Communications for Model Railroads

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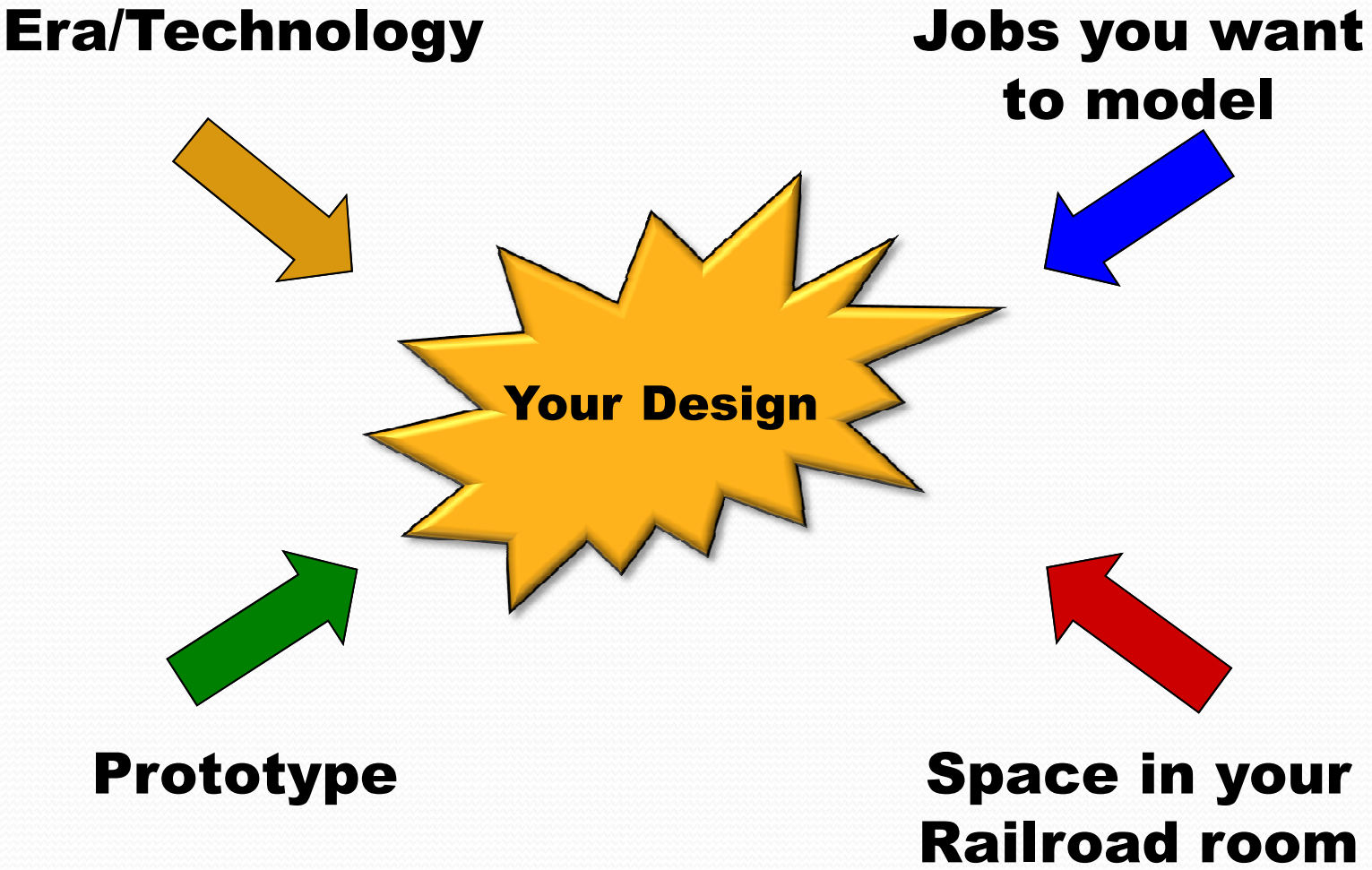
Agenda

- A little History
- Design Considerations
- Modeling From the Prototype
- What Era are You Modeling?
- How to Put it Together
- Hints & Resources

Design Considerations



Communications for Operations

- Different eras had different dispatching models based on available communications: the history of dispatching is the history of communications technology
  - TT&TO: Telegraph/Telephone:
  - CTC: Telephone/Radio
  - DTC, TWC: Radio

