Arizona Railroad Historical Society

Experience with Layout Command Control, LCC

September 21, 2019

Agenda

- Basics of DCC and LCC
- ARHS Decision Process
- Building Blocks of LCC—Ad for RR CirKits
- Building the Hardware—How we put it together
- Configuring the Cards--
- What we Learned--
- Summary—LCC is the Best Decision we Ever Made!

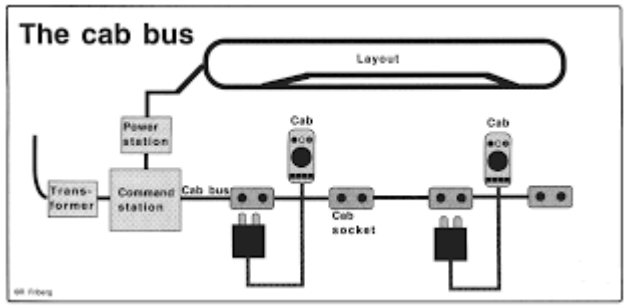
DCC Is Designed for Operating Trains

- DCC provides digital information with the power in the rails
- Command Station communicates with each throttle (or other input device)
- Command Station then sends signal to engines (or other equipment)
  - Each decoder receives all signals and reacts only to those sent to it's address
  - Does not provide feedback that it has done anything
- Sound equipped engines drive more data
- As more trains (or stationary decoders) are added, the response rate to new commands (think horn/whistle) slows

LCC Is Designed to Operate the Layout

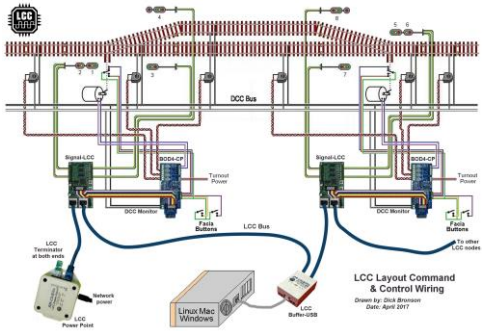
- NMRA Definition: LCC stands for "Layout Command Control," and it's a system for controlling all the functions on your layout that don't have to do with how fast the locomotive is moving -- things like signals, or sounds, or passenger car lighting.
- Protocol is defined by NMRA standard—just like DCC
- Any manufacturers equipment will talk to any other manufacturer
- Designed for Layout functions:
  - Turnout Motors
  - Block Detection
  - Signals
  - Road Crossings
  - Building lights
  - Ambient Lights
  - Arduinos

DCC and LCC are Complimentary



ain

- Powers the track
- One-way signal to decoders
- Each decoder is independent



- **LCC Operates the Layout**
  - No connection to track
  - Two-way communication
  - All nodes have all information

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Subsequent Charts Develop the Logic Behind the Following Decision Tree

DCC

Many Suppliers

- NCE
- Digitrax
- Lenz
- CVP
- Atlas
- Bachman
- Zimo
- MRD

Layout

Three Basic Approaches

- NCE for train & Layout
- NCE + Digitrax
- NCE + LCC

LCC

One Source

- RR CirKits
- ?

These are actual charts from ARHS decision briefing

NCE is an Easy Choice for Train Control, but Layout Control is a More Complex Decision

- Train Control– (DCC)
  - Choices include: NCE, Digitrax, Lenz, CVP, Atlas, Bachman, Zimo, MRC…
  - This was an easy decision
    - Currently have NCE equipment from previous layout
    - Most members currently have and operate NCE
    - NCE is an intuitive system for operating trains
    - NCE has provided excellent support in the past
      - (although innovation is not their strong suit)
    - No sign of NCE departing the market
  - Don't reinvent the wheel—stay with NCE

- Layout Control
  - This includes:
    - As a minimum: turnout motors & block detection
    - Also desired: signaling, animation (crossings, etc) and lighting effects
  - System Choices are more Limited
    - Use NCE for Both Layout and Train Control
    - Use NCE for Train control and Supplement with:
      - Digitrax (Loconet)
      - Layout Command and Control

There Are Three Choices for "Supplemental" Layout Control

- Use Digitrax Loconet for Layout control functions
  - This approach was (and is) used by Scottsdale
  - It was not recommended for another new layout:
    - Required many "patches" to get the two systems talking
    - Sharing data and commands was difficult
- Use NCE with Auxiliary Input Unit (AIU) for Layout Control
- Use New NMRA Standard called Layout Command and Control, LCC
  - Currently only one major supplier—RR CirKits

Digitrax approached dropped based on recommendation of club that used it

The Final Choice Came Down to NCE with an Auxiliary Input Unit Approach or LCC

NCE Advantages

1. Compatibility with existing system
2. Confidence in Company
3. Proven Past Experience
4. Interfaces to JMRI

NCE Disadvantages

1. Limited expandability
2. One way communication

LCC Advantages

1. Operates all train related functions and many layout functions
2. Expandable into the future
3. Flexible two way bus structure
4. Easily talks to JMRI

LCC Disadvantages

1. New Company
2. Untested future support
3. Unknown-Unknowns

Cost of either system was about the same

Risk Mitigation Plan for Implementing RR CirKits

Risk	Mitigation Plan
Single Source of Supply	•Uses NMRA sanctioned interface—so cards "should be" interchangeable—like decoders are today in DCC •Buy sufficient "spares" up front to guard against shortages.
Systems Integration	•Others are working on elements •Systems Integration—Detlef Kurpanek •Signals—Paul Davidson
Unknown-Unknowns	•Received commitment from Principal developers for support •Dick Bronson—RR Cirkits, President •Ken Cameroon—JMRI Development Team •Balzas Rach—LCB Code Development
Obsolescence	•Common to any electronic system •Buy sufficient spares to assure parts availability through life of system
Being the first "from the Ground up" layout	•Use this to our advantage—Get publicity in MR and MRH to provide interest then the community (NMRA, Developers, Suppliers) must see that it succeeds

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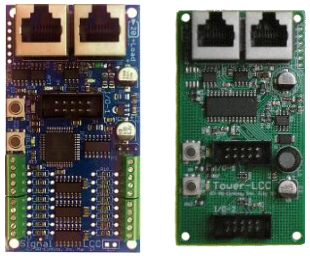
LCC Is Like Building with LEGO's

There are three basic building "blocks"

Interface

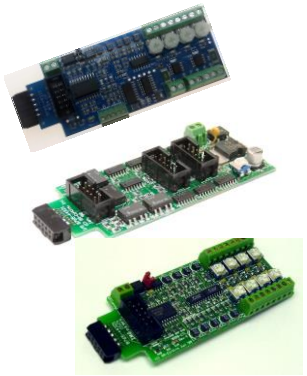
Provides interface to Computer:
- Configure LCC Cards
- Communication with JMRI
- Cat 5 Cable connects to LCC System

"Brains"



