How to Get Your Computer to Control Your Layout

...plus other goodies

Using C/MRI and DCC

Seaboard Air Line – West Georgia Subdivision

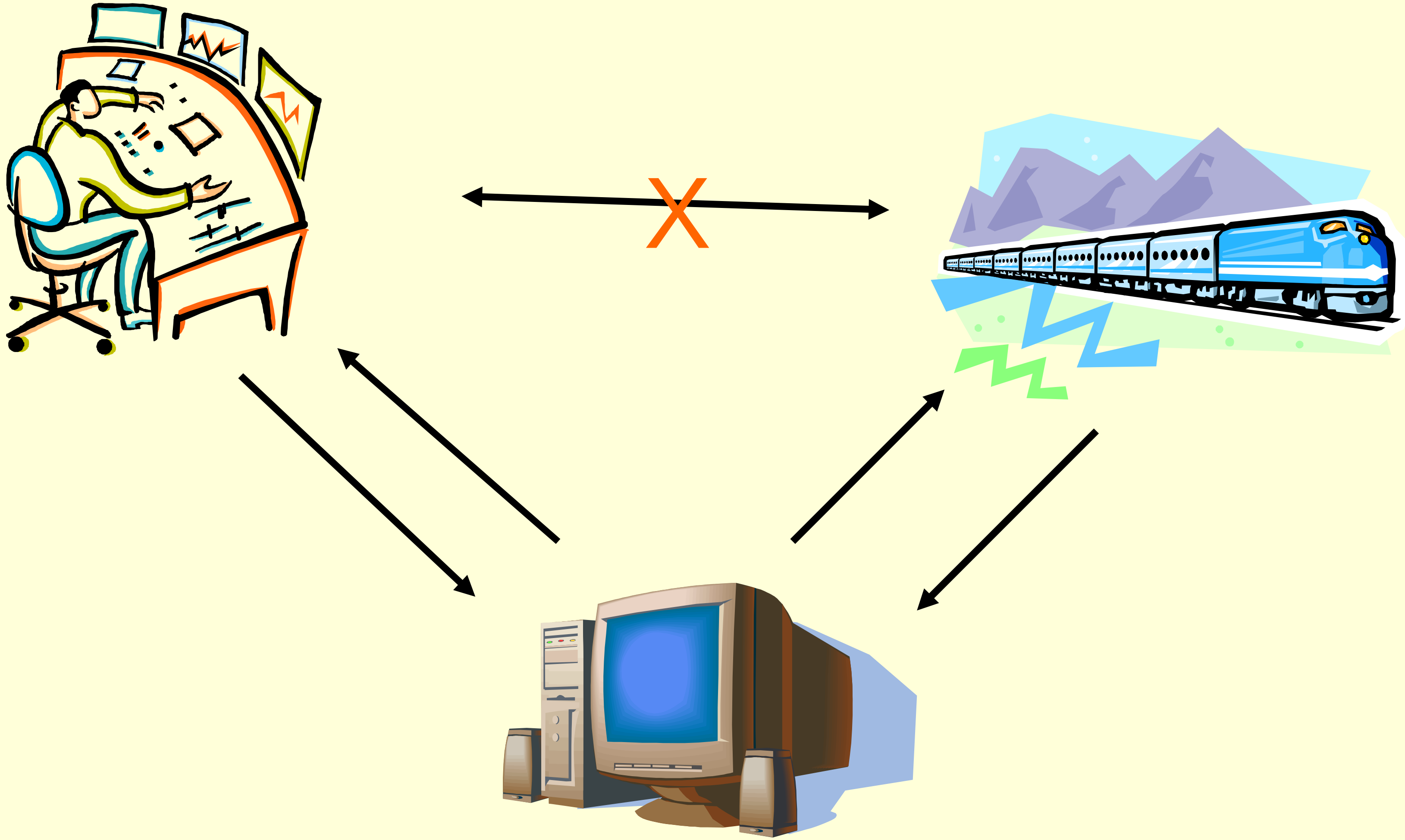
What We'll Discuss

- What C/MRI is
- Why it's not as complex as you'd think
- Modularization of layout electronics
- Documenting layout electronics
- Planning layout electronics

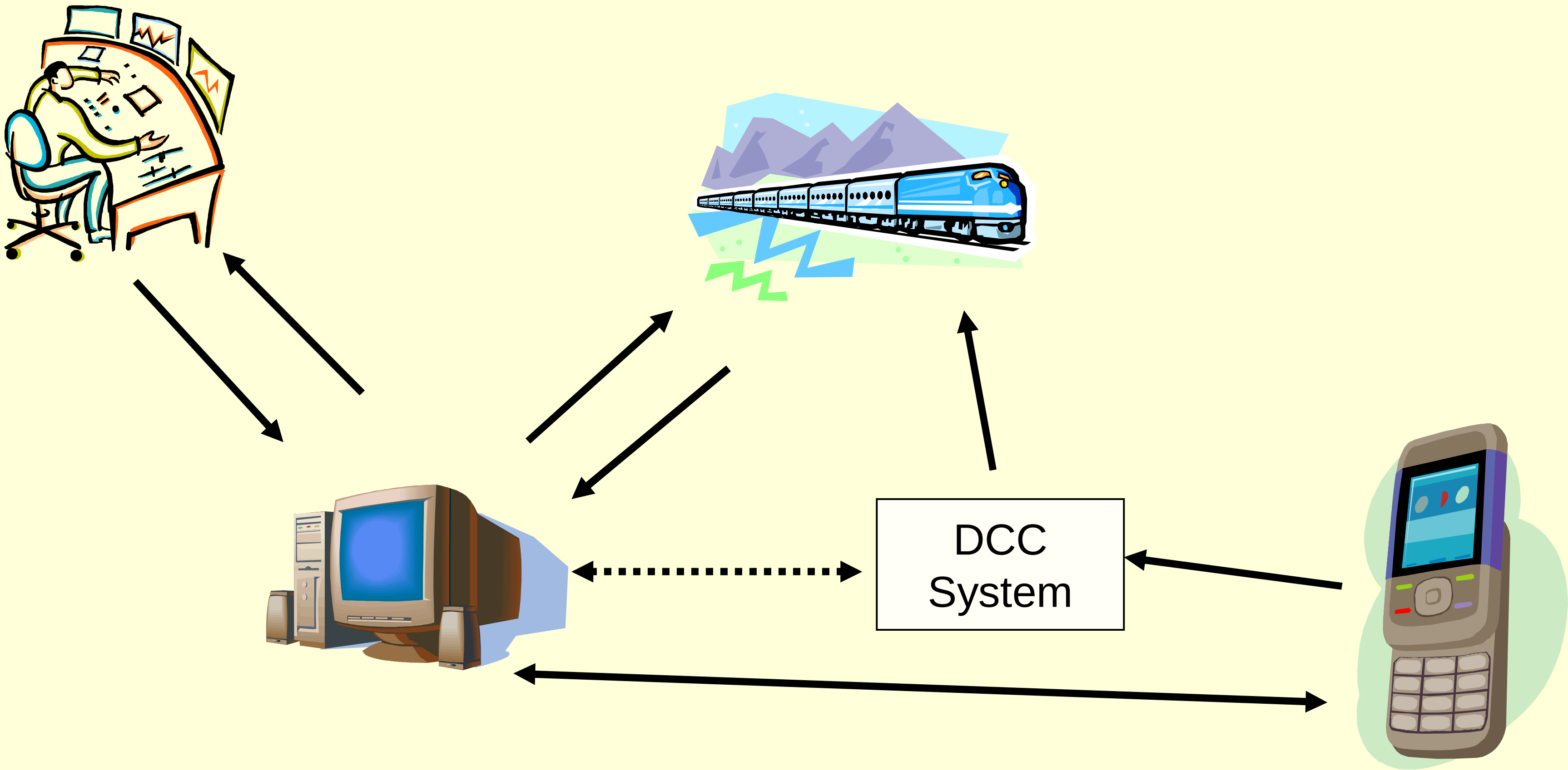
Hopeful Takeaways

- Computer control is not difficult, and it really helps layout operation flexibility
- Modularization of electrical components can make layout wiring and maintenance easier
- It is possible to wire electrical panels without becoming a contortionist
- Planning and documentation of electrical systems is beneficial to any layout!

How C/MRI Works (Basic)



How C/MRI Works (Advanced)



The Myths

- Computer control is just for geeks
- This is way too hard for anyone to understand
- This requires programming skills
- Computer interface is only for large layouts
- DCC can do everything

- None of this is true….

WHAT IS COMPUTER CONTROL?

- It's NOT computer running trains – although that is possible
- It is computer controlling the layout infrastructure
  - Turnouts
  - Signals
  - Reversing Loops
  - Panel Displays
  - Animation & Lighting
  - As little or as much as you want….
- You *could* have it control trains… if you want to
- Don't have to do this with DCC – can use DC and cab control too
- This complements DCC, does NOT replace it!

Why would I ever want a computer to control my layout?

- Simplicity of wiring
  Easy to establish standards
- Simplicity of User Interface
  Easy to use, easy to understand control panels
- Flexibility of design
  Wire it once, change the way it works later.
- Ability to expand capabilities
  CTC and Visitor Modes – disable panels from curious visitors!
- Computer does the hard work
  Easier to modify logic than change wiring
- Lots of stuff can be done with low voltage wiring
  Cat 5 cable (8 conductor network wire) is relatively inexpensive
- System is Modular
  You can replace or change modules without destroying the layout
- Used Computers are CHEAP (or free)

Other Advantages

- Forces you to use standards (that’s good-saves time)
- Allows modular design of electrical components (assemble on workbench!)
- Encourages documentation of the layout
- Uses that old computer
- Use that broken computer’s power supply
- Change things with software, not a soldering iron
- You don’t have to know the ‘turnout number’ to throw the turnout! (good user interface)
- Separates propulsion control data from layout control data

Requirements

- Computer (PC – Macs have been used)
- Railroad
- Wiring Standards (yes, planning ahead)
- Ability to document what you do
- Enjoyment of electronics
- Soldering skills (optional)
- Some programming skills (optional)

Yeah, But I don't like complexity

Implementation can be phased

- Start with controlling turnouts and panels
- Control animation
- Then add occupancy detection
- Add signals
- Set up CTC system (use monitors for panels)
- Control trains directly
- Control room lighting

Yeah, But I Can’t Program

- Ever heard of the JMRI project?
  - **J**ava **M**odel **R**ailroad **I**nterface
  - Public domain code
  - Setup your layout via an interface, **no coding necessary**
  - Works with DCC <u>and</u> C/MRI
  - Designed/maintained by model railroaders
  - See: http://jmri.sourceforge.net/
- But if you like it Visual Basic works well too (or BASIC or GWBASIC or PowerBasic or C or whatever) – a small amount of sample code shows up in a few slides…

This stuff has got to be expensive!

- Like anything in model railroading, good stuff is not cheap
- BUT … this is not expensive
- The SMINI costs about $1.40 per I/O line if you buy the parts yourself.
- The SMINI is about $1.50 per line as a kit
- It costs about $2.50 per line assembled

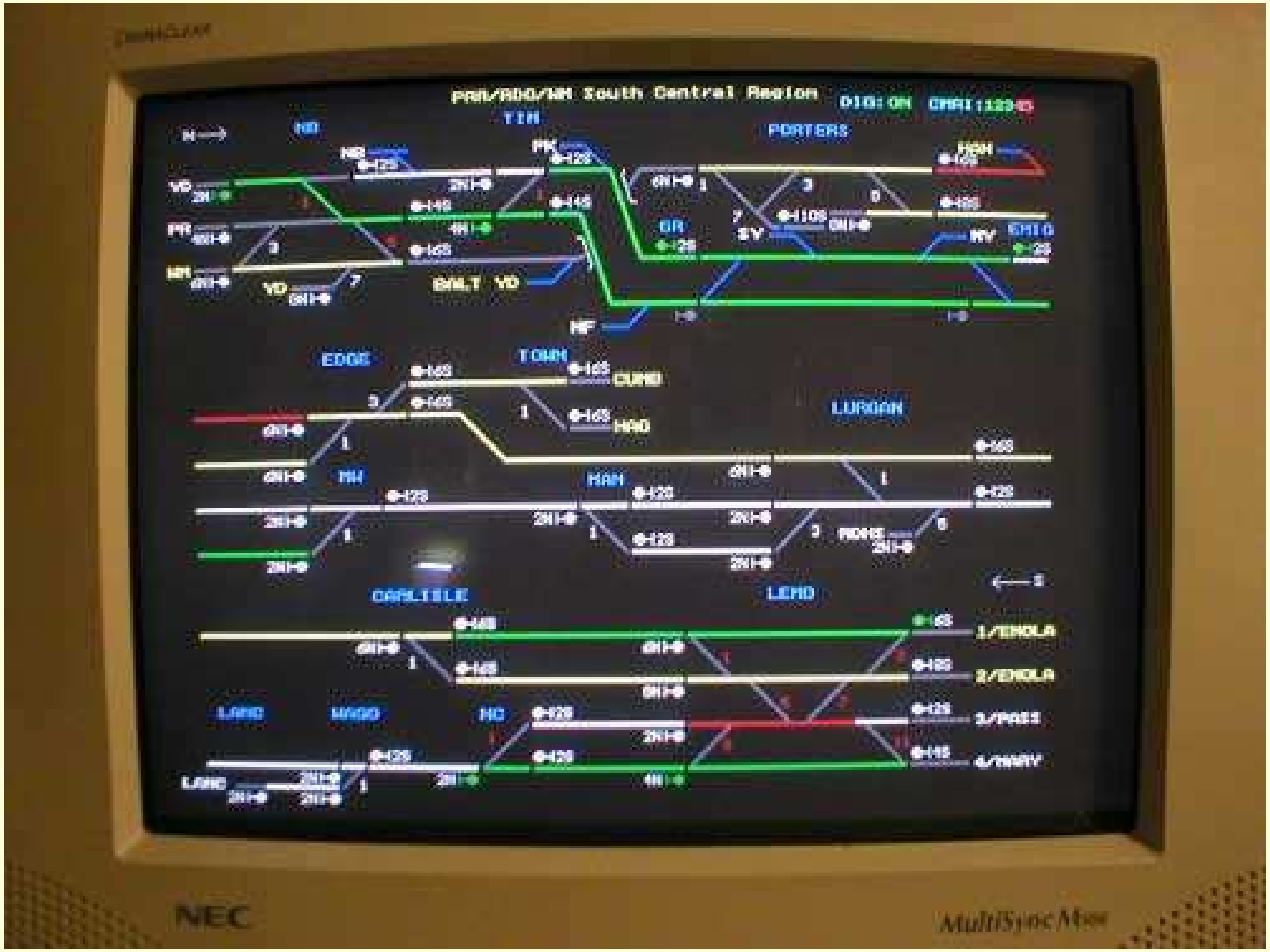
What’s the bottom line ?

