A Railroad Signaling Primer For Modelers

Part 1: MORE THAN JUST A PRETTY LIGHT

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WHAT IS SIGNALING IN GENERAL?

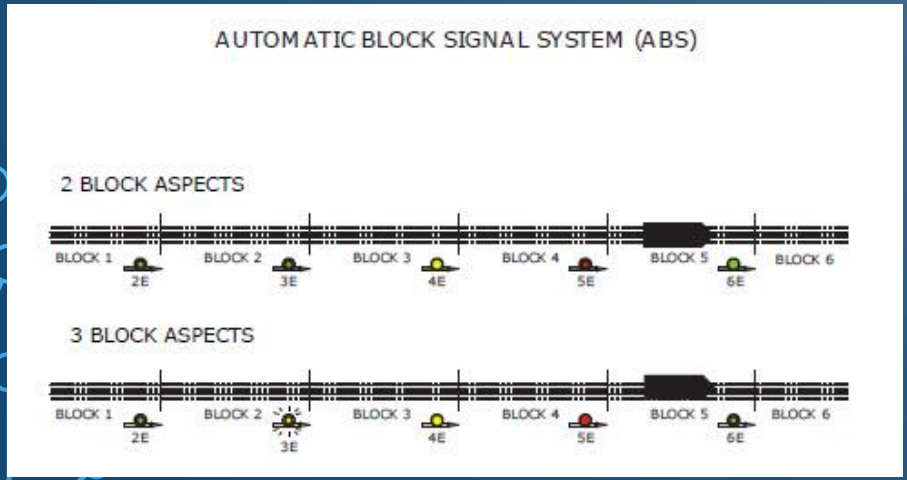
- Since the beginning of the railroad system, signals and signaling methods have been an important part of controlling the efficient operation of trains
- Together with a set of rules for the railroad, a variety of signaling devices:
  - Keep trains moving at best possible speed
  - Keep trains on the correct route
  - Keep crews and other railroad personnel in communication with each other
  - Keep operations and the general public SAFE
- Signals are, in essence, the language of how trains and railroads communicate in real time