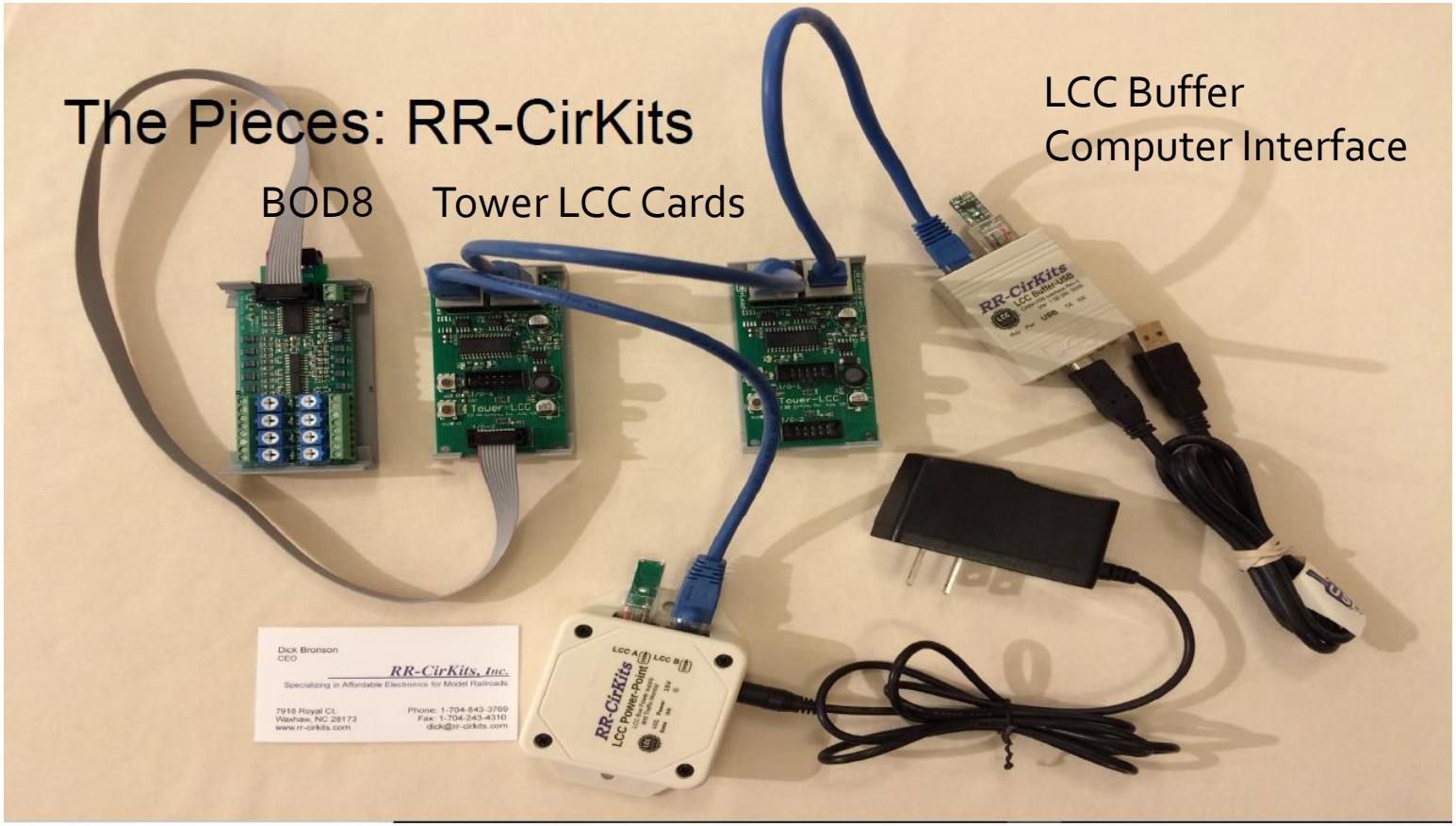
Tower or Signal Cards provide computation and communication
Daisey chain with Cat 5

Function



Functions are "Daughter Boards" to Tower or Signal Cards
Operate Turnouts, Detect Occupancy, or control discreets
Connect with 10 wire flat cable to Tower or Signal Card

The Simplest LCC System



Power Point

A Computer Interface and Power are Required

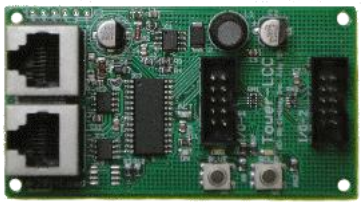
Computer Interface

NMRA CAN bus LCC® to USB interface.
2,500 Volt Digital isolation between CAN bus LCC® and USB port.
Type B USB connector for PC connection.
Dual RJ45 connectors for easy LCC® loop through connections.
4 LEDs display status. (Ready, Power, Transmit, and Receive)
Small package size. Just 1-1/2" x 2-1/4" x ¾".
Ready to run unit includes USB cable. – Nothing extra to purchase.
Standard 125,000 Baud CAN bus LCC® interface speed. – No jumpers or switches to set.
Buffered inputs and outputs for full speed error free data transmission.
Powered directly from LCC bus connections* and USB port. *
Note: Requires a powered LCC bus. [10 ma. bus load] Simplify your LCC configuration and/or use a PC based CTC. Compatible with JMRI.

Power Point

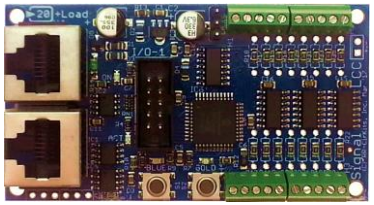
NMRA CAN bus LCC® Power Injection Unit.
•500 ma power supplied to each CAN LCC®bus jack.
•100-240VAC 15VDC 1.2 Amp Universal Switching Power Supply included.
•Internal rectifier prevents reverse polarity problems.
•Includes CAN bus data monitor for network trouble shooting.
•Dual RJ45 connectors for easy CAN LCC® loop through connections.
•2 LEDs display status. (Power, Activity)
•Small package size. Just 2-1/2" x 3-1/2" x 1". (including mounting flanges)

The "Brains" of LCC are in Two Cards



Tower LCC

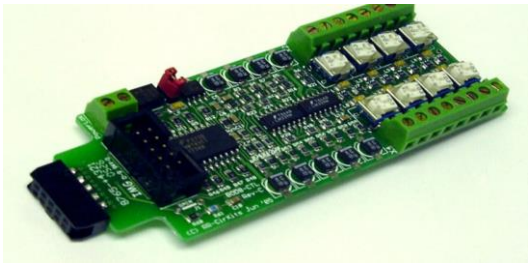
- Use this card for most applications
- 16 Line Input/output node for NMRA CAN bus LCC
  - Communicates on LCC Buss via Daisey Chain Cat5 Cables
  - It will support two "daughter boards"



Signal LCC

- Use this card if you want Signals
- 16 Led drivers plus 8 line Input/Output node for NMRA CAN bus LCC®
  - Provides LED control to up to Four Signal Masts
  - It will support one "daughter board"

Function Cards Make Things Happen



BOD8

Block Occupancy Detector

- This board operates as a DCC occupancy detector for 8 blocks using remote CT coils.
- It outputs logic levels, and has a RR-CirKits standard ribbon connector interface.
- The "Power-Lok" feature monitors the DCC bus power. A power failure latches the detection status of each block until power is restored and re-stabilized.

CT Coils

SMD8

Stall Motor Driver

- This 8 output, optically isolated, low current "H" bridge driver is designed for control of 8 stall motor switch machines. (E.g. Tortoises®)
- It can drive up to 100ma. per line, speed regulated output 4 to 12VDC.
- (PTC fuse limited to 200ma total per board for safety

BOD4CP

Block Occupancy Detector-4

- This board operates as a DCC occupancy detector for 4 blocks using remote CT coils.
- It outputs logic levels, and has a RR-CirKits standard ribbon connector interface.
- The "Power-Lok" feature optionally monitors the DCC bus power. A power failure latches the detection status of each block until power is restored and re-stabilized.
- The CP version also includes dual turnout drivers.
- When used with the Tower LCC or Signal LCC boards there are also 4 general purpose I/O connections.

