted for chart 1 above)
5	TOFC loading	Union Pacific Museum Collection
5	SW9 in yard	Union Pacific Museum Collection
6	Map of Riverside	Matt Zebrowski for The Streamliner
6	Riverside Jct. Tower	John R. Signor
6	National Orange	Brian Grogan for the California Citrus Heritage Recording Project HABS/HAER
6	Santa Fe Depot	Santa Fe Collection, Kansas State Historical Society
7	Alray Tunnel (diagram)	Rick Blanchard
7	Alray Tunnel (photo)	Joe McMillian
7	Cajon (photo)	John Shaw
7	Cajon (map)	John R. Signor
7	Summit (photo)	John Shaw, Jr.
7	Summit (map)	John R. Signor
8	City of Los Angeles	(as noted for chart 1 above)
8	Hobart Tower	(as noted for chart 5 above)
8	National Orange (photos)	(as noted for chart 6 above)