- If you build it yourself, automating a tortoise costs (bottom end) $4.20. Plus toggle switch and wire.
- If you use a pre-built system, that’s $7.50.
- An accessory (stationary) decoder costs about $8.00 per turnout.
- Plus - using C/MRI adds <u>nothing</u> to the DCC data congestion on the track.

Examples

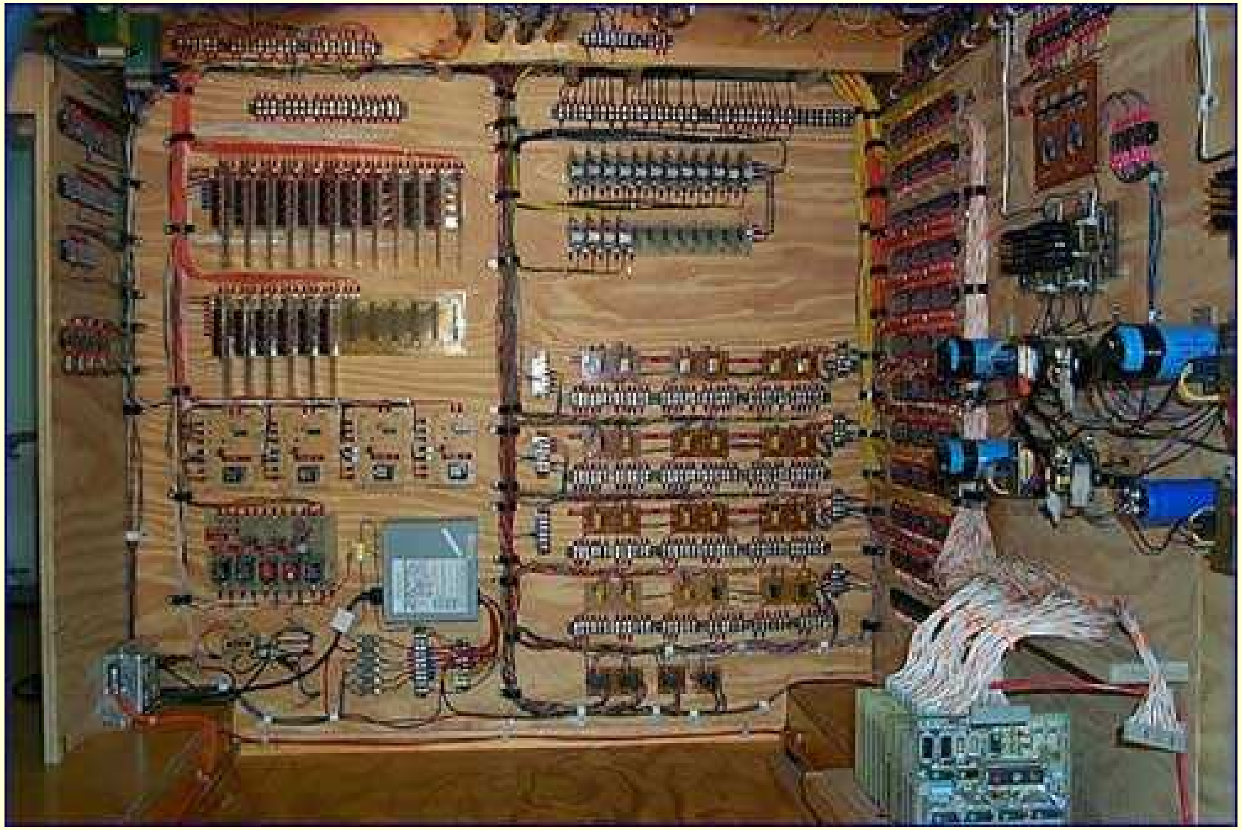
Dr. Bruce Chubb (creator of C/MRI) at his CTC Panel

Examples



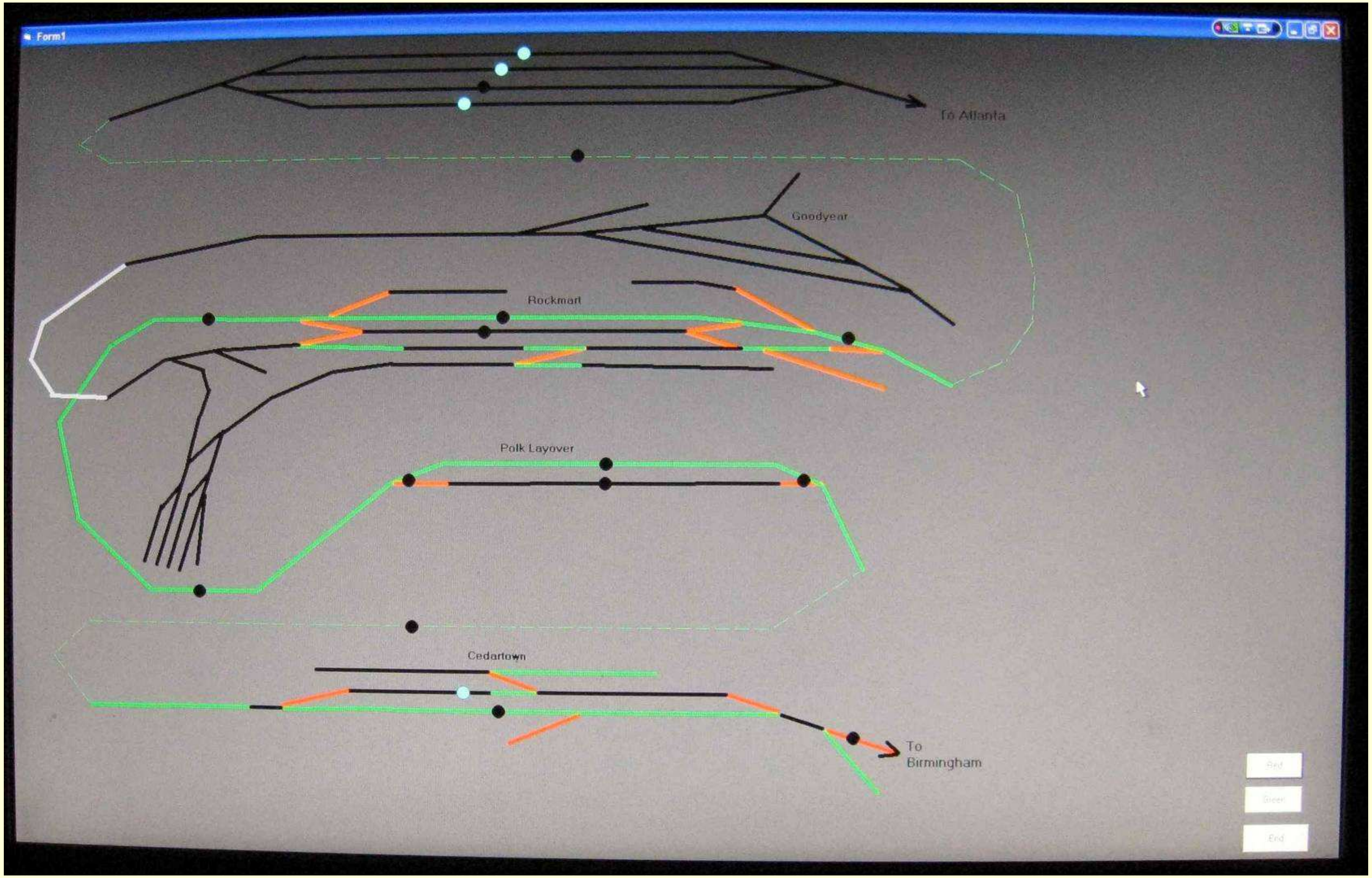
Jeff Warner's PRR/RDG/WM South Central Region - Etters PA

Examples



Ed Crone has a TOTALLY automated layout. It can run for 20 minutes on its own and includes about 24 coupling and uncoupling moves.
– OK, maybe overkill.

My Computer Interface
(still under construction)



OK, How do you do this?

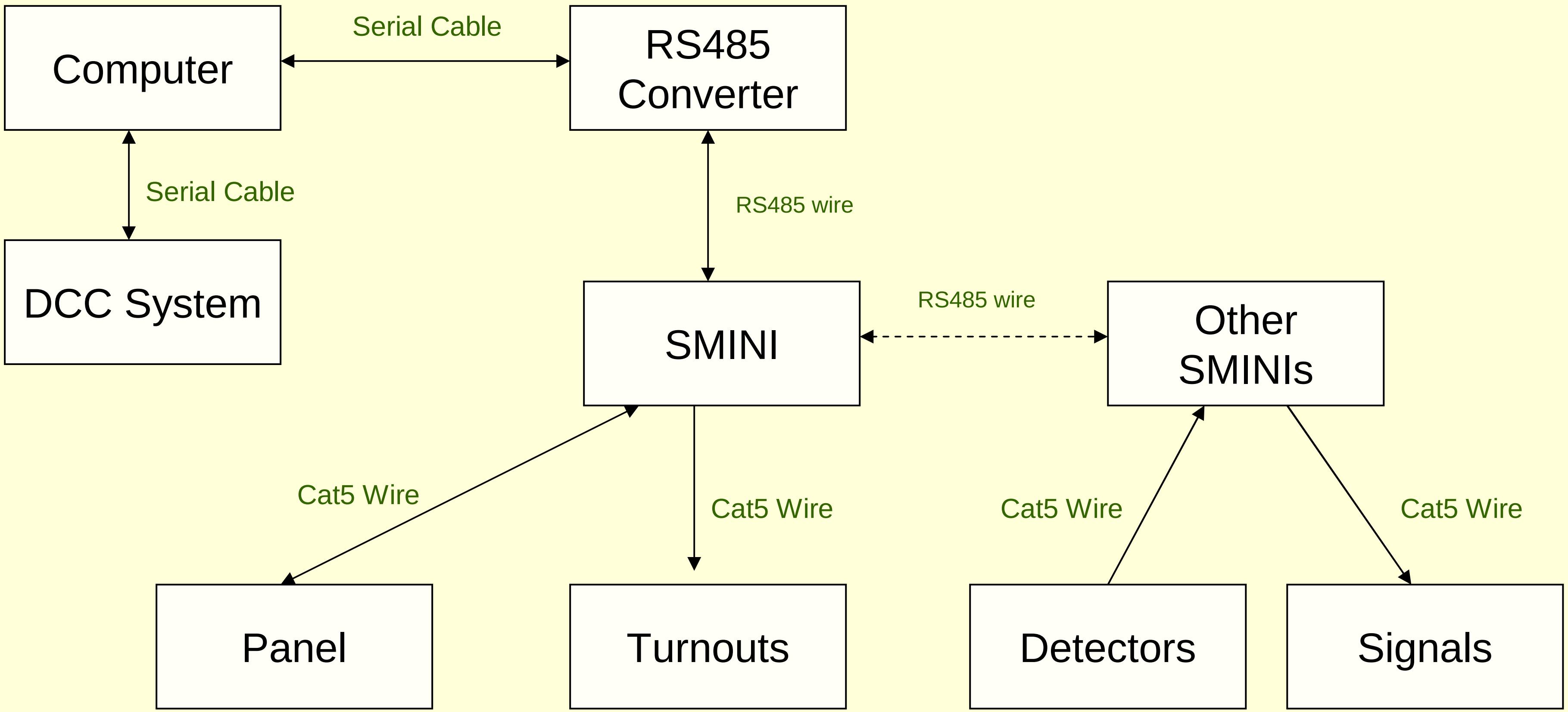
- Let’s start simple – panel controls for turnouts.
- On the layout:
  - Use tortoise machines (others can be used)
  - Use toggles or pushbuttons for panels
  - Position lighting on panel is optional (but it sure looks nice!)
  - Bring wiring to central location – or several localized nodes.