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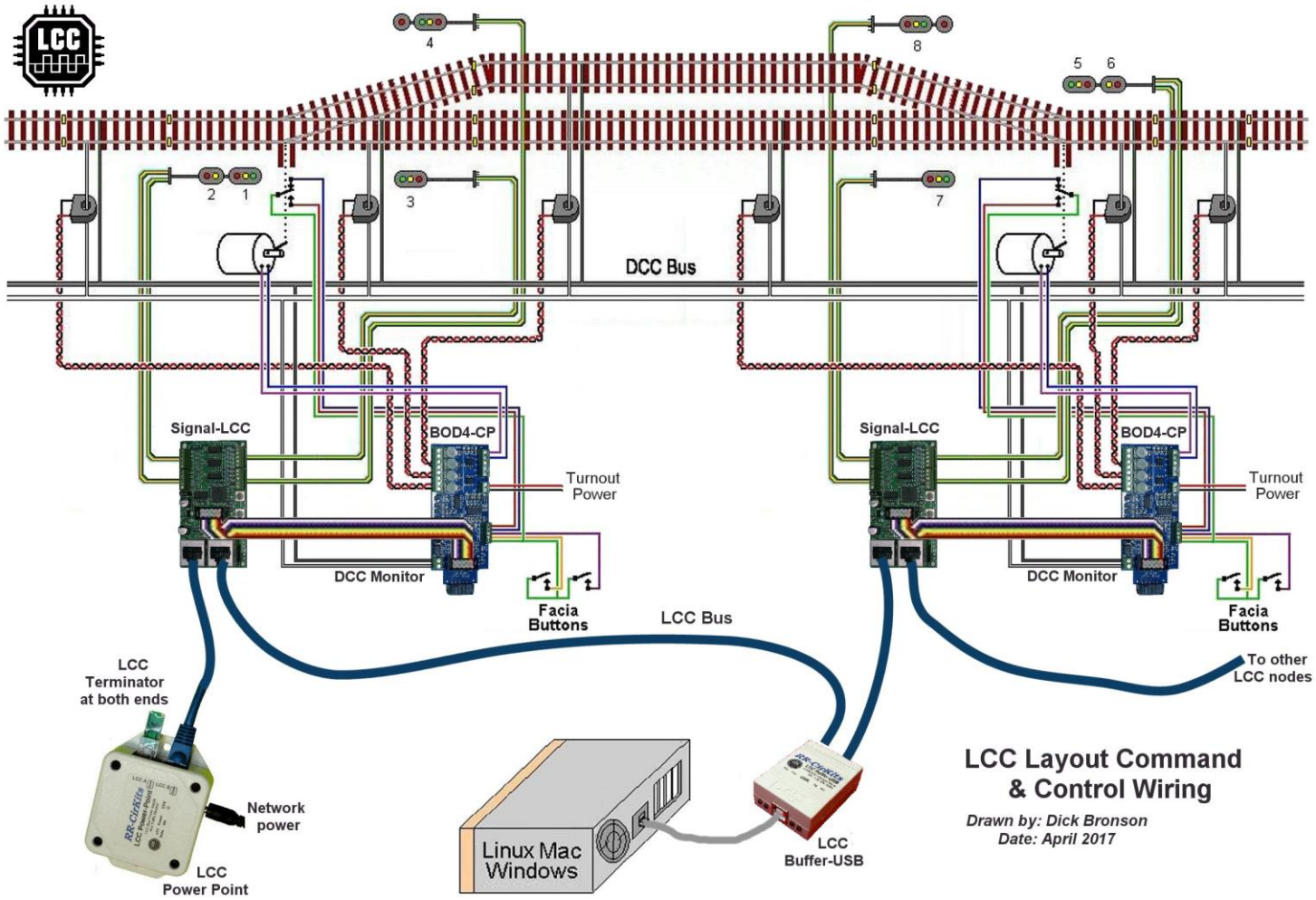
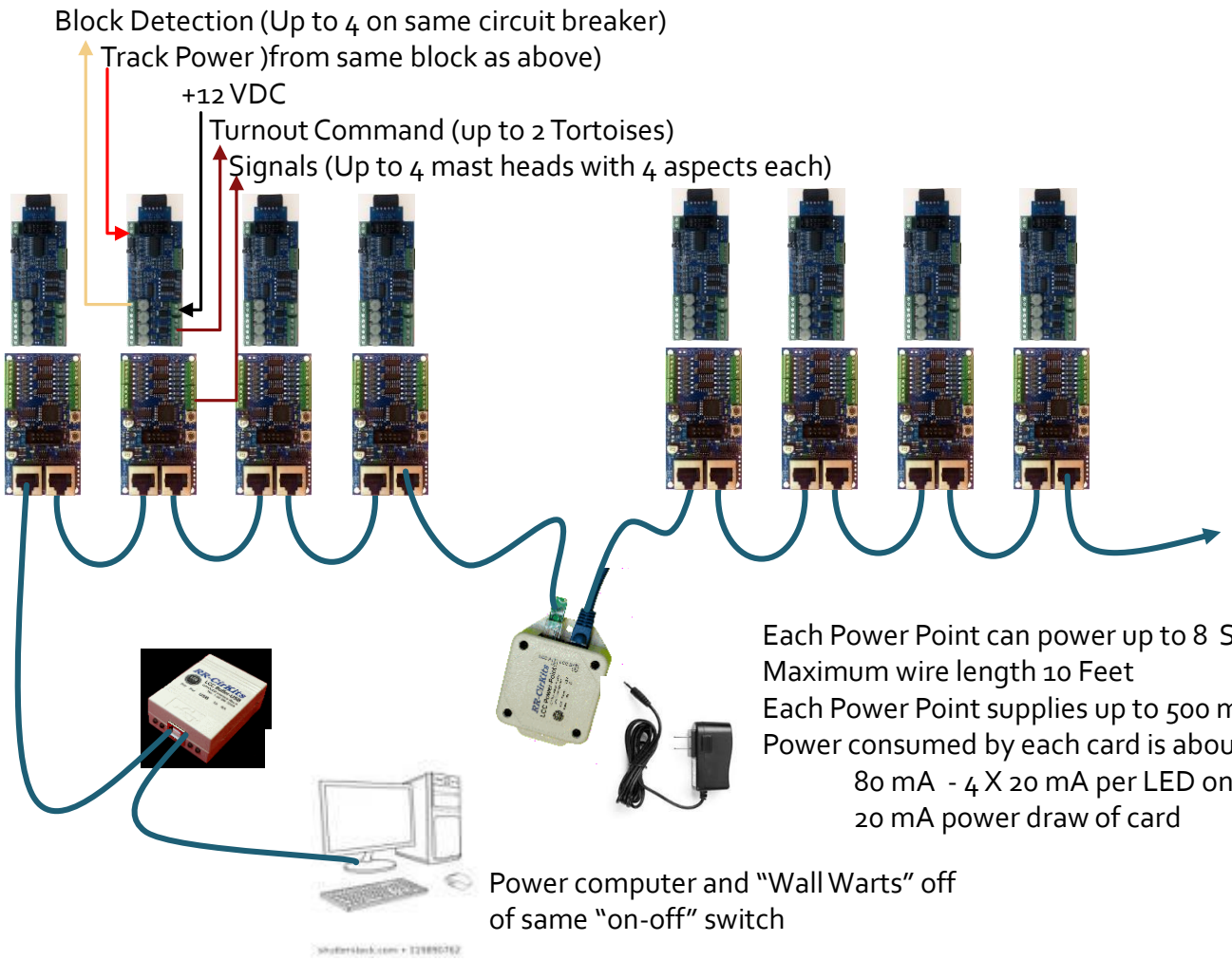
How It Works at a Single Location!