Communications Time Line

- 1845: Telegraph invented
- 1850: Telegraph used by Railroads
- 1851: Charles Minot uses Telegraph to send 1st Train Order on Erie RR
- 1869: Telephone invented
- 1920s: Telephone in widespread use for TT&TO dispatching
- 1925: CTC appears, phone booths provided at ends of controlled sidings
- 1940s: Telegraph largely supplanted by Telephone
- WWII: CTC becomes common on western mainlines
- 1960s: Radio becomes widespread, Train Orders copied over radio
- 1980s: Radio becomes ubiquitous, TWC/DTC appear in 1985

Your Prototype

- What did your prototype do in your era?
  - Single track with passing sidings?
  - Double track, rule 251?
  - Style of dispatching:
    - TT&TO
    - CTC/TCS
    - Radio
- TT&TO requires Train Order Offices, preferably with Train Order signals
- CTC requires phones at each controlled signal

Modeling Jobs on The Railroad

Operations is modeling the work of the railroad. Like everything else in model railroading, jobs are selectively compressed: we like to do the fun parts but not the boring, tedious and dangerous parts. In the transition era there were 10 clerks for every one person in train service. We could not fit all of the clerks for one good op session in this room!

Jobs to Model:

- Dispatcher
- Train Crews
- Operators (for TT&TO)
  - One for whole layout?
  - One at each station?
  - Where can you fit them in?
  - Conductor often magically morphs into the Operator at each TO office

What communications are you trying to model?

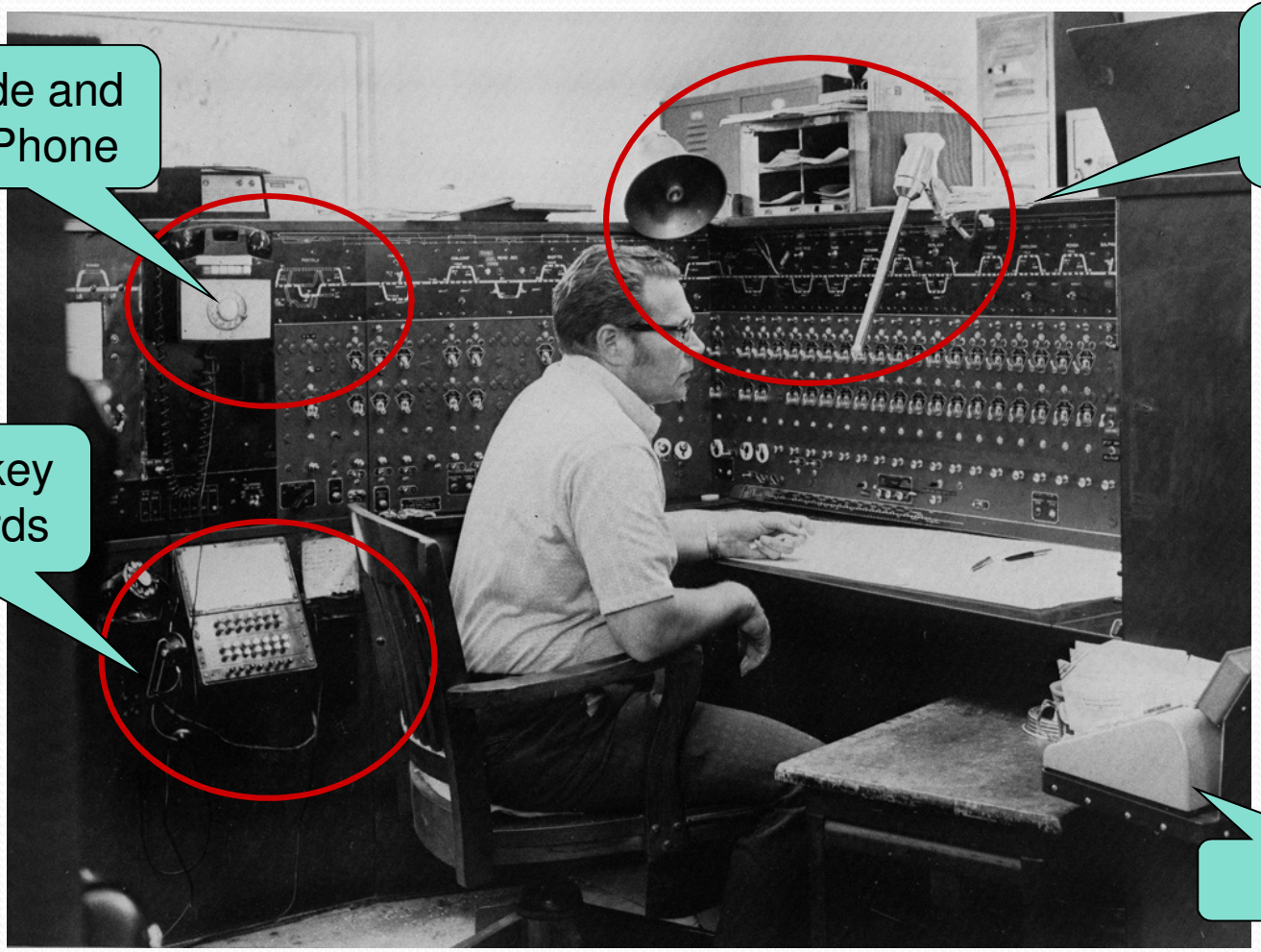
- Communications *among* DS and Operators? (TT&TO)
  - Open speakers – a wireless intercom is a quick and dirty choice IF the DS and Agent/Operators are in quiet places, isolated from the railroad. You could also build something using phone hardware OR
  - Telegraph (RR Morse or International Morse)
  - Use phones with amplified speaker across the line, provide Push to Talk and/or noise canceling microphone to control feedback
  - Remember real crews *rarely* OSd themselves, so having the crew OS is *generally* a "model railroad thought"
- Communications *between* DS and crews (CTC)
  - Idea is to keep crews "isolated" (no radio chatter)
  - Need to go to a "station" or phone booth to talk
  - "Call Lamps" on relay shacks set by DS on the CTC machine