What are the pieces?

Five basic components:

- Serial/RJ45 converter board (got to have this!)
- Controller
  - Can be USIC (universal serial interface controller)
  - …or … SMINI (my preference)
- Some sort of input/display device (i.e. panel)
- Computer
- Power Source

How the pieces hook together



Note: Power Supply not shown… everything needs juice!

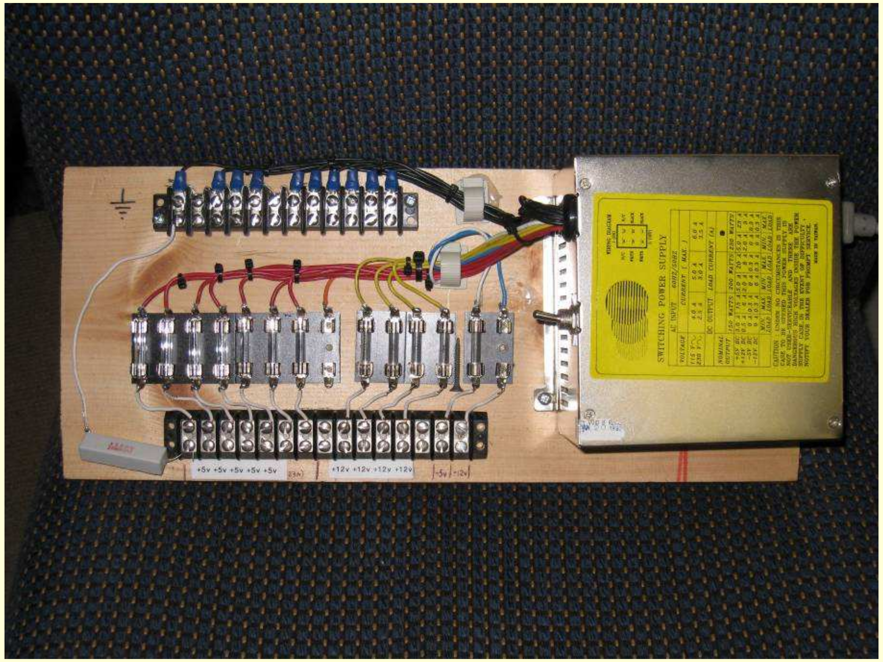
RS485 Converter

This fits between a serial port on the computer and the C/MRI controllers – you only need one.

Power Supply

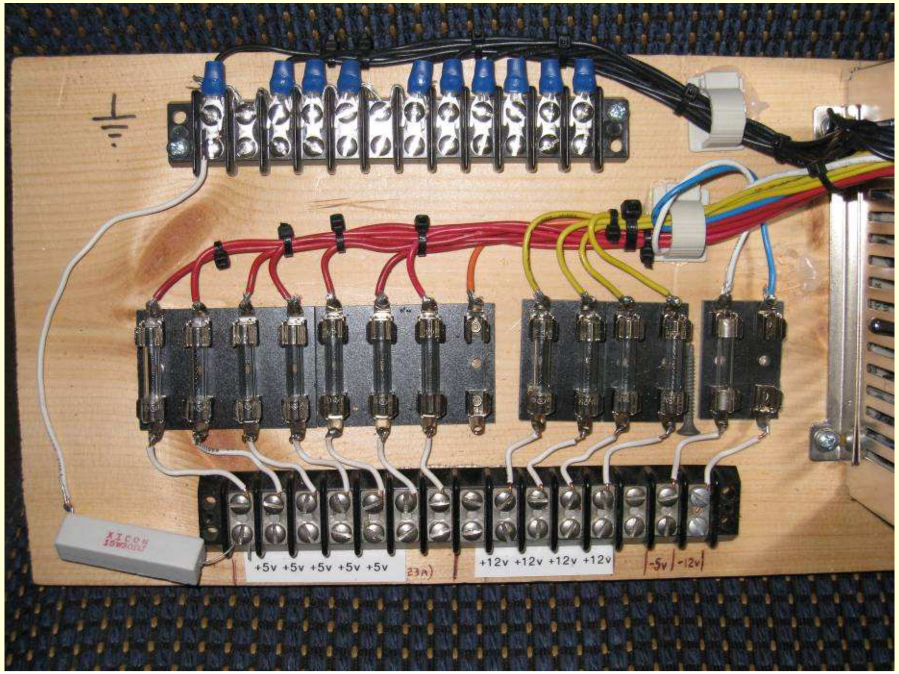
- This ABSOLUTLELY MUST be a switching power supply (like computers use.)
- Transformers have voltage levels that dwindle as load increases – that's why switching supplies are needed.
- This is, after all, a computing device – and it needs steady juice.
- My 15 year old power supply handles 5 Volts at 23 Amps, and 12 Volts at 9 Amps. Enough for about 10 SMINI's and 150 turnouts.
- It cost me nothing! (except for the fuses)

Sample Power Supply

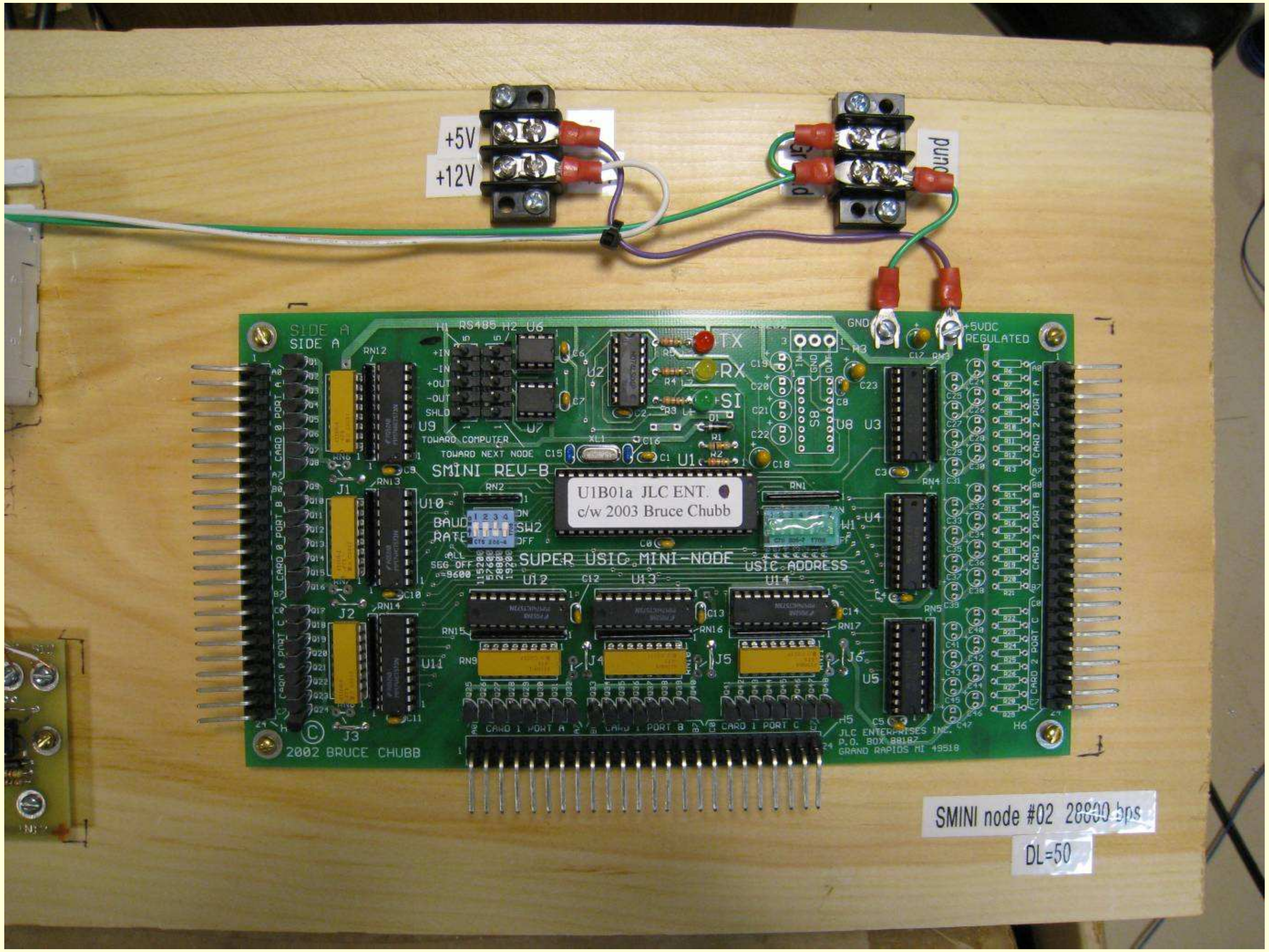


Old computer power supply with added toggle switch for on/off

This is a close up of the fuses. Note the power resistor initially used to “kick off” the supply. After 1 SMINI and several turnouts were added, this was removed.