Building a System Simply Means Connecting All of the Cards



Each Power Point can power up to 8 Signal Cards
Maximum wire length 10 Feet
Each Power Point supplies up to 500 mA per channel
Power consumed by each card is about 100 mA
80 mA - 4 X 20 mA per LED on a signal
20 mA power draw of card

Power computer and "Wall Warts" off of same "on-off" switch

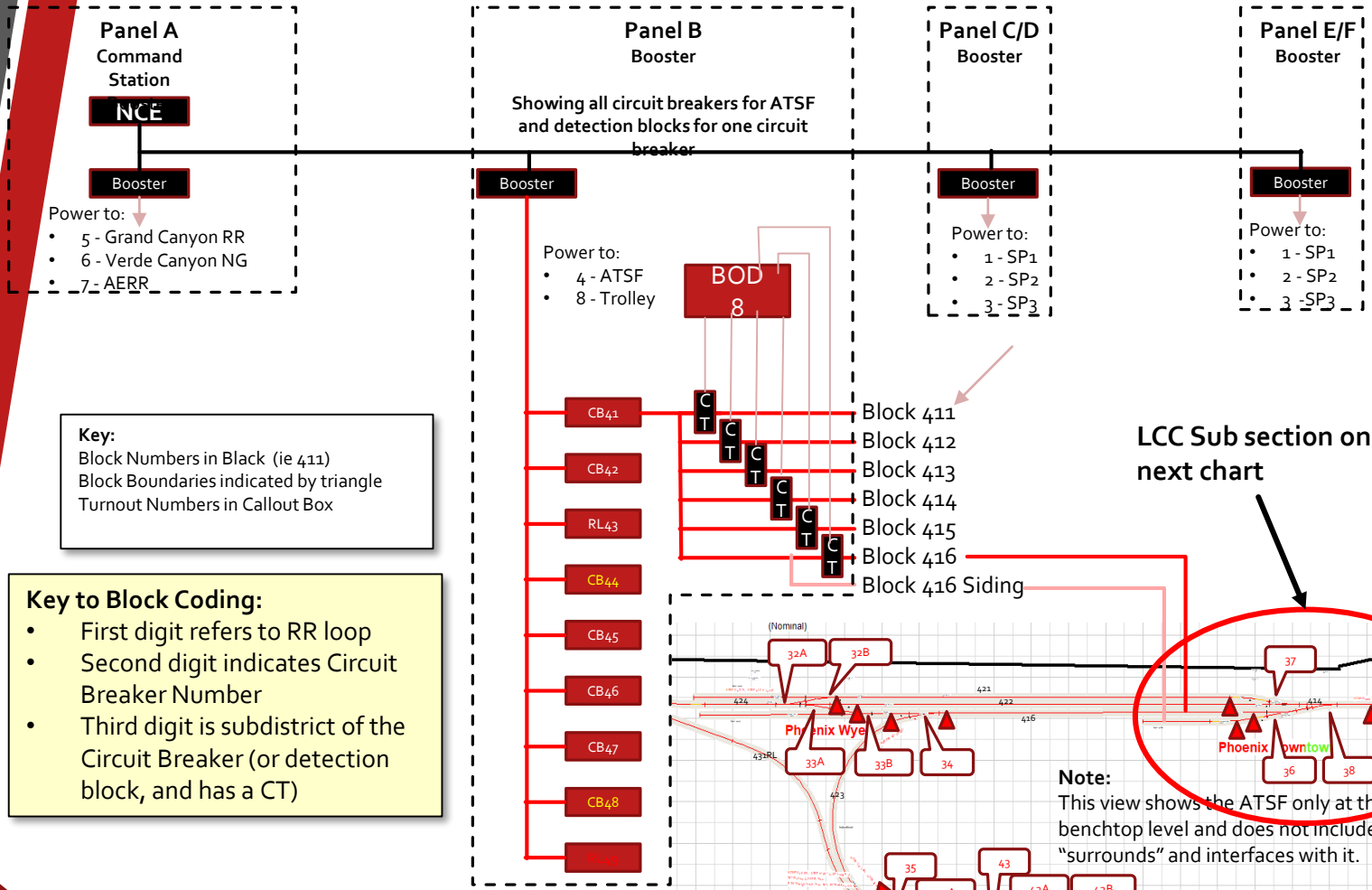
ARHS Built a "Proof of Concept" Demonstrator

Demonstrated all Functions:

- Layout
  - Block Detection
  - Turnout Control
- Control Functions from
  - NCE Throttle
  - Computer
  - Remote (WiFi) Tablet
  - Phone

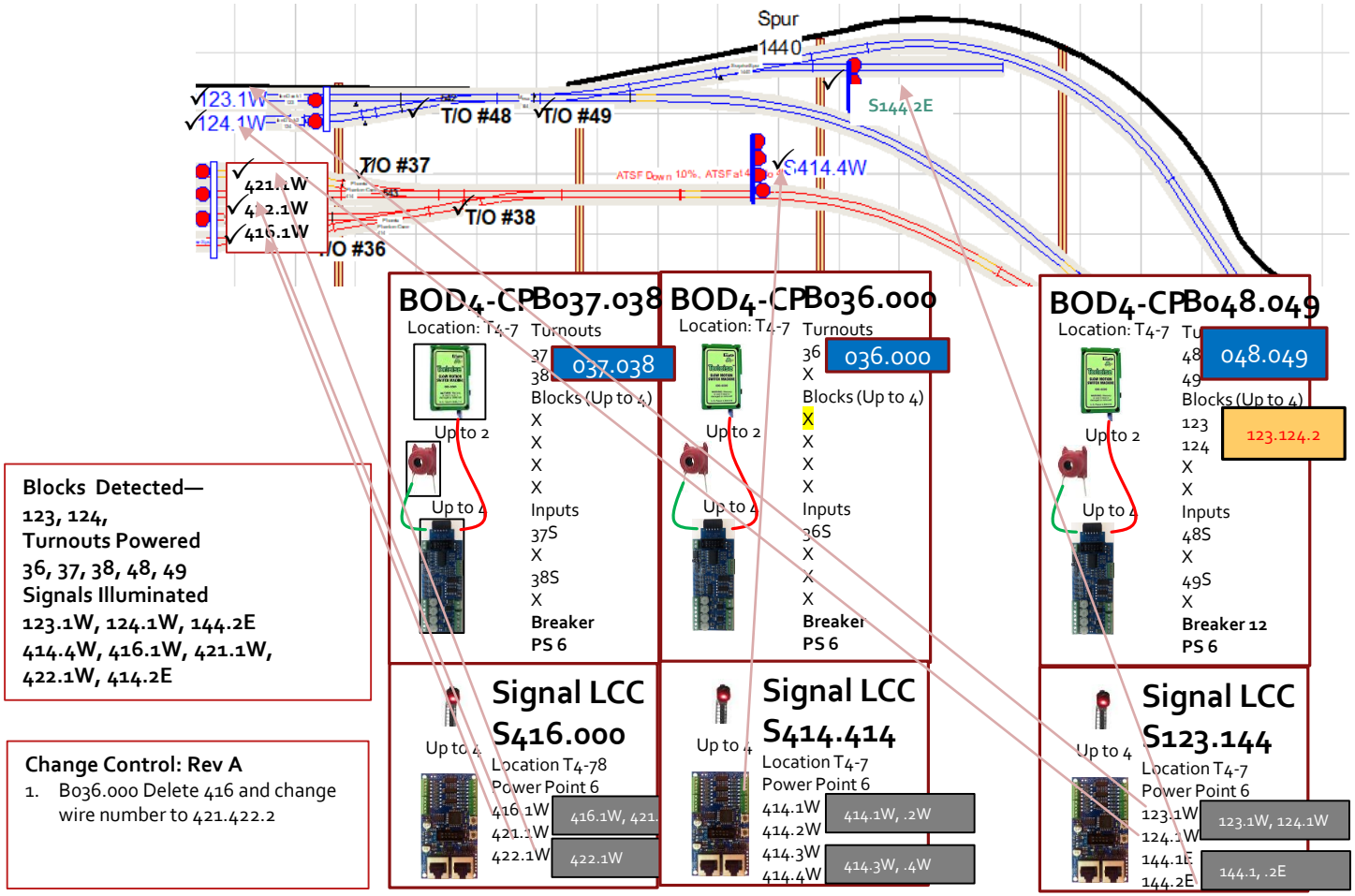
The Next Series of six slides show how the ARHS system was planned

ARHS Block Structure Showing Details of Panel B



Track Plan of ATSF on 40 inch level showing assigned Block and Turnout Numbers

Wire Connections for Each Card Were Defined



Blocks Detected—
123, 124,
Turnouts Powered
36, 37, 38, 48, 49
Signals Illuminated
123.1W, 124.1W, 144.2E
414.4W, 416.1W, 421.1W,
422.1W, 414.2E