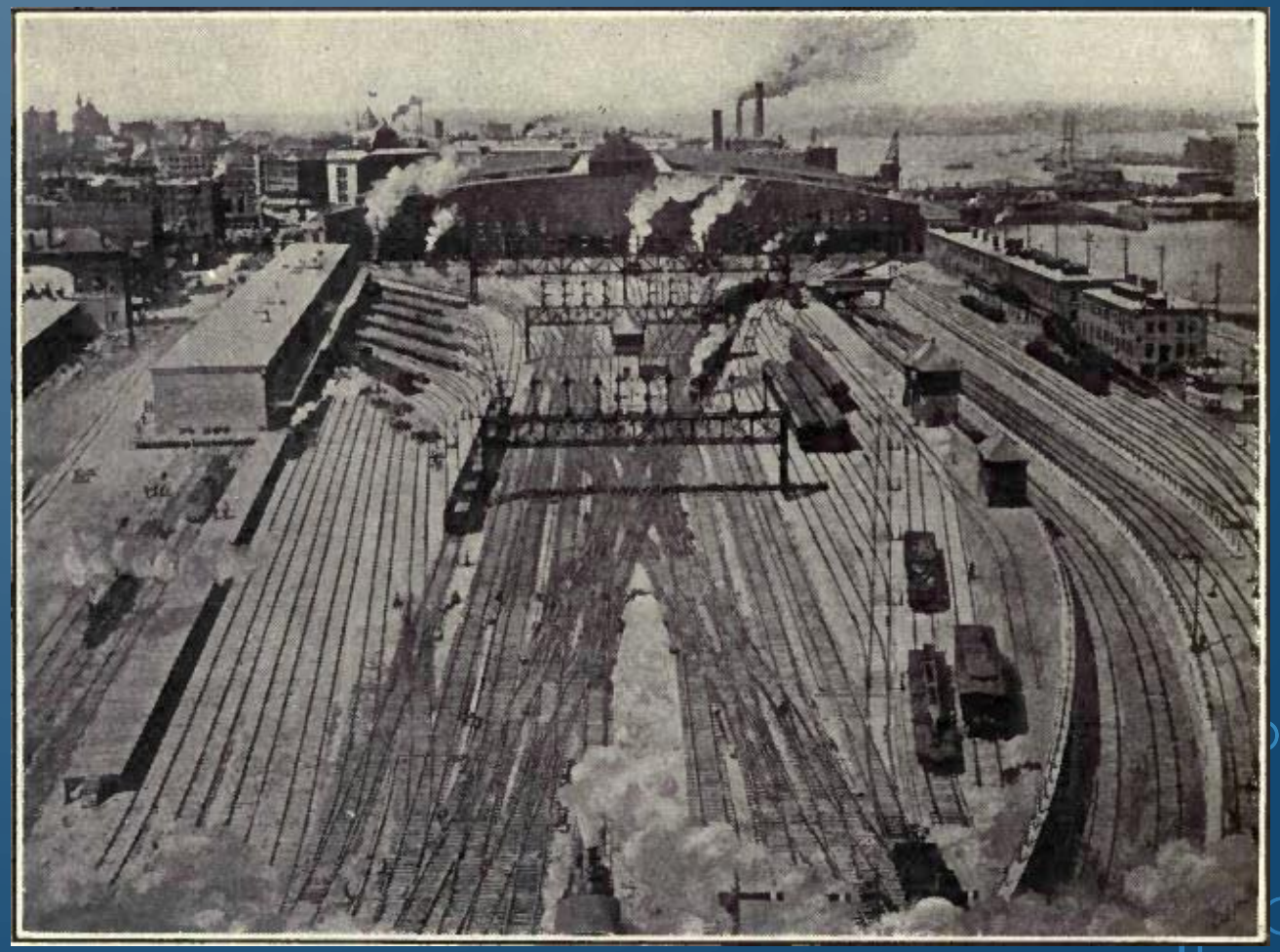
PERCEIVED DIFFICULTIES IN MODELING SIGNALS

- Why - since we see the entire route / layout / conflicting movements anyway?
- Interpreting the terminology – understanding the language
- Not complex enough to warrant adding signals – too small
- Era-specific issues - I model the 1920s…
- Rulebooks from my prototype railroad have too many possibilities – when do I use what?
- Tearing up existing trackwork / scenery to add signals after the fact is not appealing
- I don't want to do computer programming – I want to run the trains
- All that wiring is too complex…and it's going to be too expensive…

BENEFITS OF INCLUDING SIGNALS ON A MODEL RAILROAD

- Interactive Scenic Element
- Add Animation
- Increase Operational Interest
- Replicate a Prototype (!)
- NMRA Achievement Program…





SIGNAL DEFINITIONS (1)

- Signal
  - **Almost Anything** used by a railroad to control railroad operations. This includes sounds, lights, signs, gestures by crew personnel, or symbols understood by train crews operating a train over the tracks.
- Fixed Signal
  - Normally a signal head or grouping of heads on a mast or other structure at a static location used to communicate an aspect to a train crew in order to govern the operation of their train in a safe manner.

SIGNAL DEFINITIONS (2)

- Aspect
  - The visual information displayed on a signal head. This includes the number, position, color and state of lights or mechanical devices which make up a visible signal
- Indication
  - The actual interpretation and operational result communicated by a signal aspect as defined by the rulebook of the governing railroad. Visual aspects may be modified by the presence of additional devices affixed to the signal to specify the indication (stop vs. stop and proceed, for example)
- Name
  - Some railroads give a “name” to the signal, such as Clear, Approach, Restricting, Stop, etc. These are NOT INDICATIONS. A full indication is described by the rulebook, which specifies things such as what the restricting speed is, etc.

SIGNAL DEFINITIONS (3)

- Speed-based Signaling
  - The aspect of a signal indicates to a train crew the speed at which they can travel before they reach the next signal
  - A variety of signal configurations exist, with both single and multiple head arrangements
- Block
  - A section of track with defined limits used to separate trains by distance in accordance with a rulebook, train orders, appropriate signals and track circuits. A block may be of any length so as to allow for efficient traffic flow without compromising safe operation
- Automatic Block System or Signaling
  - A system of interconnected signals controlled by track circuits which is designed to indicate track condition or block occupancy in order to protect trains from collision (usually from behind).

SIGNAL DEFINITIONS (4)

- Route-based signaling
  - The aspect of a signal indicates the route (and speed) a train is to take through turnouts or systems of turnouts where a route can diverge from the main path of travel. Railroads tend to use multi-head signals for route based signaling.
- Interlocking / Interlocking Plant
  - A network of turnouts, signals, locks, etc. which are connected mechanically and/or electrically which prevent conflicting or opposing movements through the trackwork
- Centralized Traffic Control (CTC)
  - A remotely controlled system which enables a tower operator or dispatcher to define and direct operations over the tracks by signal indication. The operator may control any combination of the aspects of signals, the position of turnouts, and the setup of routes from a single location either close to or far away from the actual trackwork.