Understand your operational requirements!

Your Layout: Givens and 'Druthers

- How much space do you have?
  - Do you have room for sound-isolated Agent's stations?
  - Where to place telephones (by the station –TT&TO, at controlled signals –CTC)
  - Aisle width
  - Places to write
- How much chatter do you want in the layout room?
- Arrangements for displaying train order signals, (Semaphores, Searchlights, hooks below layout)
- Do you want prototypical phone instruments or would more comfortable and durable (and potentially less expensive) modern (but anachronistic) equivalents be better?

WP Sacramento CTC (TCS) Board



How it Worked under CTC

- Employee Call lights driven off code line
- Phones were “local battery” (like crank phones) with push-to-talk handsets and interlocks with door latches in phone booths (to save battery)
- DS had a speaker (always on except when talking), a microphone and a footswitch (stomp-to-talk)

How should it work (CTC)? - 1

- DS Calls a train:
  - DS sets Signal to “stop” at OS Section (Control Point) ahead of train
  - DS sets “Employee Call” lamp lever for that station
  - DS presses code button
  - lamp on “phone booth” lights & locks
  - Crew picks up phone (having seen lighted phone booth on arrival at station)
  - Crew announces “Hearst”
  - DS acknowledges, gives instructions
  - DS clears Employee Call lamp

How should it work (CTC)? - 2

- Train Crew calls from Siding:
  - Conductor goes off hook at phone and announces (“Hearst”)
  - DS hears speaker or DS phone buzzes
  - Or DS goes off hook – buzzer stops (speaker muted, if present)
  - DS answers
  - Conversation
  - Everyone goes back on hook

How should it work? (TT&TO) - 1

- OS from Station:
  - Station Operator (Conductor) goes off hook and announces station “Atlanta”
  - DS hears through speaker or headset
  - DS answers “go ahead”
  - OS transmitted: “X1234 West by at 245 PM”
  - Everyone goes back on hook

How Should it Work (TT&TO) -2

- DS Calls an unmanned station:
  - DS presses button corresponding to station(s)
  - Since the DS would not call an unmanned station this a "model railroad thought" but if you have train order boards, the DS would drop the board and wait for the crew to come along and morph into the Operator.
  - If not, Station buzzes, (optionally) lamp on "phone booth" lights & locks
  - Station answers (when crew sees lighted phone booth) – light extinguishes
  - TO read & copied ("EXTRA 1234 WEST MEET NO 3, ENG 9876 AT DORA INSTEAD OF GRETA")
  - Everyone goes back on hook

How should it work? (TT&TO) - 3

DS calls Operator (manned station)