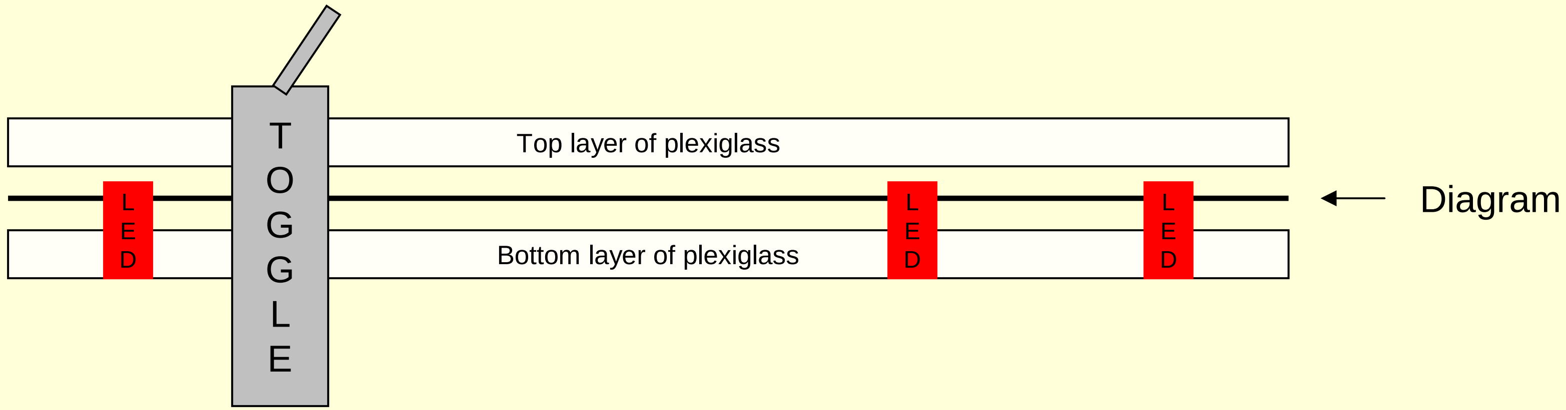
SMINI



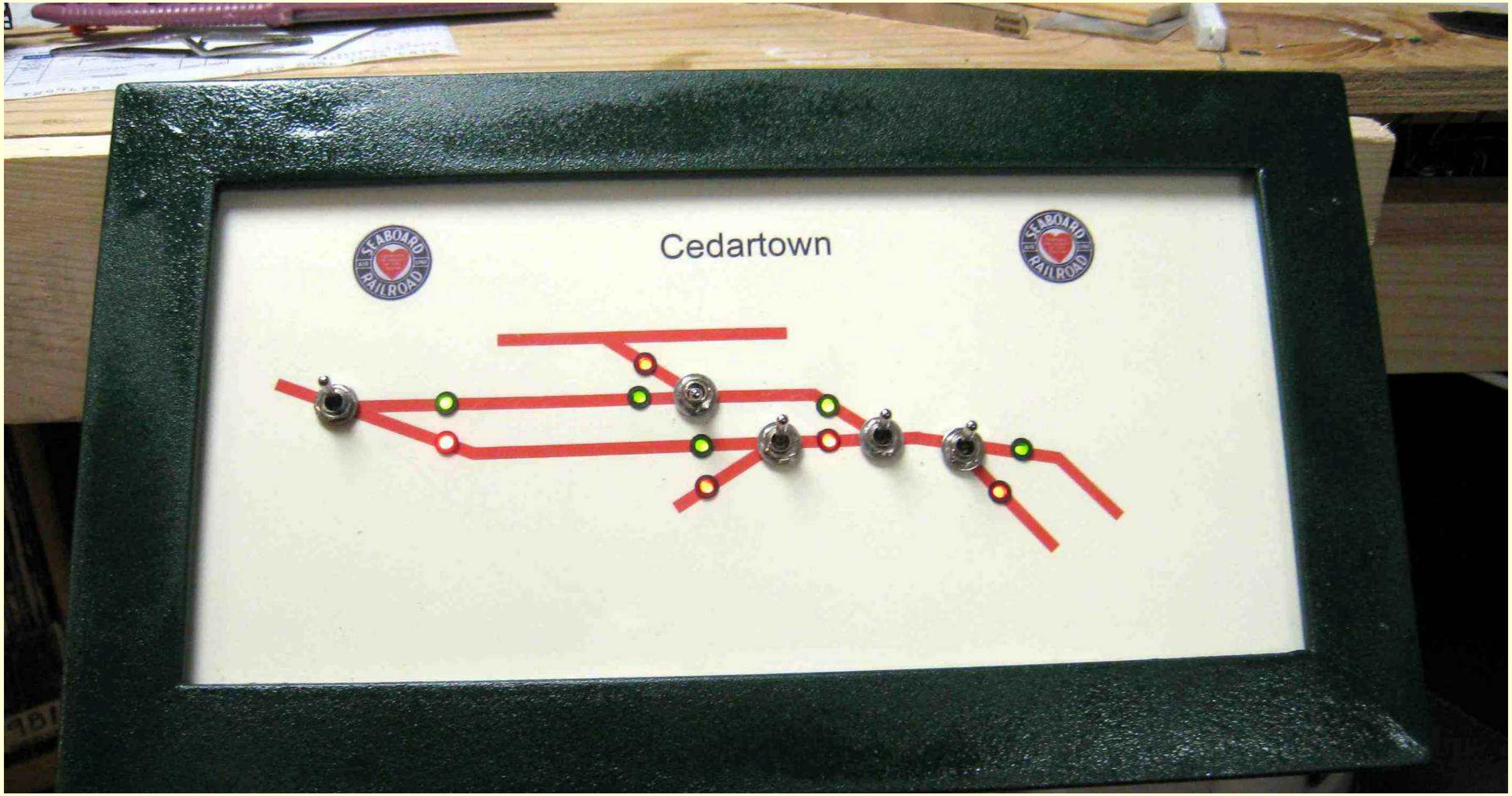
An SMINI has 24 inputs and 48 outputs

Panels

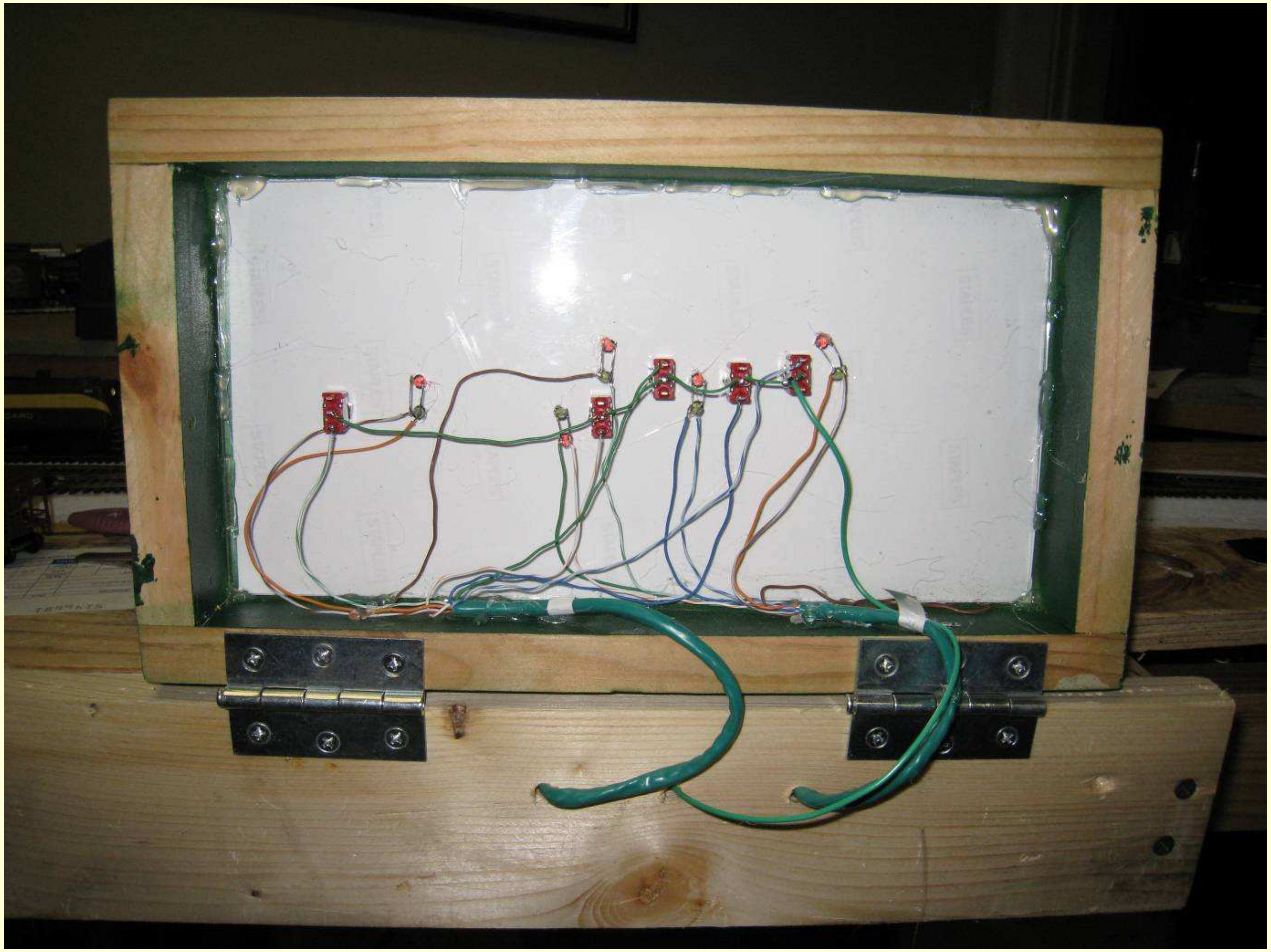
- Do them however you want
- I use 2 pieces of plexiglass with a diagram sandwiched between.
- The LED's are on the back layer, protected by the top layer of plexiglass.



Panels



The Panel 'Guts'



Only connections to the SMINI are needed…

Panel Toggle Switches

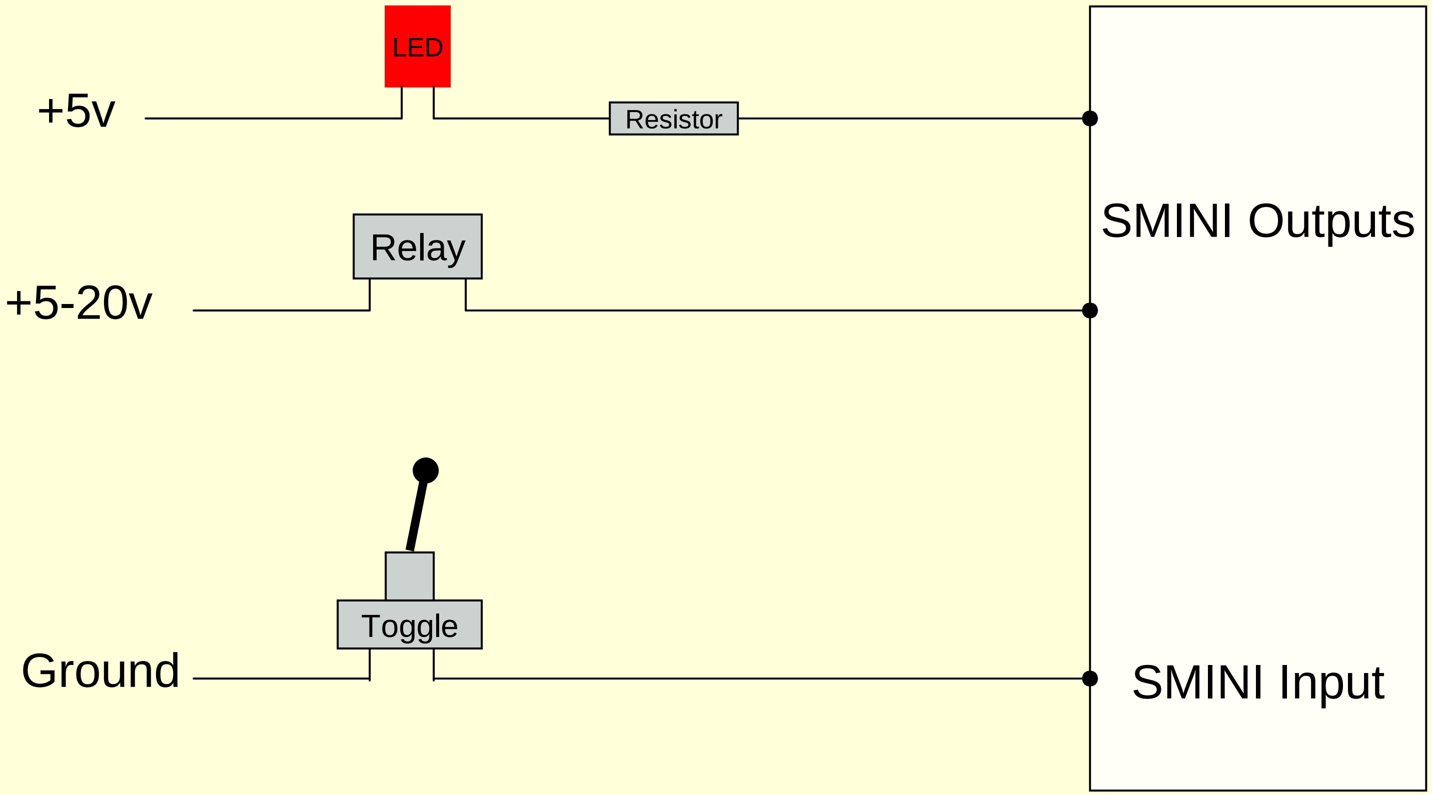
- Used for turnouts and other accessories
- Low power SPST toggles are all that is needed
- Toggle switch grounds an input tab on the SMINI
- Computer sees it is grounded, and throws associated turnout (that is if you want it to!)
- Computer could say “this is an open house” and ignore the toggle switch changes….
- Could be done with a pushbutton too… just a minor difference in the computer code.

Panel LED's

- Supply voltage to LED from a +5V source (a resistor will be needed)
- Hook other end of LED to output pin of SMINI. (output meaning that pin is controlled by the computer)
- If computer wants the LED to glow, it grounds that output pin.

OK, this is as about as technical as it's going to get…..

How outputs and inputs are wired to components



For The Geeks

a bit of control logic code….

Visual Basic code that looks at the position of the toggle switch ‘SM101’, and sets turnout ‘TM101’ to the appropriate orientation. (the constant values of TUN and TUR are defined elsewhere)

```
If SM101 = 1 Then
    TM101 = TUN
  Else
    TM101 = TUR
End If
```

Visual Basic code that looks at the position of the toggle switch ‘SM101’ and sets the 2 color panel display LED’s appropriately to indicate the direction of throw. (the values of the constants REDGRN and GRNRED are defined elsewhere and don’t change)

```
If SM101 = 1 Then
    LM101N = REDGRN
  Else
    LM101N = GRNRED
End If
```

And yes, there is code to receive the setting of the toggle, and send the turnout and panel light commands… but that is easy, doesn’t change with any logic modifications, and way beyond the scope of this presentation.

Yeah, but I could control the turnout with a DPDT switch to the panel and control the LED directly!

- Yes you could
- However… the toggle switch is ALWAYS active, even when visitors ‘bump’ into them.
- If you disable direct wired toggles, you disable the panel lights
- With C/MRI, you can disable the toggles, and still show the lights!