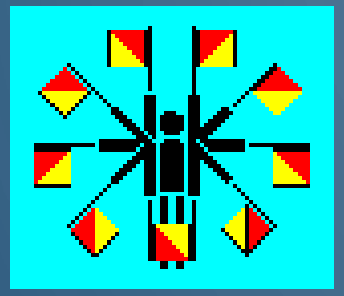
BASIC HISTORY OF FIXED SIGNAL TYPES IN THE US

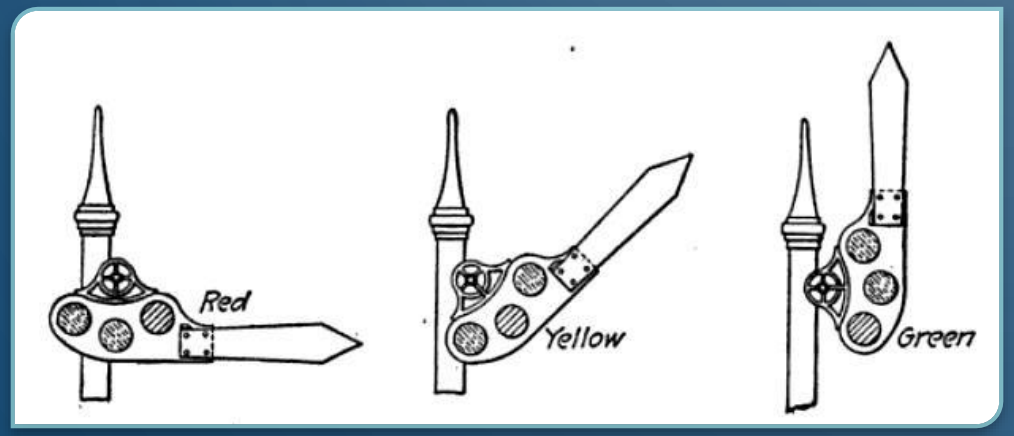
- First recorded use of fixed signals on the 17 mile long Newcastle and Frenchtown RR (connecting Delaware and Maryland)
  - Used a system of masts spaced three miles apart
  - Tracked the progress of trains using either black and white flags (later balls)
    - White balls indicated train on time, black indicated it was running late.
    - After the train had passed the mast, the ball was lowered to half-way up the mast
- Ball signal indications evolved over time such that they were used to determine whether a train could pass the signal or not.
  - Boston and Maine and Central Vermont used balls at grade crossings through the 1960s in some places!

A Boston & Maine freight rolls past a ball signal in the "proceed" position at Coos Junction, N.H.

D.S. Robinson

THE SEMAPHORE

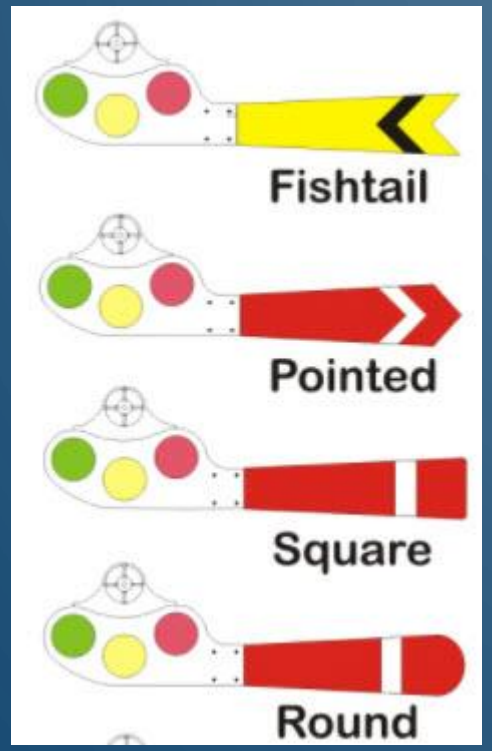




Three different “Aspects” now available

- The next advance in signal design originated in the British Navy, who had developed the use of flag semaphore signaling for ship-to-ship communication
- In 1841 the London and Croydon Railway created the first fixed railway semaphore using a variation of these “codes”, which resulted in the “lower quadrant” semaphore
- Semaphores came in a number of configurations and positions, but the most common (and safest) was the upper-quadrant semaphore
  - If power was lost, the arm would drop to the horizontal, which indicated stop
- The failsafe low horizontal position of the upper quadrant semaphore blade is one reason that modern signals have the red light on the bottom, not on top like a traffic light