Change Control: Rev A

1. B036.000 Delete 416 and change wire number to 421.422.2

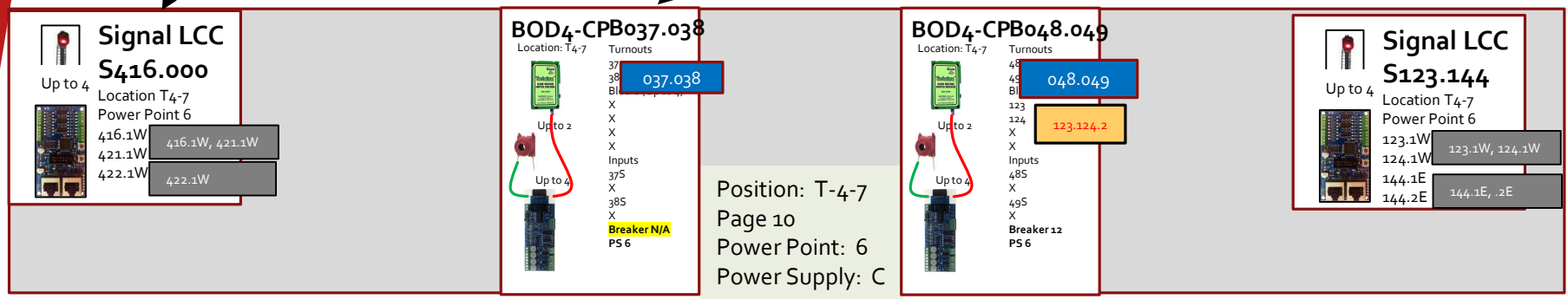
The Cards were Grouped into Panel Locations

All Critical Information for Each Signal Card is Displayed:

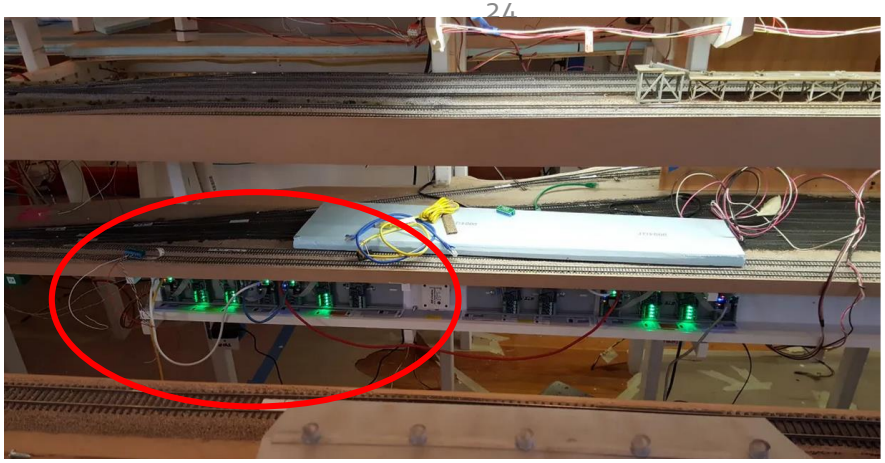
- Signal Card Name (based on two signals controlled by board)
- Signals Controlled
- Wires running from card (and color)

All Critical Information for Each BOD4-CP Card is Displayed:

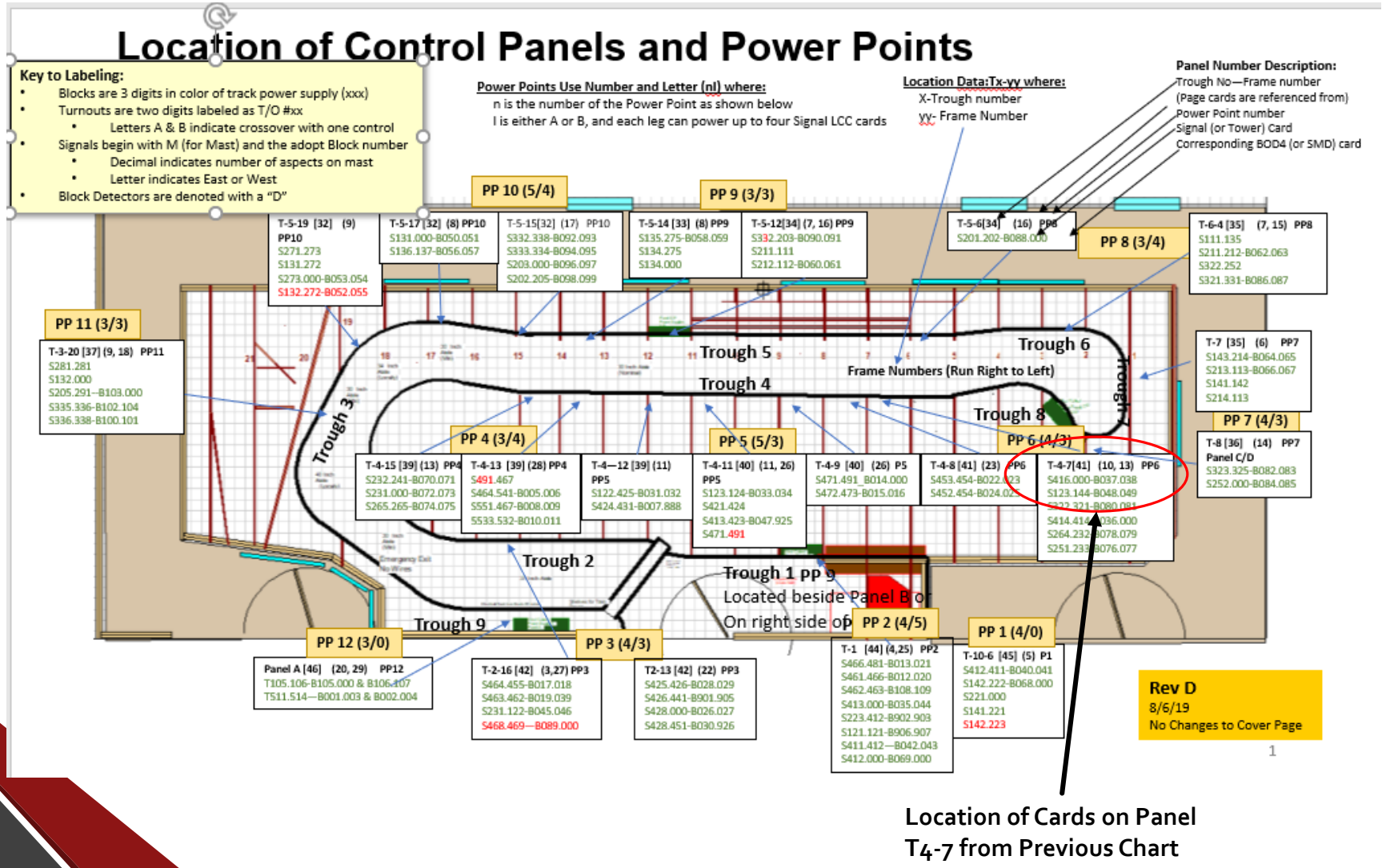
- BOD4-CP Card Name
- Controlled (based on two turnouts controlled by board)
- Wires running from card (and color) to turnouts
- Wires running from card (and color) to CT coils for block detection