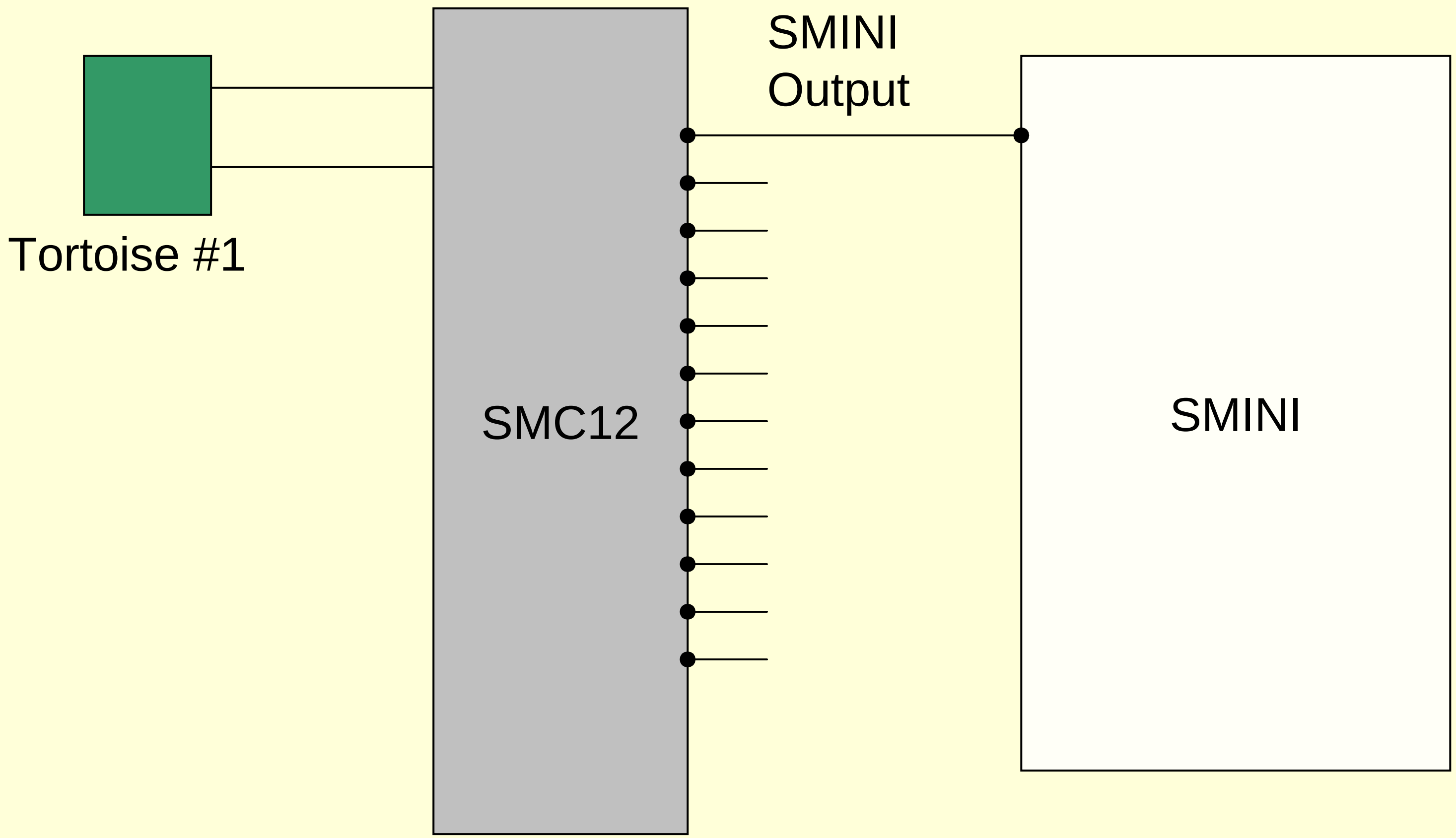
Other Useful Components

- Turnout Control (SMC12)
- Occupancy Detection (DCCOD)

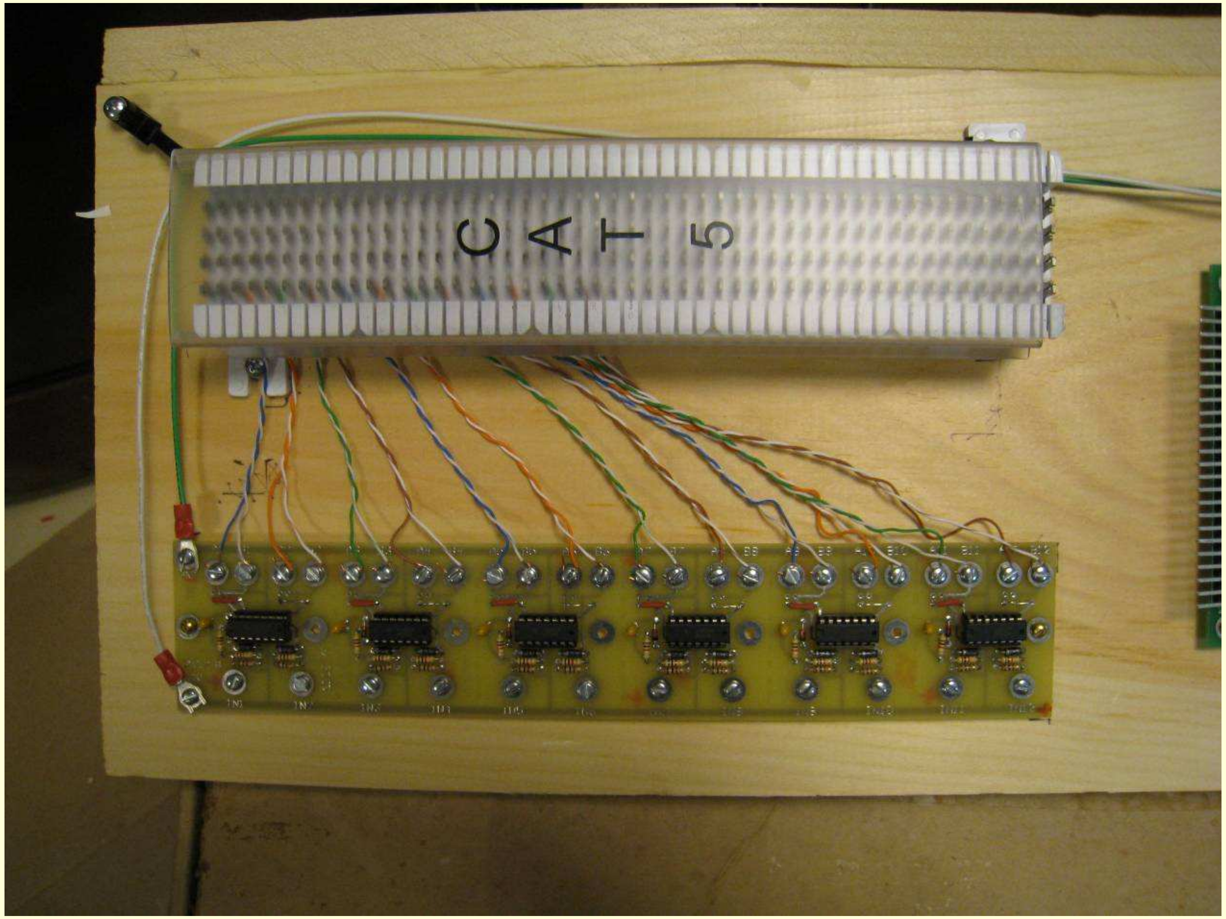
SMC12

- A standard board that allows single wire control to motorized turnouts.
- Feed it 12 volts
- An output is polarized one way when the control lead is grounded
- It is polarized in the opposite way when the control lead is open
- The board can be ‘broken up’ for local control
- The board can be modified (hacked) to be used as an infrared block detection controller… but that’s another story…

Turnout Control



SMC12 Turnout controller

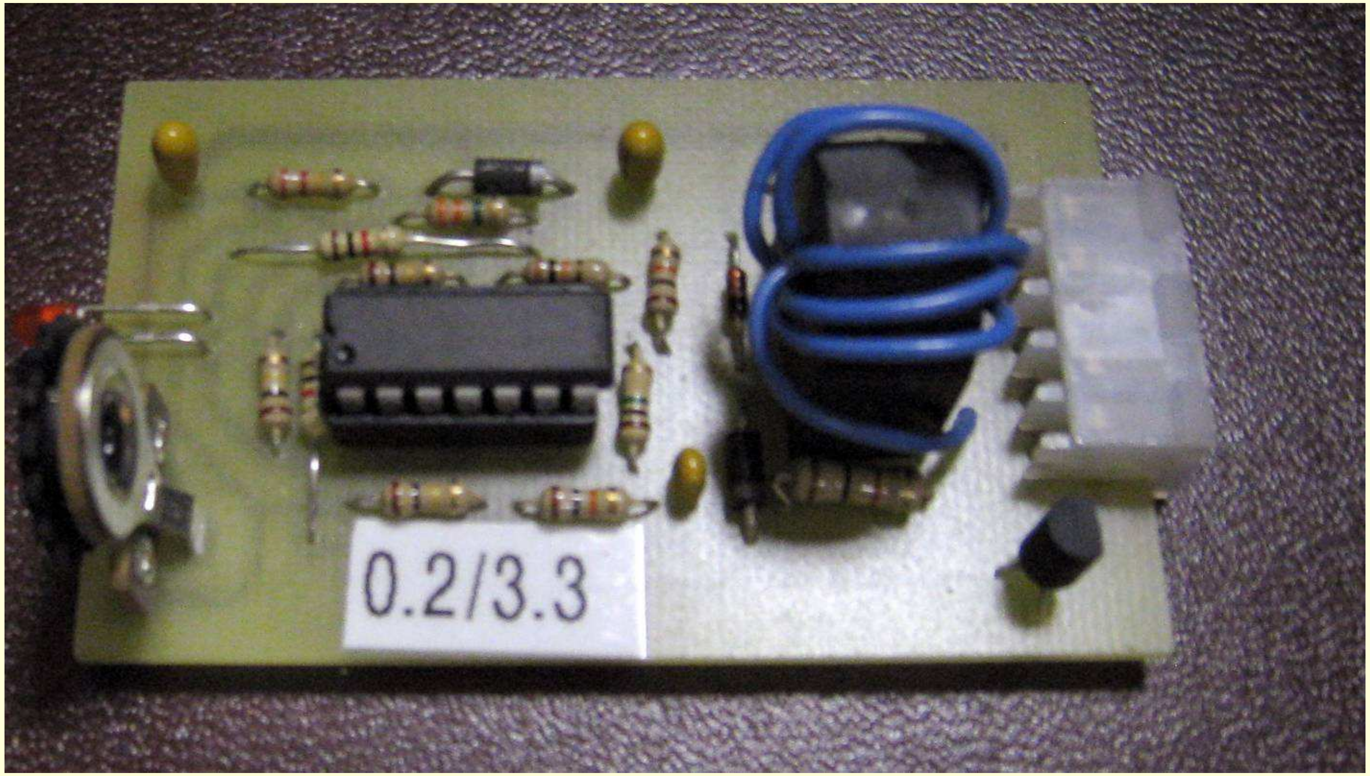


SMC12 hooked to a telco distribution block

Occupancy Detection

- Done with NO connections to track power (none – zero – zip…)
- Uses current sensing coils to keep logic electrically isolated and independent from track current.
- Block supply current goes through coil, inducing current and activating the detector
- Adjustable sensitivity
- Cheap (about $11/block)
- Hooks directly to SMINI
- You must have a blocked layout
- It can work with CAB control layouts
- NEVER, EVER hook track voltage to SMINI

Occupancy Detector



The numbers indicate the time (in seconds) that the detector delays indication of occupancy or dropping occupancy (controlled by resistors).

Note the coil at the right – the detector causes no track voltage drop.

Plug at right allows connection to a motherboard

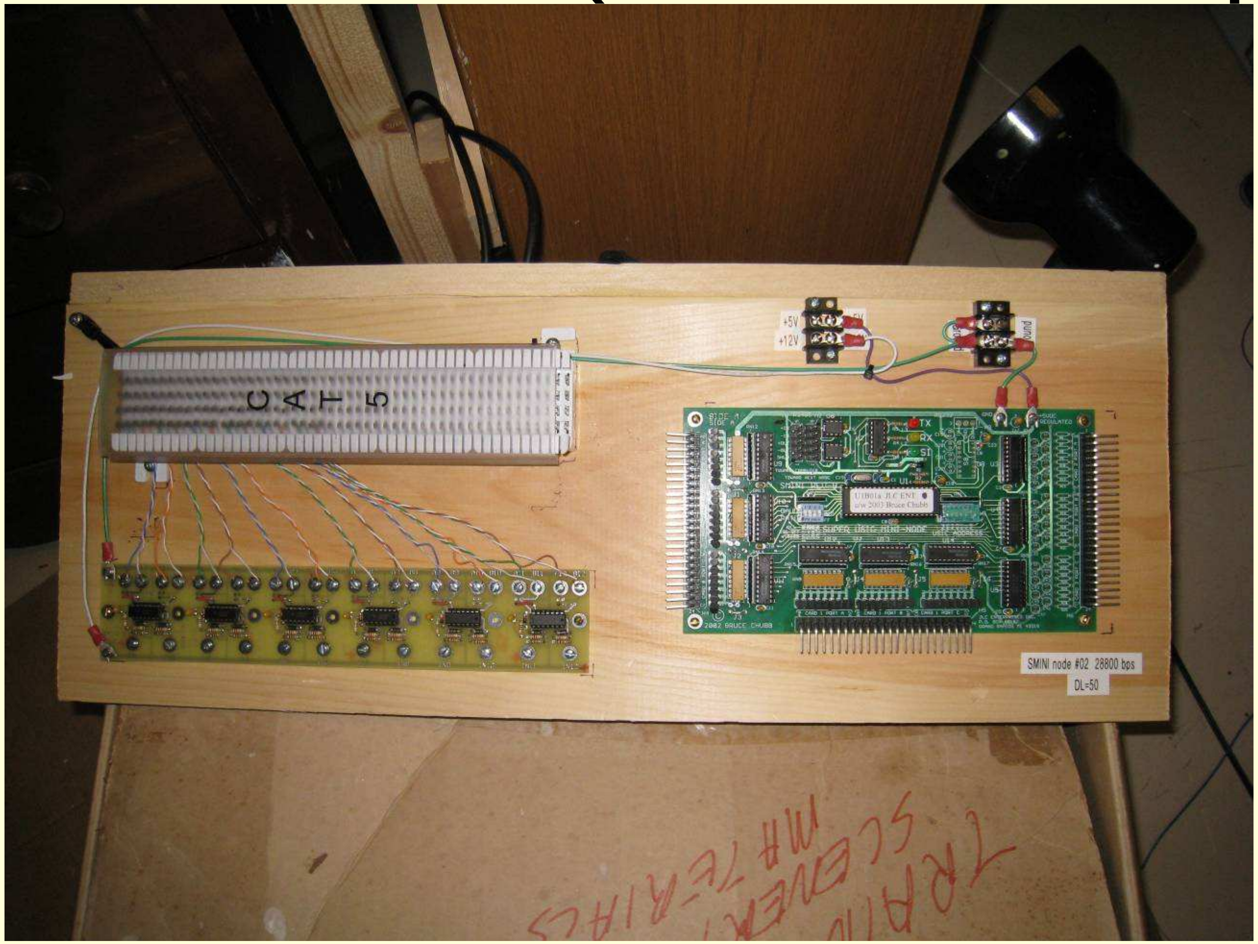
Lots of hardware – so what?