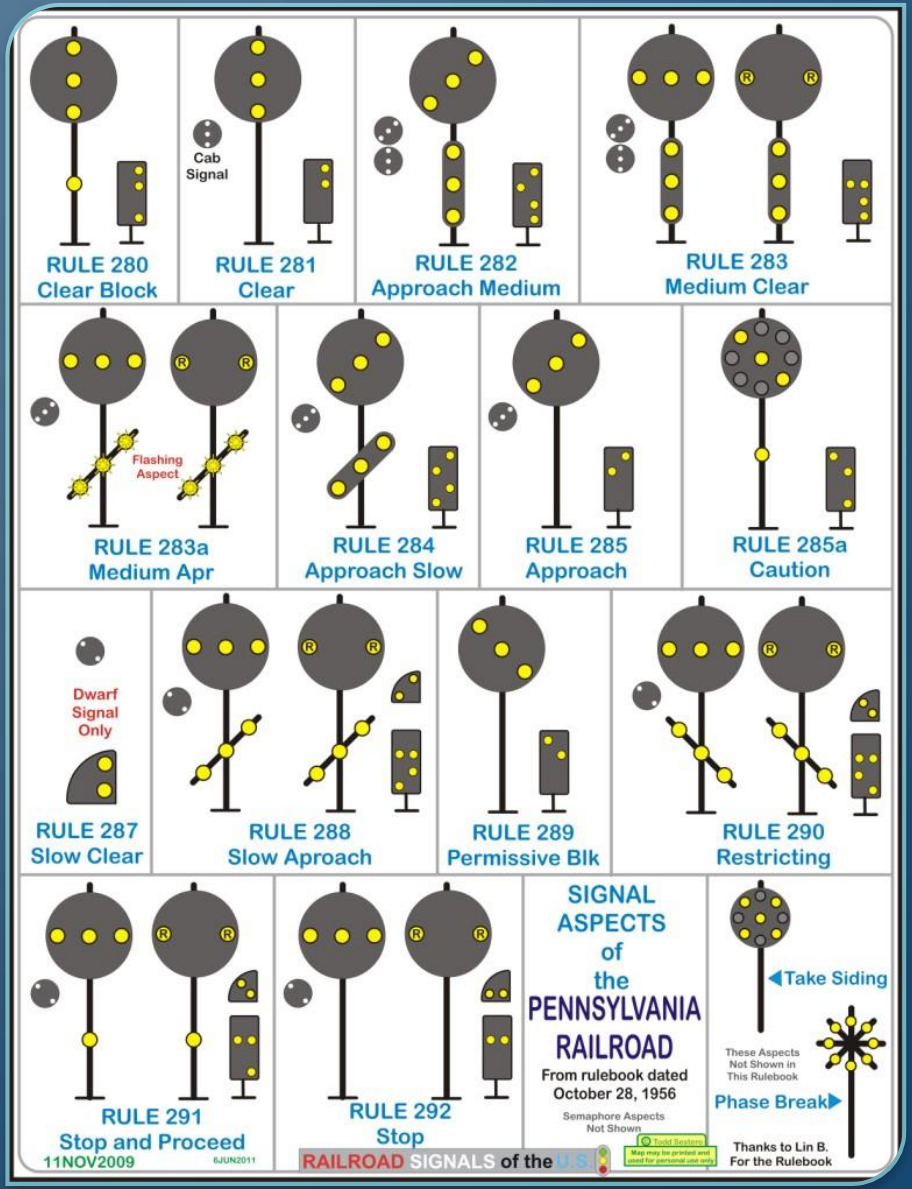
THE SEMAPHORE



- Blade shape also conveyed information
  - Fishtails were used to indicate “distant” signals
  - Pointed ends indicated this was an automatic block home signal
  - Square ends indicated it was an absolute signal (home or block)
  - Round ends were usually on train order signals, but could be used in other cases depending on the rulebook
- Problem #1: At night, with poor illumination, what shape or color is the blade?
  - Lights would convey aspect, but the information conveyed by shape or background color was essentially lost
- Problem #2: In certain climates, a fully mechanical device subject to the elements could freeze in position, as semaphores (in general) did not have heating elements…