The resulting installation on the layout is shown to the right



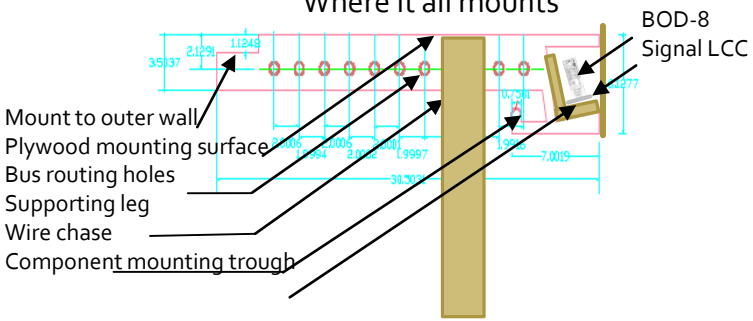
The Location of Every Panel is then located on the Layout

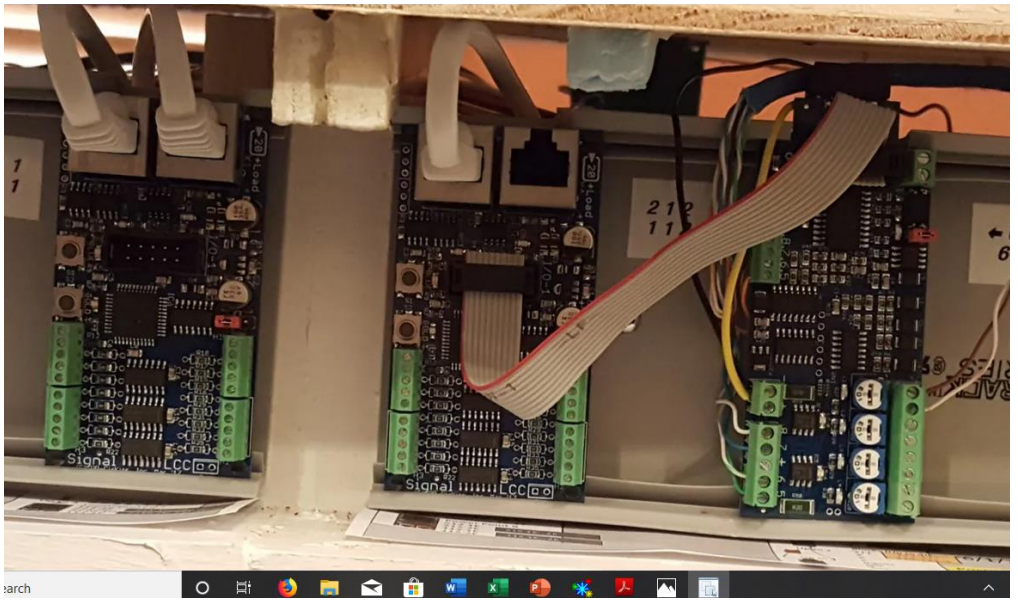


Front Mounted Components Make Installation Easy

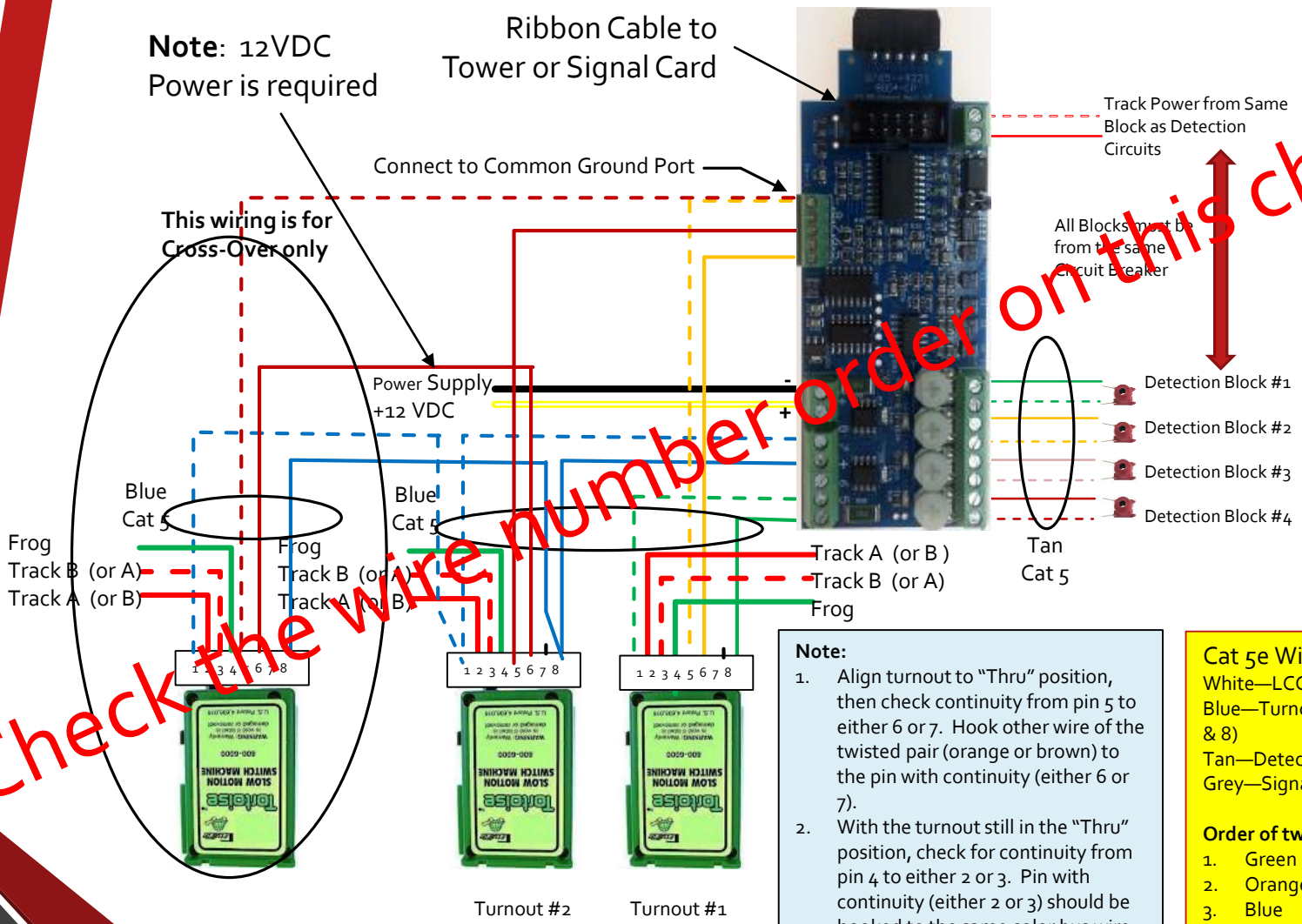
Cross-section of Stringers

Where it all mounts





BOD4-CP Wiring Standard used by ARHS



Note:

1. Align turnout to "Thru" position, then check continuity from pin 5 to either 6 or 7. Hook other wire of the twisted pair (orange or brown) to the pin with continuity (either 6 or 7).
2. With the turnout still in the "Thru" position, check for continuity from pin 4 to either 2 or 3. Pin with continuity (either 2 or 3) should be hooked to the same color bus wire as rail for the "thru" position.