- Operator is listening on speaker or headset
- DS Calls “CLARA”
- Station responds “CLARA”
- DS responds with “19 West Copy 2”
- Op answers “SD” and “Ready to copy”
- TO read and read back (“EXTRA 1234 WEST MEET NO 3, ENG 9876 AT DORA INSTEAD OF GRETA”)
- Everyone goes on hook

How should it work? - 4

DS calls Yard Master (manned station)

- Station buzzes and optionally latches with lamp*
- Operator answers with station name
- DS responds with whatever he needs (Status of train in yard, “Soup”, etc)
- Information exchanged
- Everyone goes on hook

How to Model - Planning

- Determine where the DS will work. Is it a separate room?
- Determine where the phones will be. Do you have room for a phone at each end of each controlled siding?
- Find a clean, well lighted place for the common equipment. Be sure there is room to work, you'll be spending some time here!

How to Model it - Station

- There are many ways to do stations
- Here's what Tommy Holt did: (note the Call Lamp on the phone)
- I recommend stations have PTT and/or noise canceling mics
- Enforce communications discipline!

Possible Station Solutions

Custom w/ PTT	Most flexible	$75
Vintage	swap meets, web vendors	$50-250
554/2554 Wall Set	Wherever you can find, garage sales	< $50
Big Box Cheapie on modular plate	Buy a few spares, anachronistic. Some control circuits won't work	$ 15

Stations

211 w/ F handset

554/2554 without
Case and dial
Installed thru fascia

2554

Custom

554

“Space Saver”

- W.E 211 type “space saver”
- Doesn’t take much space in aisle
- Needs external speech network and ringer/buzzer*
- Appropriate for 20’s thru 80’s
- Originally had E or F type handset – consider replacing with G type handset (correct for 50s and 80s)
- Phoneco >= $125
- MRCS sells parts to build one for $125

302/354 Set


Original


Repro

- 302 type desk set
- Has internal speech network
- Appropriate for 30s through early 50s
- Equipped with F type handset
- 354 wall set available (after 1947), Walmart sells/sold Repros by Colby
- Phoneco >= $200

500/554 Set

- 500 type desk set
- Designed by Henry Dreyfus of NYC Hudson fame
- Improved internal speech network
- Appropriate for 50s through early 80s
- Equipped with G type handset
- Has useful extra hook switch contacts
- Phoneco >= $99, but often available ~$25 at garage sales and swap meets -- beware of late model phones with electronic guts
- MRCS has used ones for $40 and up but they come and go

Roll your own

- Electrically a 500 set
  - G type handset
  - 425 type network
  - Cradle and hook switch
- Can be panel or Fascia mounted
- MRCS sells parts – new ones can be assembled for $75 and up, we have used parts from time to time

Yosemite Valley RR - Jack Burgess

How to Model it – Dispatcher/Operator

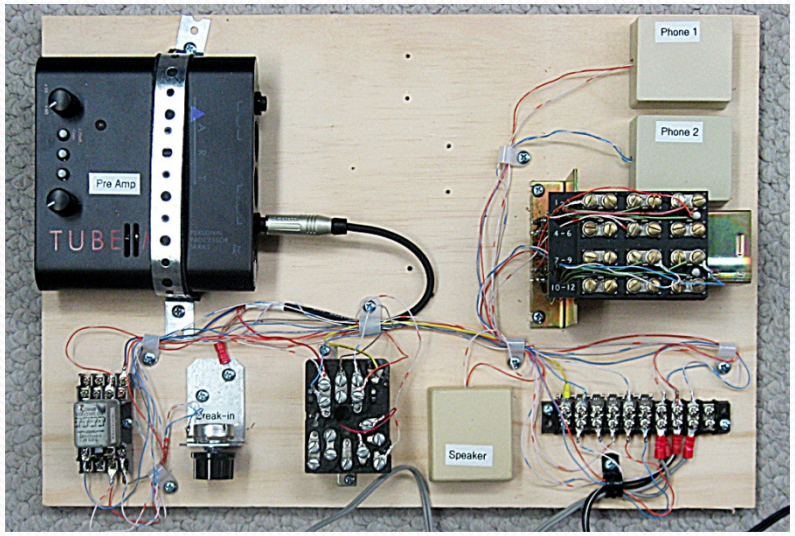
- If there is a separate, sound-isolated room for the CTC machine, I recommend using the microphone /speaker/footswitch arrangement. You may want to match photos of your prototype's dispatcher's office at that date.
- If not, it's probably best to use a noise cancelling headset, with a footswitch. These are available from many vendors and can work with virtually any phone. Your regular dispatchers may use one a modern headset at work.
- MRCS is introducing a single board for a dispatcher's set that supports either a dynamic mic/speaker/stomper or a computer headset
- In any case the DS should be able to work with both hands free.