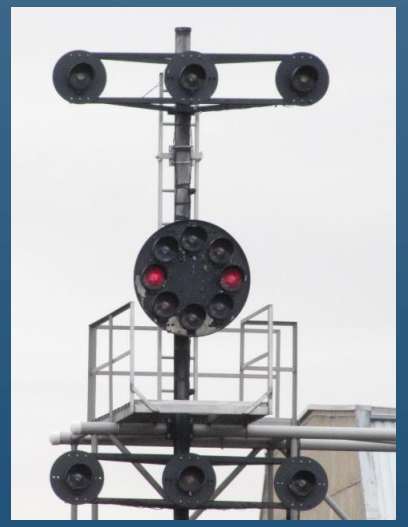
THE ELECTRIC SEMAPHORE – AKA POSITION LIGHT…

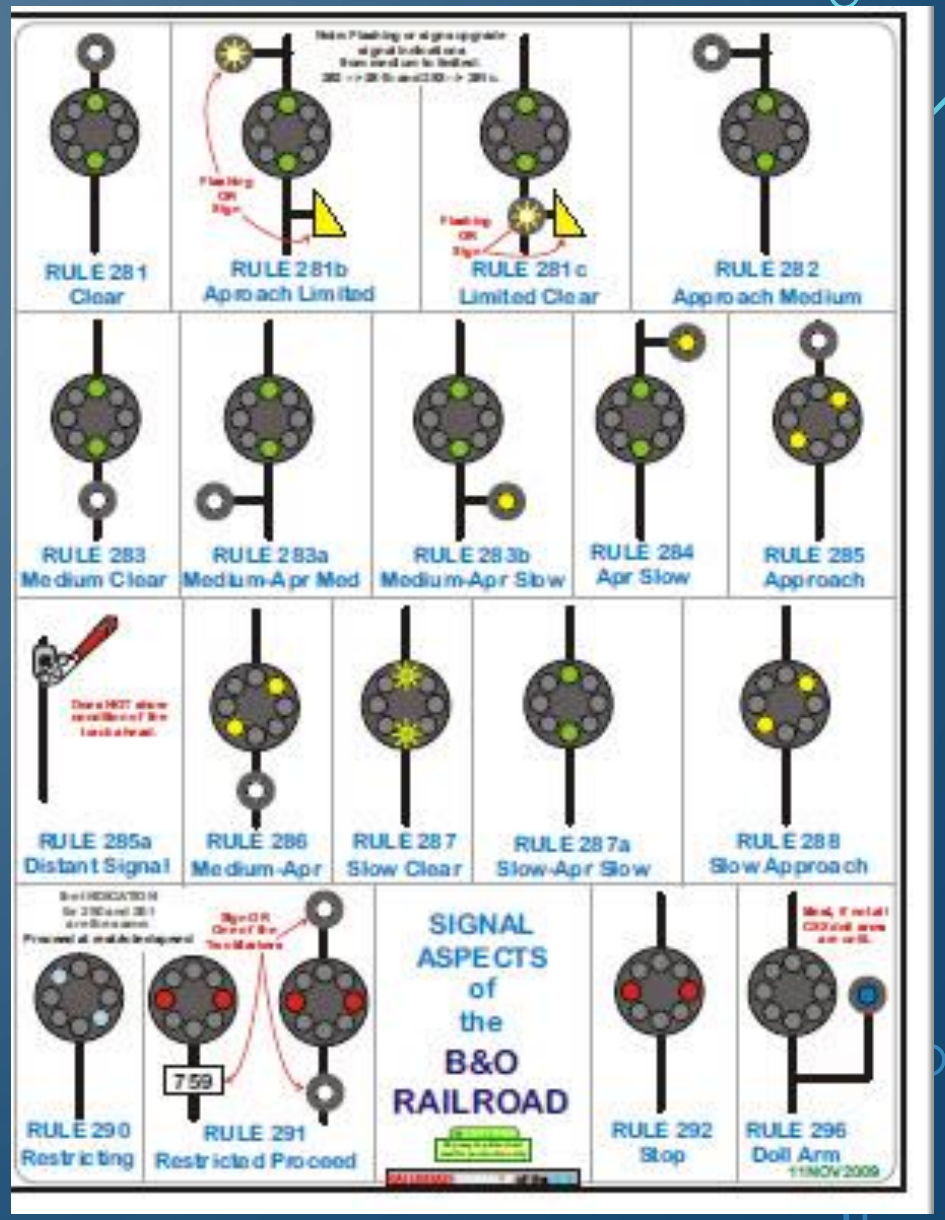
- Transitioning from the mechanical semaphore, several eastern roads (PRR, B&O most notably) maintained the familiar position information to convey aspect, but used lights instead
  - This gave the railroads many more aspects they could create…
  - This also improved visibility and maintenance, since there were no blades to freeze in position.