- The SMC12 and DCCOD are both useful on any railroad – even without using a computer.
- The SMC12 allows single wire control of stall switch machines (a common ground and power supply is fed to the board – it's gotta eat…)
- The DCCOD detectors are nice since they are isolated from track current – and cheap. ($11 per block - $12.40 if you use a mother board)

MAKING WIRING MODULAR

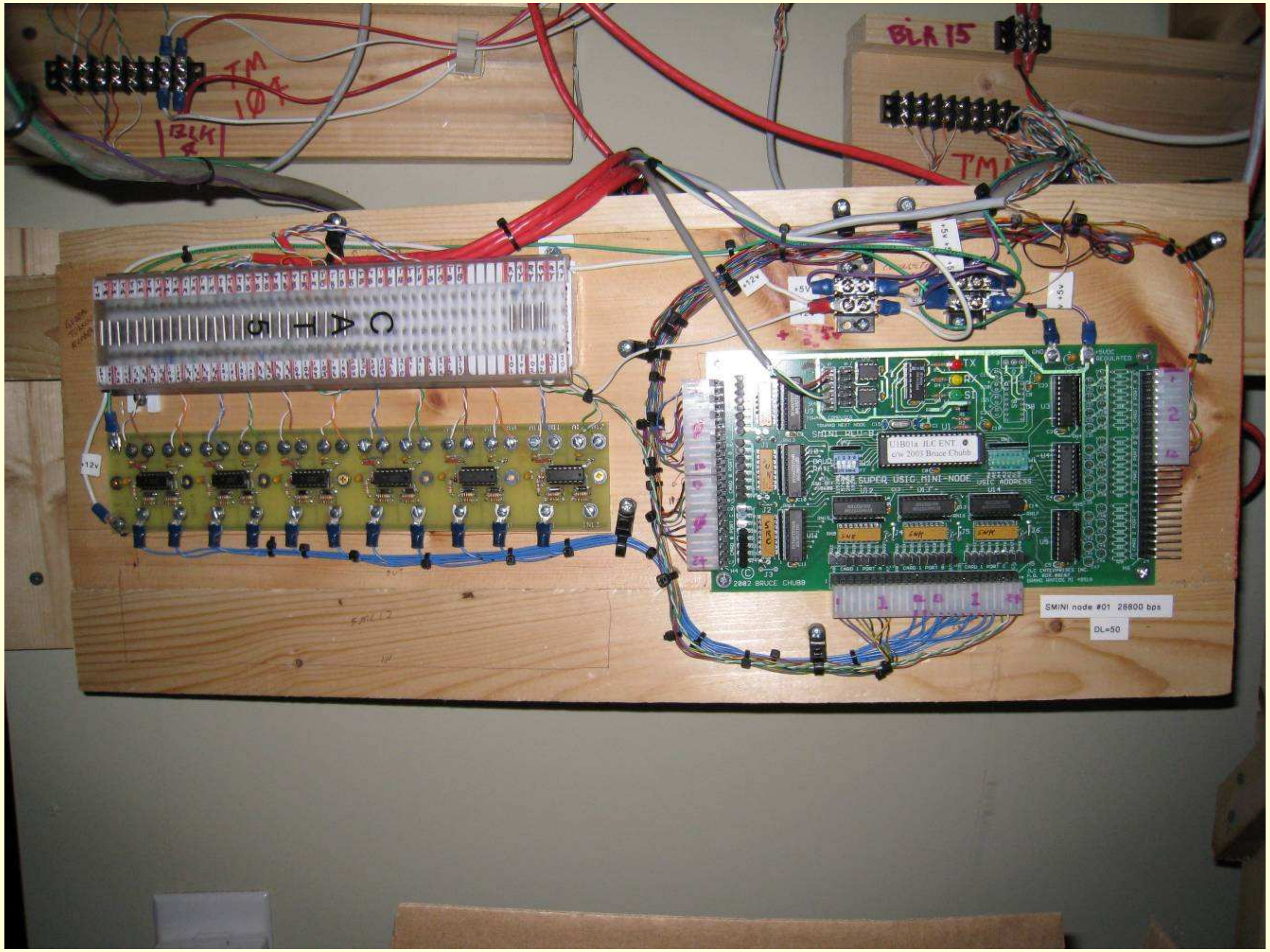
- C/MRI lends itself to modular construction
- You can use this for ANY layout electrical panels
- Simplify and standardize electronic devices
- Allows bench built components
- Allows the use of spare components.

Simple Control Station for Turnouts and Panels (not hooked up!)



Panels are *created on the workbench* – and wired so they can be modified while sitting in a chair next to the layout (lots of slack for the cables is necessary for that – but worth it!!!!

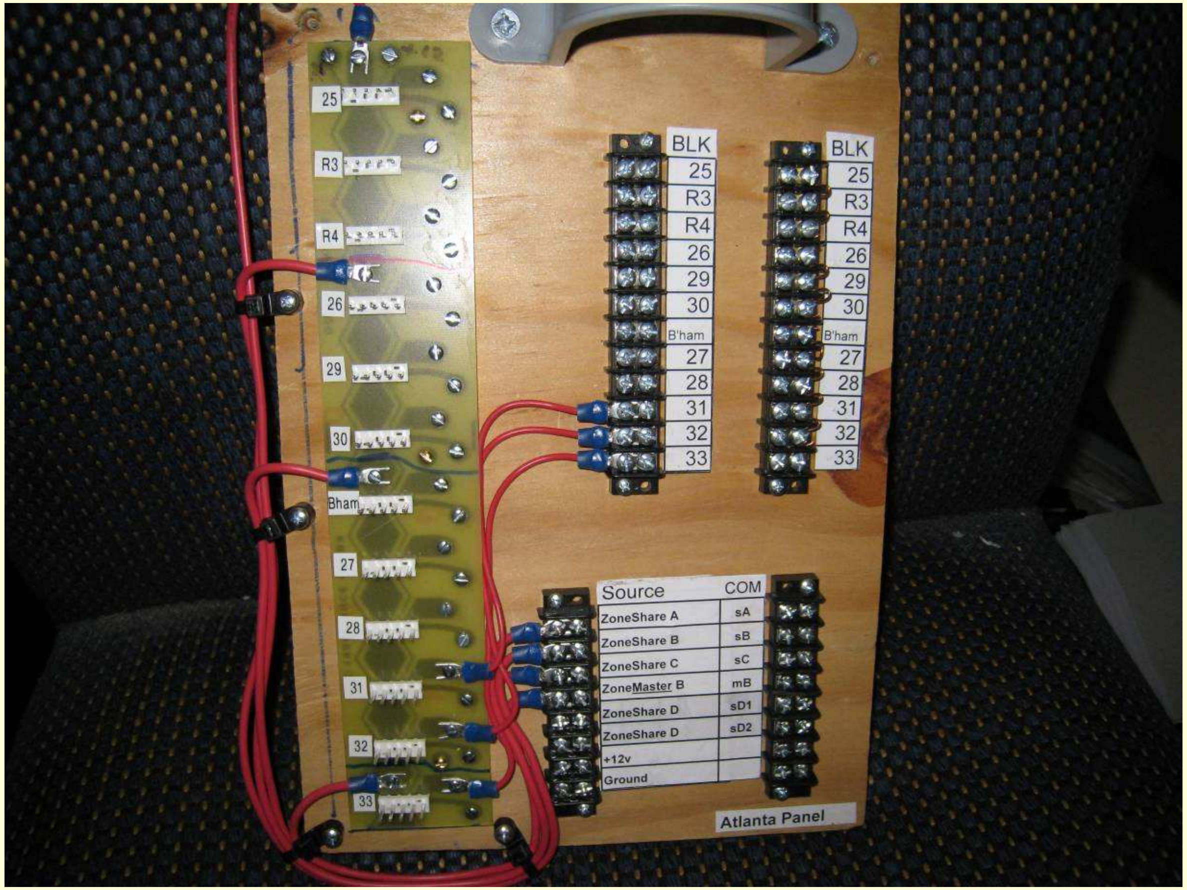
Panel/Turnout control hooked up



Note spare terminal at lower right – destined for occupancy detection

Power Distribution

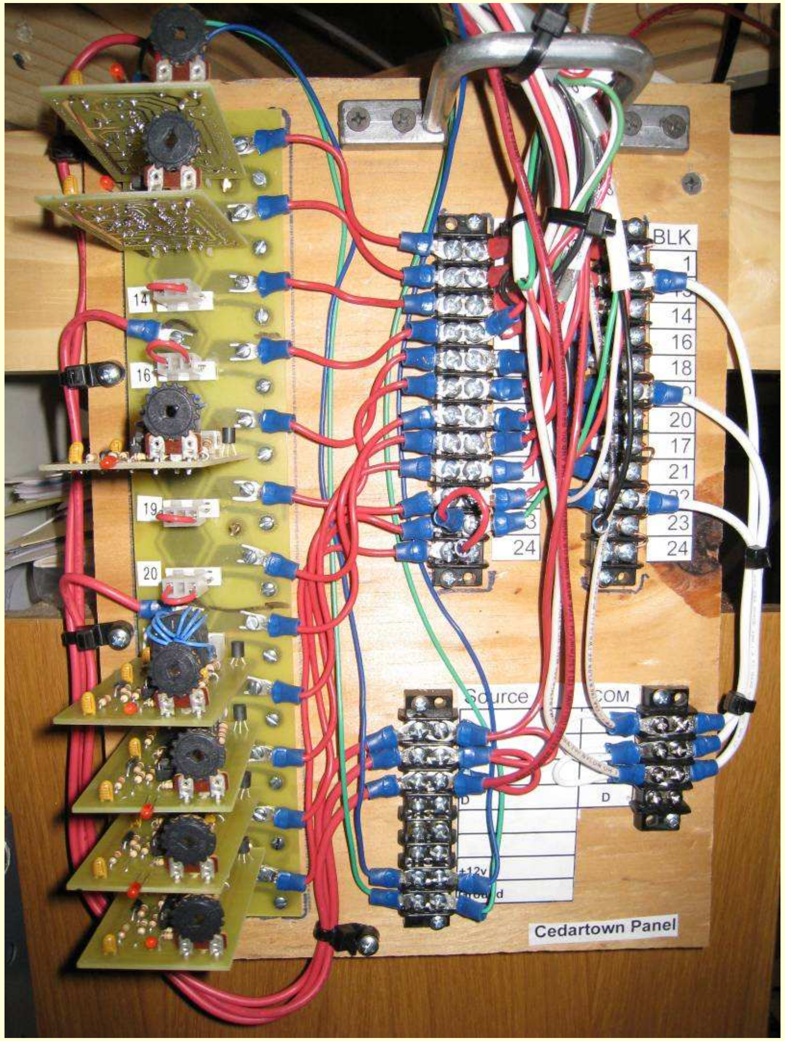
- This could be used for ANY layout



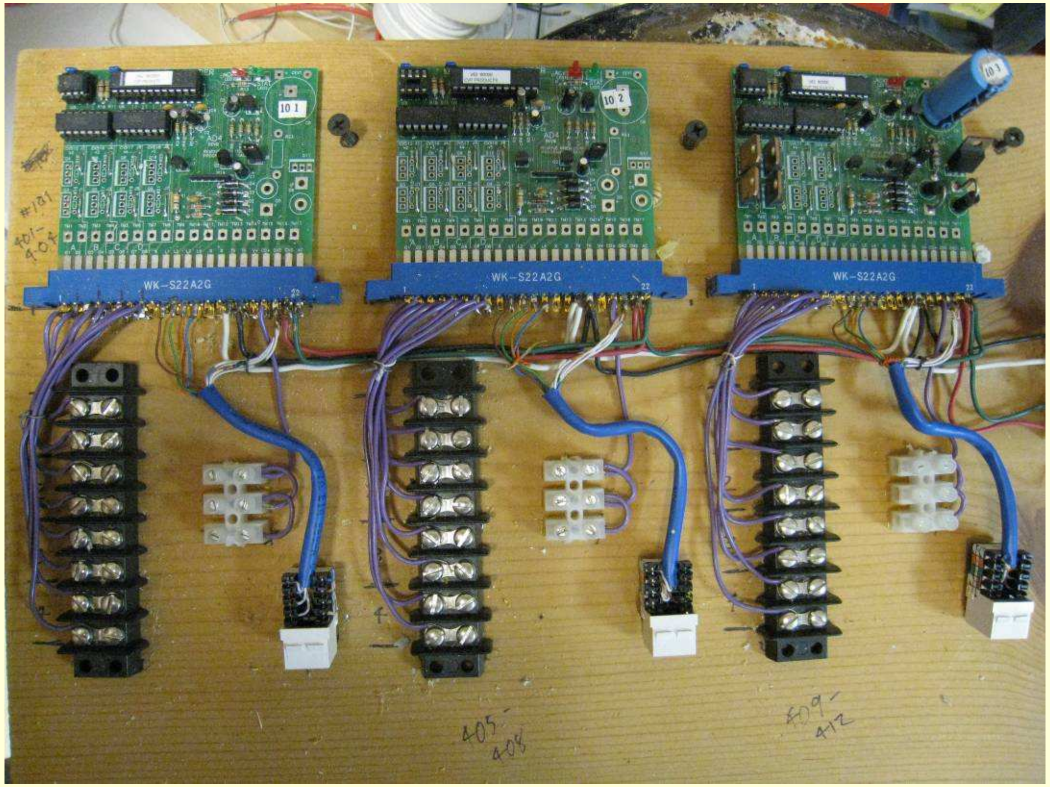
Confession Time

- The distribution node was built at the workbench
- But…
- It's not hooked up
- Here's what it looks like in practice
- (by the way, it could be easily disconnected, reconnected or replaced…)

Power Distribution Hooked Up



Yes, you can modularize DCC too.