Cat 5e Wire Colors:
White—LCC Bus
Blue—Turnout Drive (Tortoise 1 & 8)
Tan—Detection (CTs)
Grey—Signaling

Order of twisted pair colors:

1. Green
2. Orange — Turnout #1
3. Blue
4. Brown — Turnout #2

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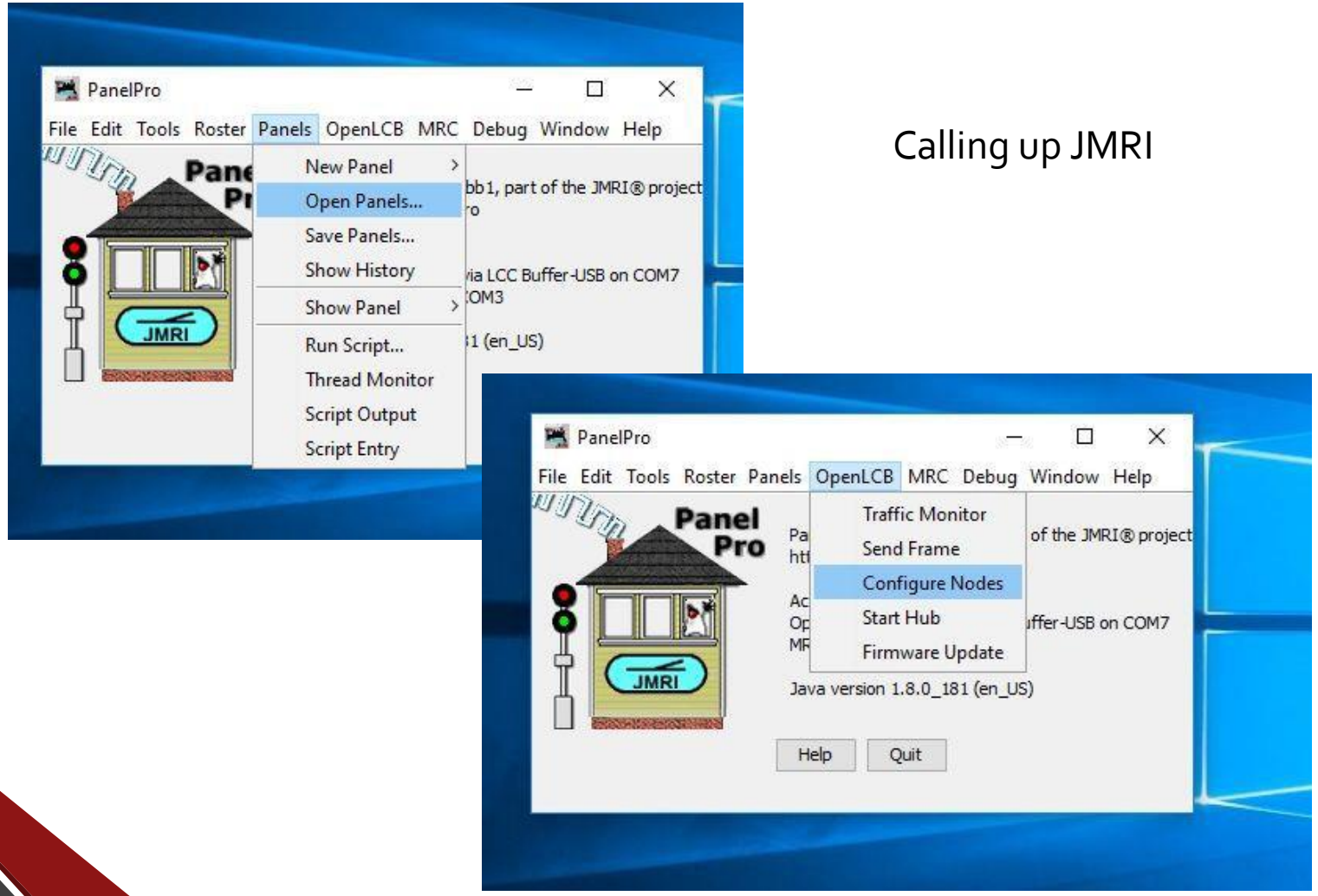
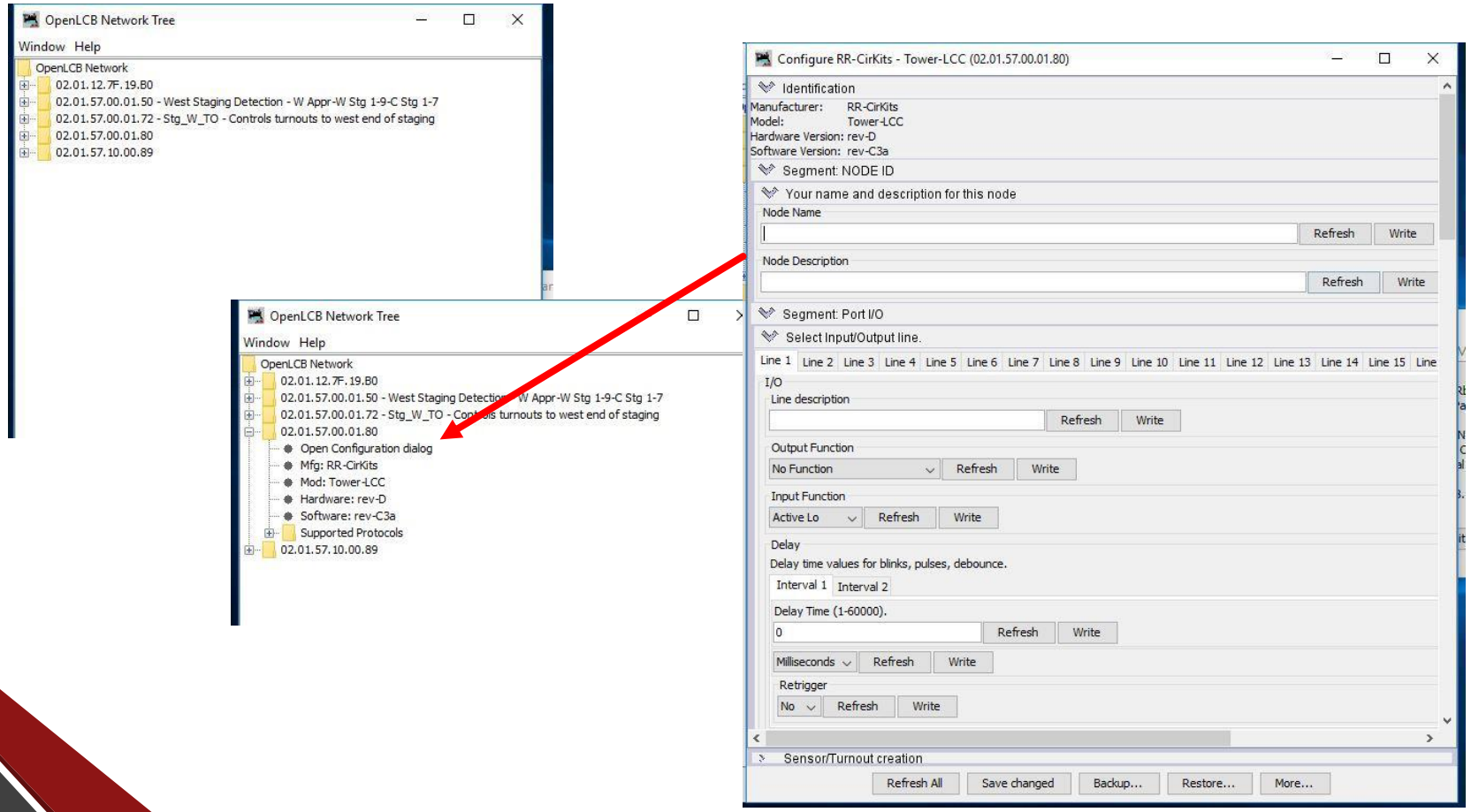
Dan need help!!
Below are Screenshots from a Detlef Presentation