THE ELECTRIC SEMAPHORE – AKA POSITION LIGHT…

- B&O not only used colored lights for the semaphore positions, but added more marker lights for even more options…
- To add these to your model railroad, you need a rulebook, a track signals diagram, a bit of planning…
  - And perhaps a stiff drink



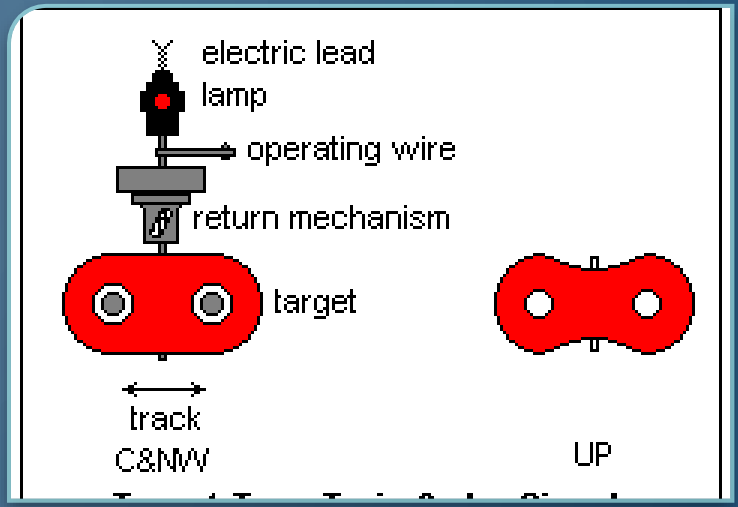


THE REST OF THE RAILROADS…

- Rather than duplicate semaphore positions, some roads realized that just the colored lights were enough.
- Several styles emerged, along with single and multiple head installations
- Signal backgrounds (targets) could also vary, and some roads used these to indicate specific types of signal (bridge, etc.)
- Modern signals are primarily either three individual lights or a single light searchlight, whose colors are normally signal green, yellow (or amber), and red, plus lunar white where applicable

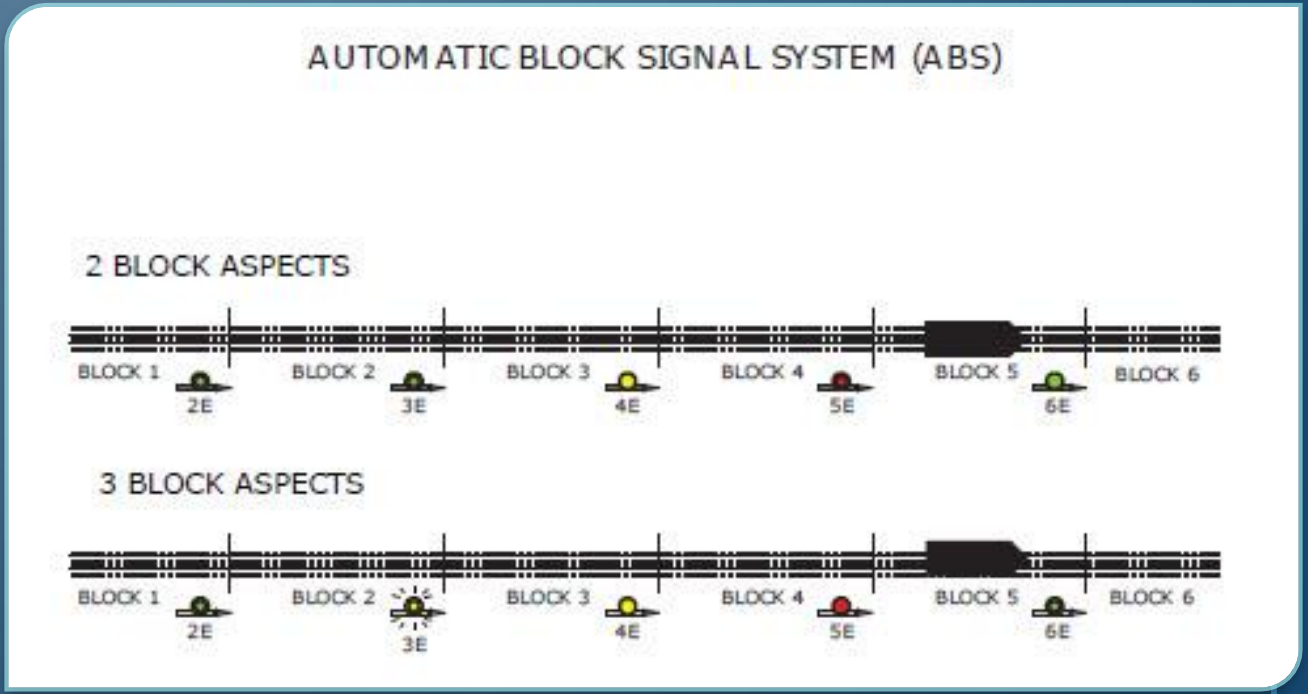
FIXED SIGNALS ON A LAYOUT

- The simplest signal to add is a train order signal
  - Can be as easy as a single color LED that you manually turn on and off to notify a train to stop and pick up orders
  - Can use a two-color LED (Red / Yellow or Red / Green) in a signal head or marker-light fixture for more detail or for replication of prototype
    - Most train order light signals have very simple targets, and are a good scratchbuilding project!
      - PRR old horizontal 2-light signal, for example
  - Could go all the way and set up a semaphore version or a rotating lamp. NMRA Electrical Animation element….