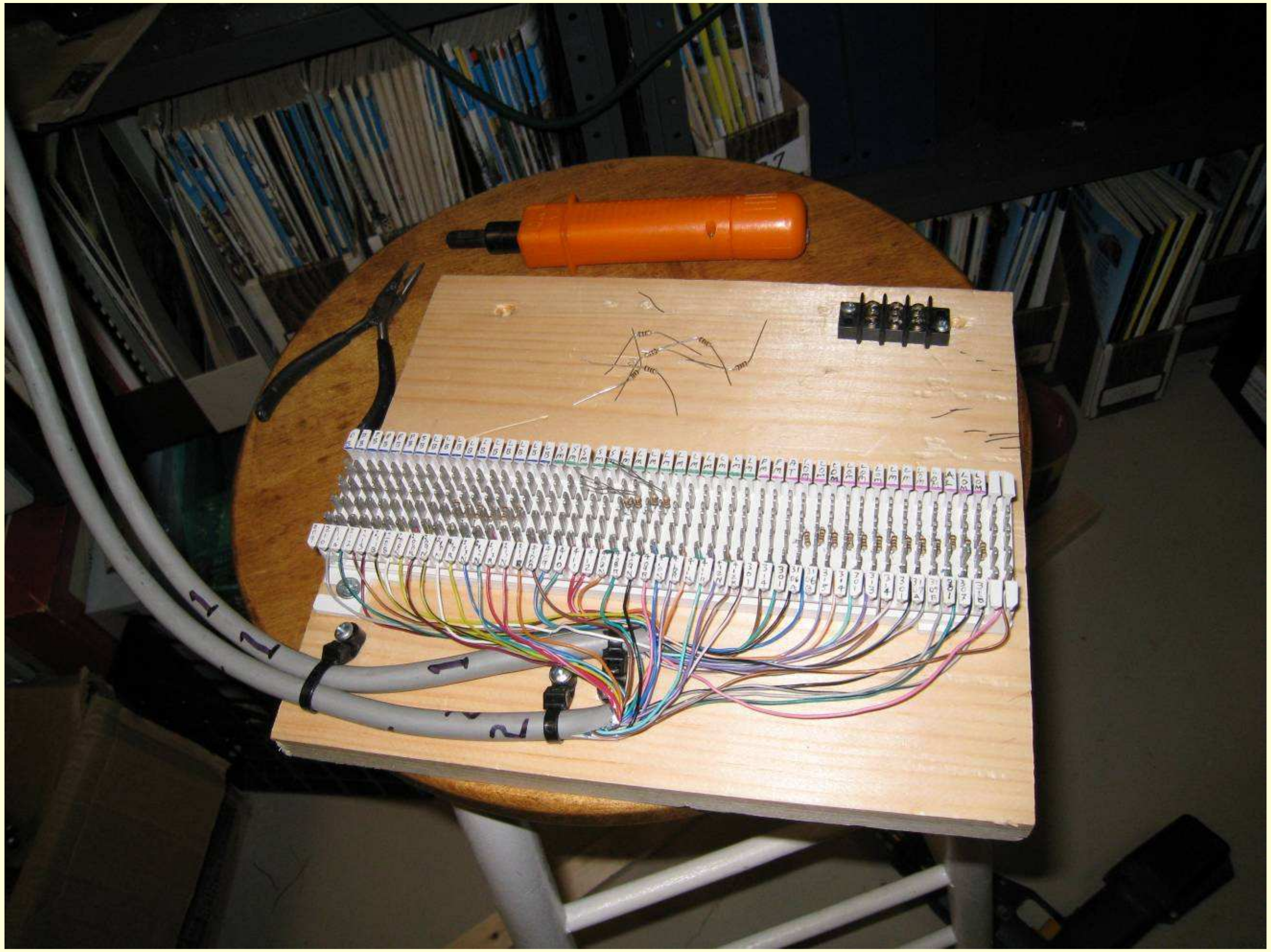


- This is a board containing 3 CVP Products AD4 DCC accessory decoders. It uses RJ45 connectors to link to panels for local turnout control, and seriously oversized barrier terminal strips for turnout connections.
- This device controls 12 turnouts – 8 Tortoise and 2 solenoids
- The AD4 controllers were built from kits
- Note that the controllers can be replaced via sockets
- This was built years ago on a coffee table accompanied by some good brew

Accessible Pieces

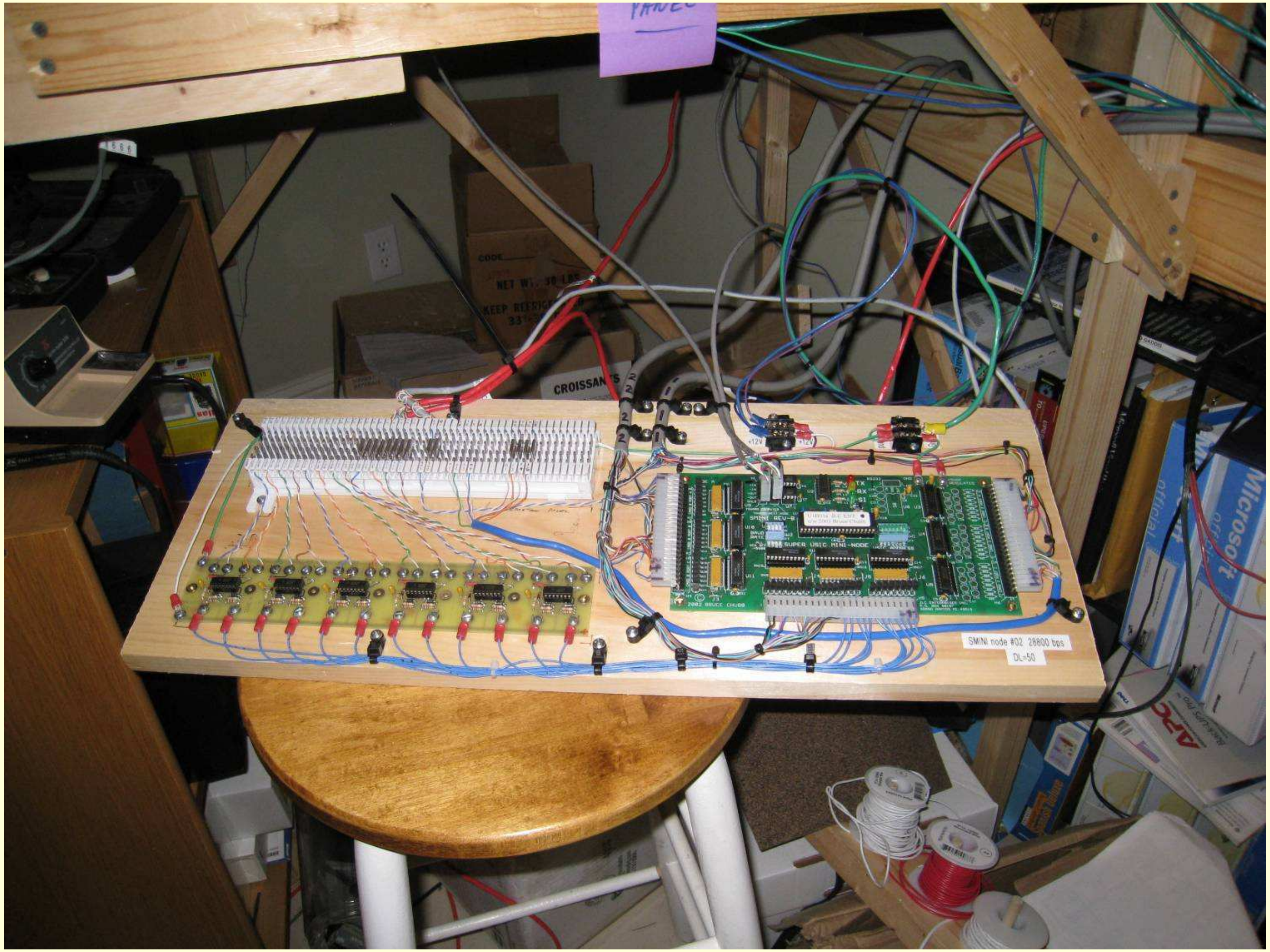
- I like to work on the layout either standing up or sitting in a chair.
- Not lying on my back under the layout.
- So the control modules can be moved for easy maintenance.

Simplified Maintenance



I don't like crawling beneath the layout to do detailed wiring…
so long cables are used

Working on an SMINI



Useful Tools

- A Good Spade Lug Crimper
- Molex Connector Crimper (Waldom)
- A GOOD wire stripper (avoid cheap ones)

What else can be done?

- It get more complex if you want multi color target signals, but the SMINI will drive RYG LED’s!!!
- If you want to flash panel lights, you do it in the code. Not really that difficult.
- You can run relays too (up to 20v coils)

Gotcha's

- You **MUST** have a good power supply. It must be computer grade. It MUST be a switching power supply. Power packs <u>will not</u> power CMRI.
- The computer must be running the layout software if you want to run the layout. (but it can be wired so that this is not necessary…)
- As in any situation, it's good to have spare parts. (things only break when visitors are around.)
- It requires some planning and documentation (which should be done anyway…)

Stuff I've Learned

- Yes, you can do it all with one power supply – after all, computer power supplies run about 250 watts+ … thought I'd need 2 or 3.
- When providing +5v and +12v from a central location … WIRE SIZE ***REALLY*** MATTERS!!! 10 or 12 gauge wire is a good idea since SMINI's minimum voltage is 4.8 v. Check the voltage at the controller location with everything running.
- Be REAL careful when putting IC's into their sockets (nuff said…)
- Use a soldering station – it can save $$$ in fried parts
- Use strain reliefs on ALL connections
- Label your wires!
- An SMINI costs about $100 if you order the stuff yourself.
- An SMC12 costs about $30
- An occupancy detector is about $11
- This makes control panels very easy to wire (and changeable)