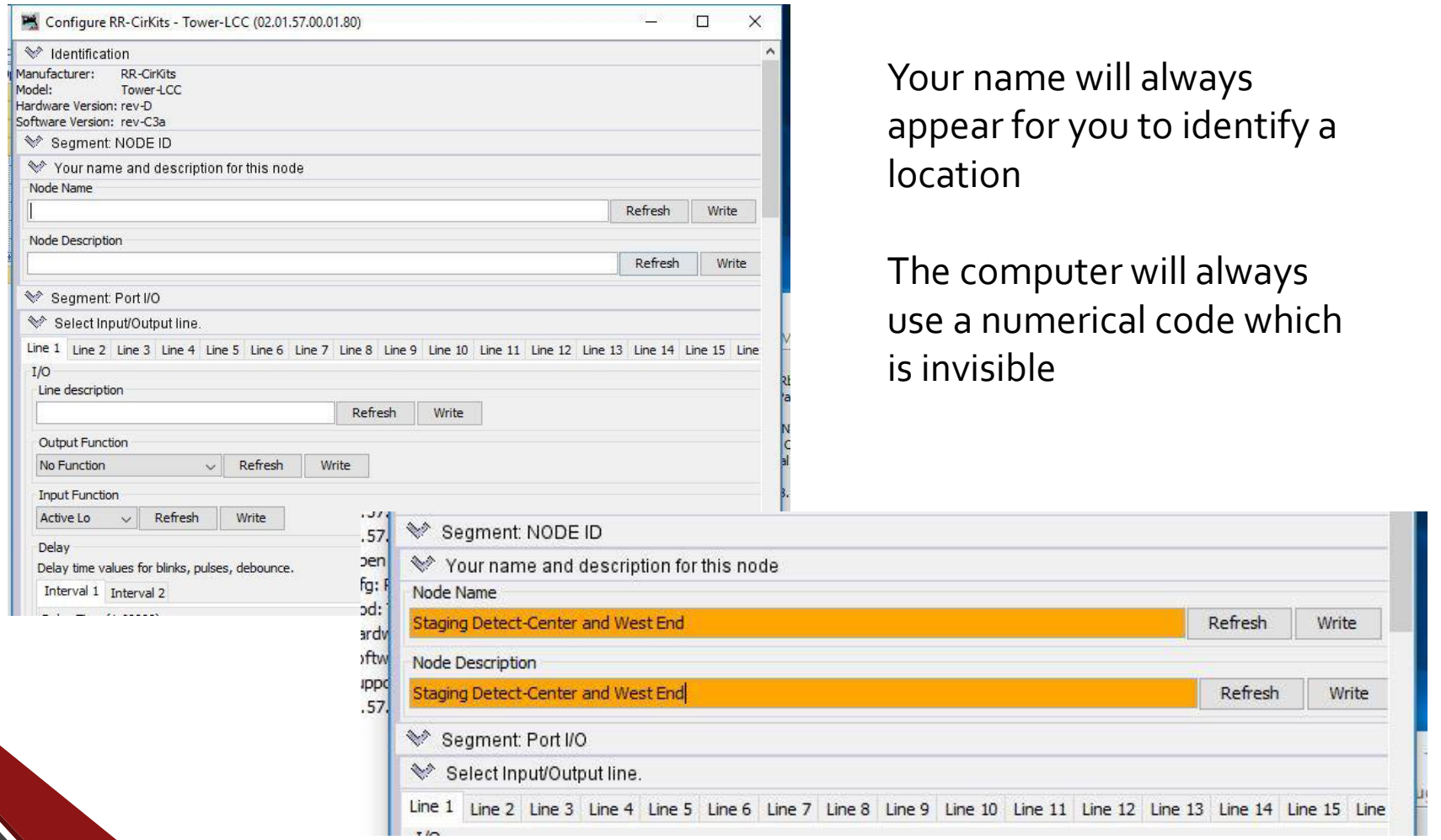


Calling up JMRI

RR Cirkit Cards Self Identify and Load Configuration Options



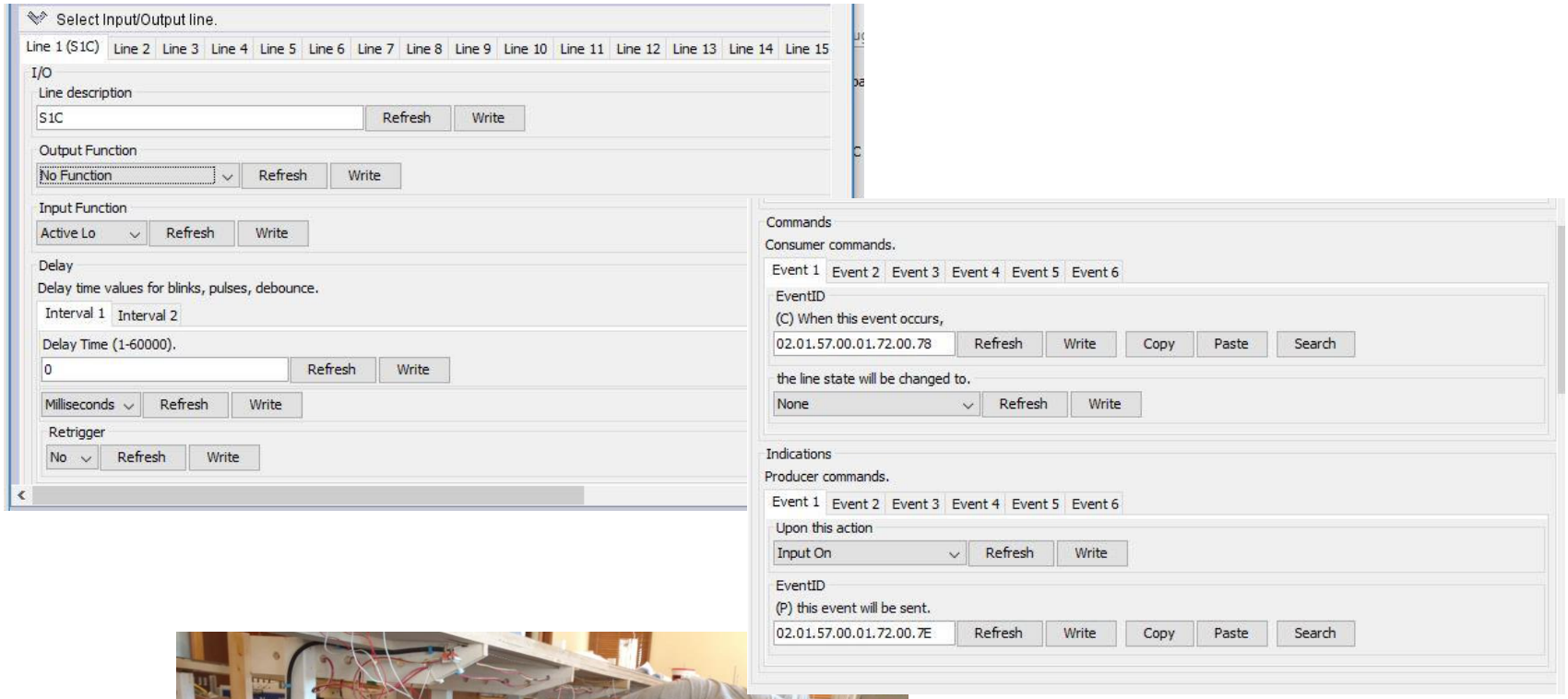
Add Your Name for a Location



Your name will always appear for you to identify a location

The computer will always use a numerical code which is invisible

Then Tell it what to do!



Throwing the first turnout on the ARHS Layout

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Lessons Learned

- Up Front Planning is Important—this all loads into LCC Cards
  - Names and numbers for all Block Locations
  - Names and numbers for all Turnouts
  - Names and number for all Signals
- Layout of the Cards must be done in advance
  - Number for each Card must be determined
    - Number of Signal Aspects drive the number of Signal Cards
    - Number of Turnouts drive the BOD4CP or BOD8 Cards
  - Location of cards must be planned
    - Must be "daisy chained"
    - Need to be close to function
    - Must inject power within 10 feet
- **Configuring requires patience at first, but then is a repeatable tedious task**

- The "Rule of Twos" in LCC Design
  - All cards support 2, 4 or 8 components—having an odd number of times makes layout more difficult. A four or six track yard is easier to layout than a 3 or 5 track yard.
- CTs can be located either on a panel or near the point of "use"
- Creating a separate "sub-block" can be used for auto-throw of a turnout or activating a crossing signal etc…
- The future applications boggle the mind
  - Arduinos
  - Lighting
  - Special Effectss….

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