BLOCK SIGNALS - ABS

- Next level of signaling (beyond manual control or an animated R/Y/G on a timer) is a working ABS block signal system
- ABS protects the rear of a train from being overtaken by following trains
- Depending on the number of aspects desired, normal ABS systems protect 2 or 3 blocks behind a train



ADDING SIMPLE ABS SIGNALING TO A LAYOUT

- At a minimum, you need signal heads capable of displaying three aspects, controllers, a way to connect a signal head to a controller, and a way of triggering the controller
  - Triggers can be manual, such as a SPDT switch (Atlas #215 Selector) or automatic
    - Automatic triggers are commonly called detectors
- You need to determine the size and location of blocks that will be protected by signals
- (Advanced) You might need to identify sections within blocks that should incorporate route-based signals – interlocking plants

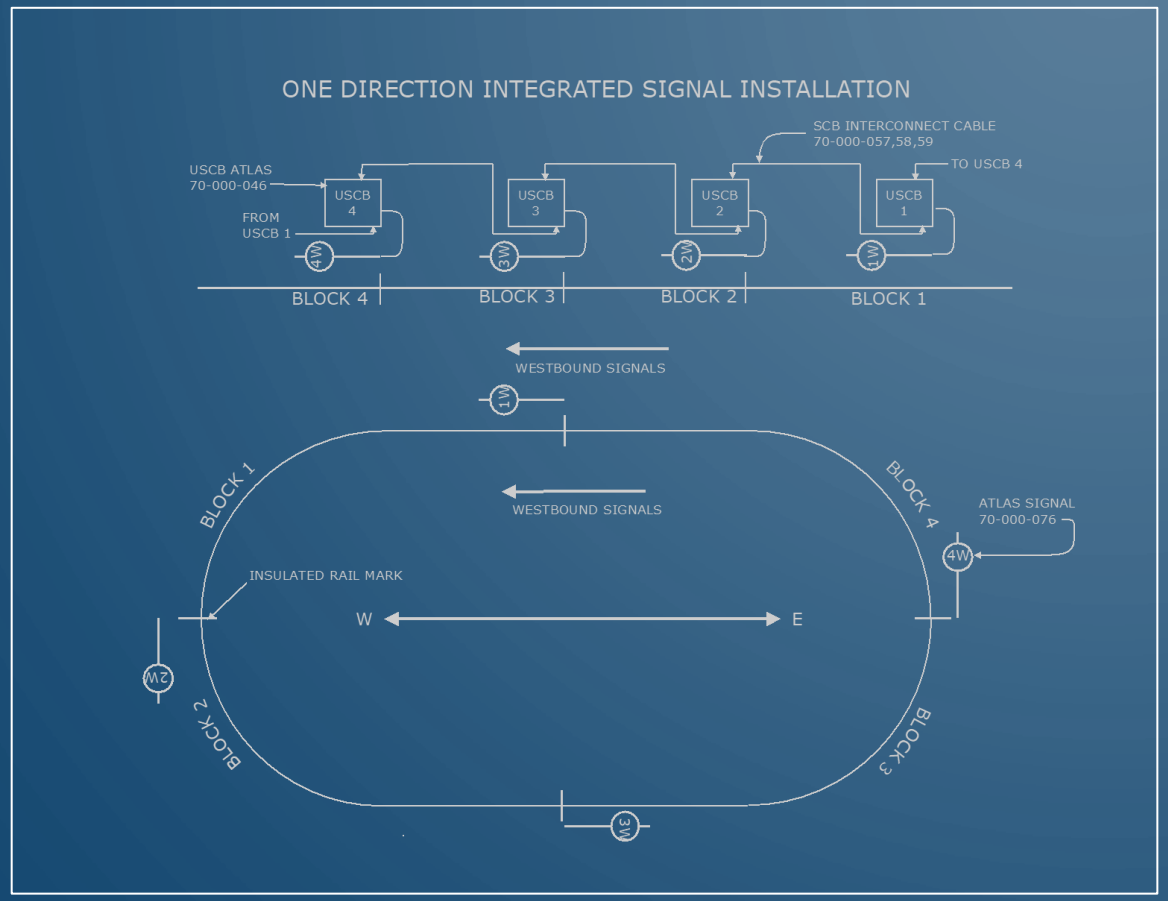
BLOCKS

- A block is at is core a region of track which is protected by a signal
  - On the prototype, the sizes (lengths) of blocks are set in order to move the most traffic over the line in the shortest amount of time in a safe manner
    - Block sizes can, and do, vary!
- For modeling and appearance's sake, a block should probably be a little longer than the longest train that will traverse it
  - Not a requirement, as there are always instances in real life where a train can span multiple blocks, especially in low-visibility / high traffic density areas.
- Blocks are similar to power districts or areas where gaps are inserted in rails for normal operations, and can share the same gapping if necessary