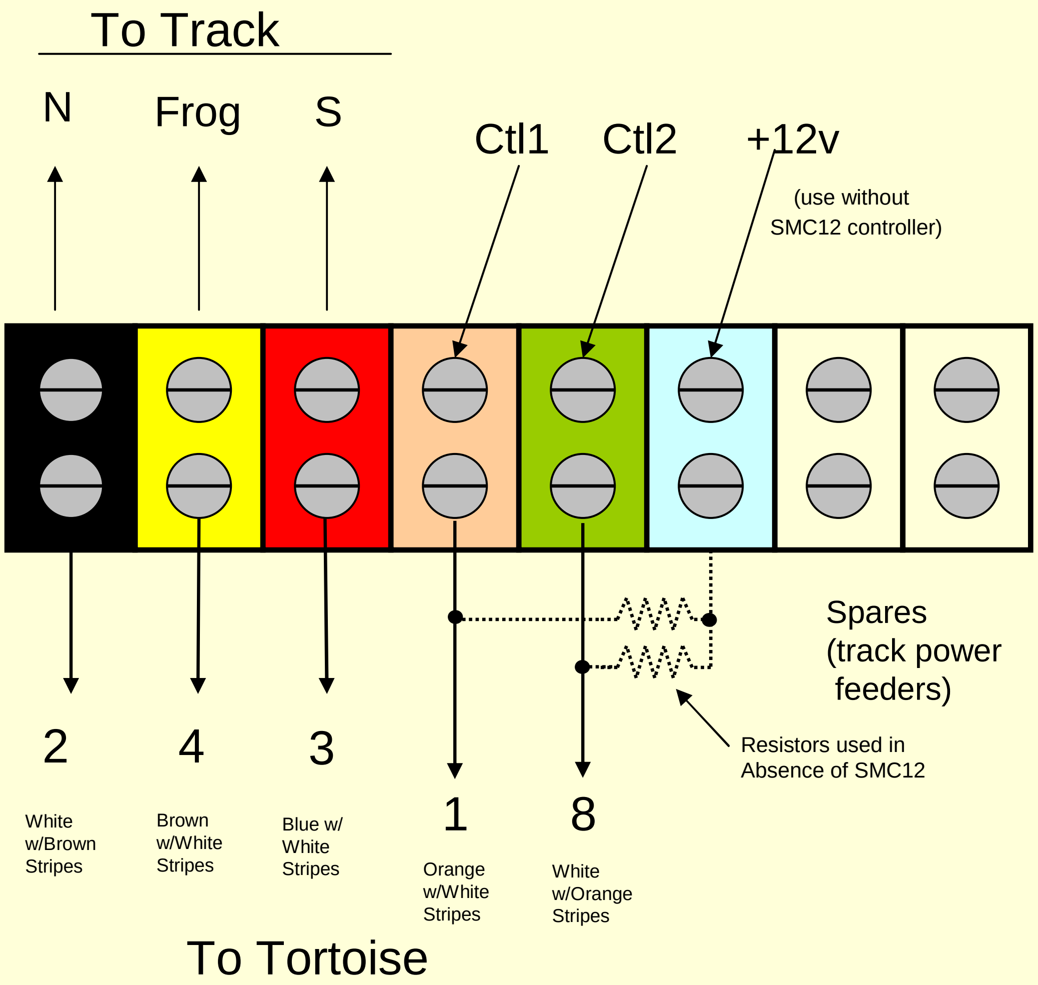
DOCUMENTATION

- Do it to even if you don’t use C/MRI
- Document and plan in advance
- Don’t do this just to meet some requirement… do it to save your sanity
- It is EASY to wire something from a plan, as all you need to do is hook up the wires

Sample Hookup Documentation

SMINI #2 Inputs - (Goodyear Cord, Cedartown and Polk Layover Panels)										
Card 2	Bit		66 Blk	Aspect		Panel	Cbl	Color	Stripe	
1	1-1	PB209 Button	Rem1			Goodyear	1	Grey		Main East
2	1-2	PB210 Button	Rem2			Goodyear	1	Green	Black	Siding East
3	1-3	PB211A Button	Rem3			Goodyear	1	Orange	Black	Wye East
4	1-4	PB212 Button	Rem4			Goodyear	1	Red	Black	Siding West
5	1-5	PB213 Button	Rem5			Goodyear	1	Yellow	Black	Main West
6	1-6	PB211B Button	Rem6			Goodyear	1	White		Wye West
7	1-7	SB208 toggle	Rem7			Goodyear	1	Yellow		Power Plant
8	1-8	SM408 toggle	Rem18			Cedartown	1	Blue	White	Cedartown E
9	2-1	SM409 toggle	Rem19			Cedartown	1	Green	White	Cedartown I
10	2-2	SM410 toggle	Rem20			Cedartown	1	Red		Cedartown I
11	2-3	SM411 toggle	Rem21			Cedartown	1	Red	White	Cedartown W
12	2-4	SM412 toggle	Rem22			Cedartown	1	Orange		Cedartown -
13	2-5	PM301 Button	Rem33			Layover	1	Brown		Polk Layover
14	2-6	PM314 Button	Rem34			Layover	1	Green		Polk Layover
15	2-7	AT301	Rem35			Layover	1	Black		Polk Layover
16	2-8	-spare-					1	Pink		
17	3-1	IR Detector	Loc		IR01	n/a				Polk Layover
18	3-2	IR Detector	Loc		IR02	n/a				Polk Layover
19	3-3	IR Detector	Loc		IR03	n/a				Polk Layover
20	3-4	IR Detector	Loc		IR04	n/a				Polk Layover
21	3-5	Occ Detector	Loc		DCCOD01	n/a		Green	White	Polk Layover
22	3-6	Occ Detector	Loc		DCCOD14	n/a		Brown	White	Polk Layover
23	3-7	Occ Detector	Loc		DCCOD13	n/a		White	Brown	Polk Layover

Turnout Wiring Documentation Example



Tortoise Connections

Pin 1	Orange/White
Pin 2	White/Brown
Pin 3	Blue/White
Pin 4	Brown/White
Pin 5	Green/White
Pin 6	White/Blue
Pin 7	White/Green
Pin 8	White/Orange

Tortoise Cat5 Connection Spare Leads:

White w/Blue Stripes	- #6
Green w/White Stripes	- #5
White w/Green Stripes	- #7

- Note: Pre wiring a Tortoise with Cat5 wire is not an original idea – I got the concept from Bob Young and modified it a bit…

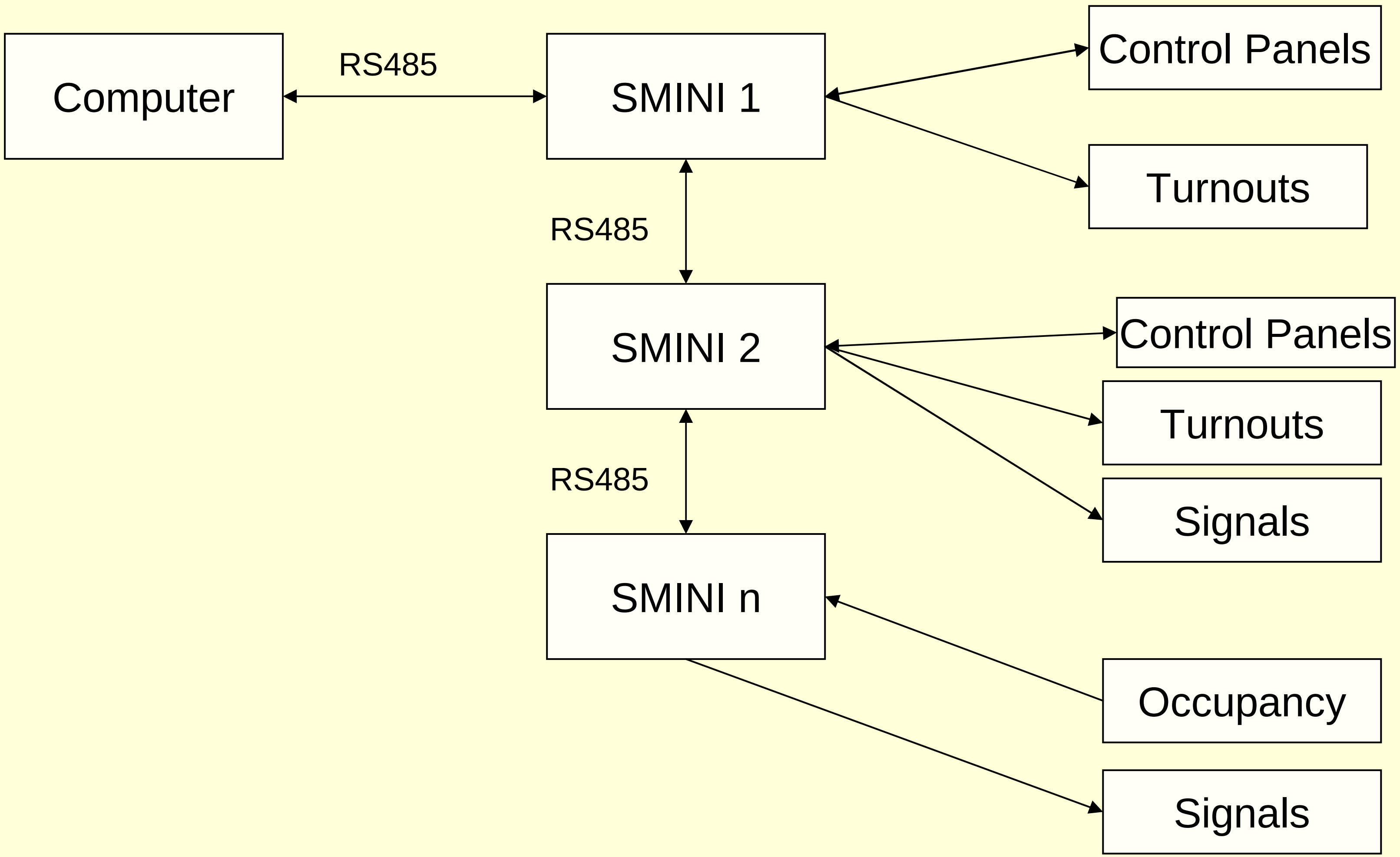
Why do all this documentation?

- Reduces errors
- Allows thinking before doing
- Makes assembly ***MUCH*** easier
- Makes bug fixes easier
- Makes modification and update easier

PLANNING THE SYSTEM

- Everything is modular and expandable
- Group components in logical locations
- Plan for expansion and future use
- Keep it neat as possible
- Document what your going to do <u>before</u> you do it!
- Allow room for changes

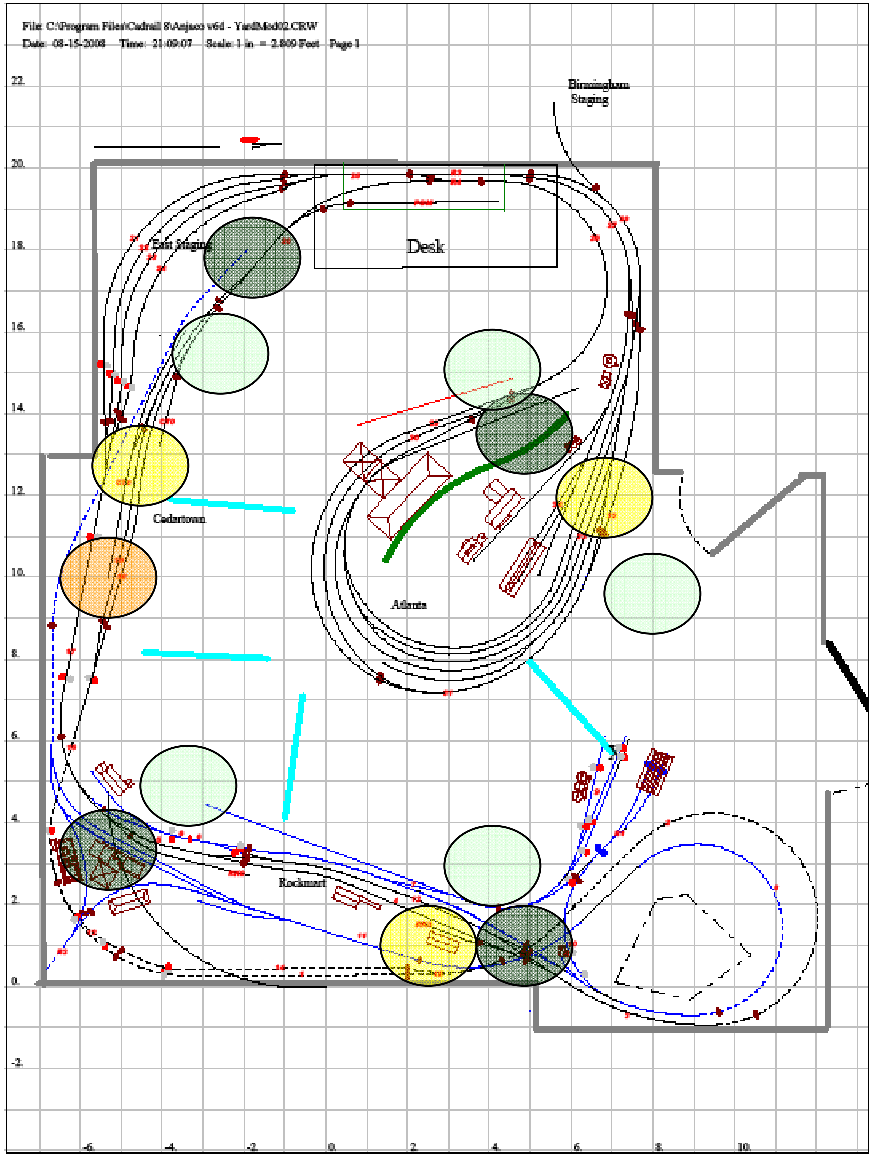
Distributed Controls



Set up the layout in nodes

(dark green oval)	SMINI Node
(yellow oval)	Power Dist. Node (OD units here)
(orange oval)	C/MRI Power Supply
(light green oval)	Major Control Panel

Note:
Nodes are located near panels and congestion.
Several SMINI's could be at any one node.



Where do you get this stuff?

- You can build it yourself from parts
- You can order and build kits
- You can order completed components
- You could even etch your own boards if you really wanted to.

Conclusion

- Computer control is not as difficult as you'd think
- Computer control allows for significant layout operation flexibility and expansion
- Making modular components makes wiring easier
- Document wiring before installation

Reference Information

Information and kits:

- JMRI http://jmri.sourceforge.net/
- C/MRI www.jlcenterprises.net/
- Easee Interfaces – Don Wood (kits and custom completed CMRI modules) easeeinterface@msn.com

Parts:

- Jameco Electronics www.jameco.com
- Digikey www.digikey.com
- Mouser Electronics www.mouser.com

Seaboard Air Line – West Georgia Subdivision