DETECTION OF TRAINS IN BLOCKS

- How you do this depends a lot on where you are in the construction of the railroad
- DC detectors measure voltage drop to the rails when a powered loco / lit car / resistor wheelset enters a block
  - These require appropriate attachment to a gapped block section, which can be easy or not…
- DCC detectors measure current draw from the power to the rails in a similar way
  - Somewhat easier to install, as the detector can utilize track feeders without significant re-wiring
- Optical detection does not need to change the wiring or track gapping at all
  - Visible and IR detectors do require a source of light, so do not work that well if you run in the dark
    - Also require some installation either between tracks or nearby, so can disrupt existing trackwork a bit
  - Laser detectors now appearing on the market
- RFID location – not cheap and requires special hardware, but most non-invasive…

A SIMPLE OVAL PLUS SIGNALS



- Using off-the-shelf products, you can set up a working multi-block system quickly and easily
- Disturbance to existing trackwork and scenery is low, as masts fit into small holes, and control circuits are self-contained and mounted beneath the layout
- *ALMOST* QUALIFIES FOR NMRA ELECTRICAL POINTS…

SIGNALS ANYONE CAN IMPLEMENT RIGHT NOW!

- The most basic signals in every rulebook are not fixed signals at all
  - Markers / flags for car and siding protection
    - Simple scenery addition – can change around as needed
  - Protection devices (blue flag / light), fusees
    - Adds simple electrical concepts to scenic additions – recent articles in MR and RMC
  - Train lights / markers
    - Scenery in motion! Caboose markers, FREDs and passenger car markers, locomotive class lighting or flag provisions, proper headlight operation…
  - While these won't qualify you for the NMRA achievement award, they do significantly add to both scenic and operational enhancement

USING FIXED SIGNALS WITH THE REST OF THE RULEBOOK

- Have a crew member act as a fireman / conductor and call aspects of fixed signals. Have the engineer repeat as per manual and execute accordingly
- Manually Knock Down and hold restrictive signal aspects for work crews or other TTO (Timetable and Train Order) cases – temporary changes to normal operation
  - Make these a random event at different locations – operators won't become complacent!
- Expand visible aspects with signs on masts and apply the correct speed rules
  - See if the crews notice…

ADVANCED SIGNALING TOPICS

- Part 2 of this series (The Sound and the Fury), covers the under-utilized area of prototypical signaling with sounds and non-fixed signals in the days before radio communications
- Part 3 of this series (You Can Get There From Here) covers advanced topics in signaling, such as incorporating Route-Based Signaling, Interlocking Plants and Tower Operations (including CTC), Single Main, Two Direction configuration (and variations) and the practical considerations on when you might need or want these…

WHY INCLUDE "ASPECTS" OF SIGNALING?

- Makes your scenery modeling better – signals and accompanying signal equipment are perfect lineside detail to make your layout stand out
  - If you are a B&M modeler – have a ball!
- Makes your electrical knowledge better – start with simple projects to build confidence, install and operate a turnkey commercial system and then tackle design of interlocking plants or computer aided systems
  - Or just figure out B&O CPLs and why they needed so many aspects…
- Makes your operations better and "nonpredictable" – following signal rules helps slow down the pace of operation and more accurately replicates prototype behavior
- Makes your understanding of the history of railroading better – we can always learn from the past, as it helps us to comprehend the "why" of the present, and consider what the future could be
- IT'S FUN, BUT JUST REMEMBER……

IT'S YOUR RAILROAD – PUT THAT HAPPY LITTLE SIGNAL MAST WHEREVER YOU LIKE….

SOME GENERAL REFERENCES

- Online Sources of Information
- GCOR: http://1405.utu.org/Files/%5B4886%5DBNSF-GCOR%202011-08-01_gcor_updated.pdf
- NORAC: http://www.hubdiv.org/docs/signaling/NORAC.pdf
- Several Common Aspect Tables: https://www.railroadsignals.us/rulebooks/ALLaspects.pdf
- Additional (unofficial) Aspects Tables: http://signals.jovet.net/rules/index.html
- Overview including some Canadian Practice: http://dougkerr.net/Pumpkin/articles/Rail_signal_aspects.pdf
- Books
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