Possible Dispatcher Solutions

Scissor Mount Candlestick with Headset (listen on headset)	Antique telephone suppliers	$250-$500 depending on condition
“PA” type microphone with speaker	Commercial sources, see example later and demo	$50-250
Modern Phone with headset (listen on headset)	HelloDirect, etc	< $250
Modern Phone with buzzer, relay control	Whatever you can find, garage sales	$ 50

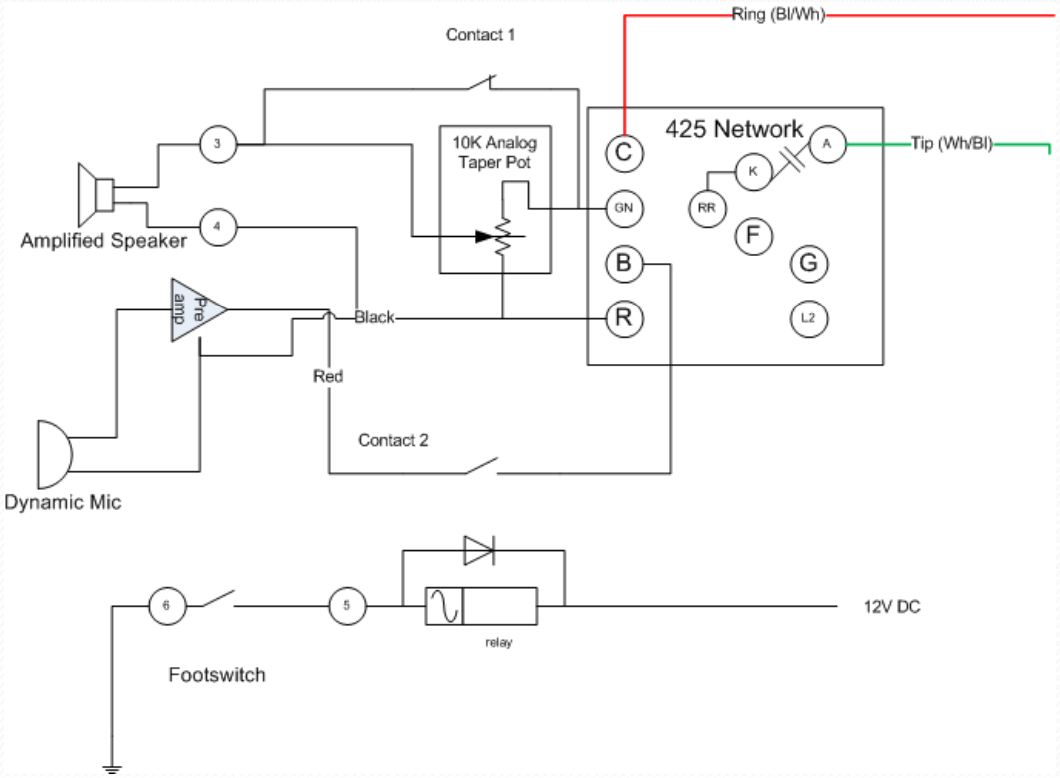
Dispatcher Phones

Mic/Speaker Arrangement



Vintage Candlestick and Scissor mount phones can be upgraded with dynamic mics and made to work with this arrangement. This gives improved performance while still keeping the vintage look.

Dispatcher Set Schematic



Dispatcher Bill of Materials

Quantity	Description	Price	Vendor
1	Microphone	$20	Radio Shack
1	Preamp – ART Tube MP	$50	Sweetwater
1	Mic Stand	$15	RS/Sweetwater
1	Speech Network	$15	Old Phone, PhoneCo, me
1	Amplified Speaker	$25 and up	RS, Best Buy
1	Relay and socket	$ 10	Jameco, RS
1	10K Audio Taper Pot	$3.50	RS, Jameco
1	12V Regulated Wall Wart	$15	RS, Jameco
1	Footswitch	$20	W.W. Grainger
	Total incl hardware	$200	

New Dispatcher Board

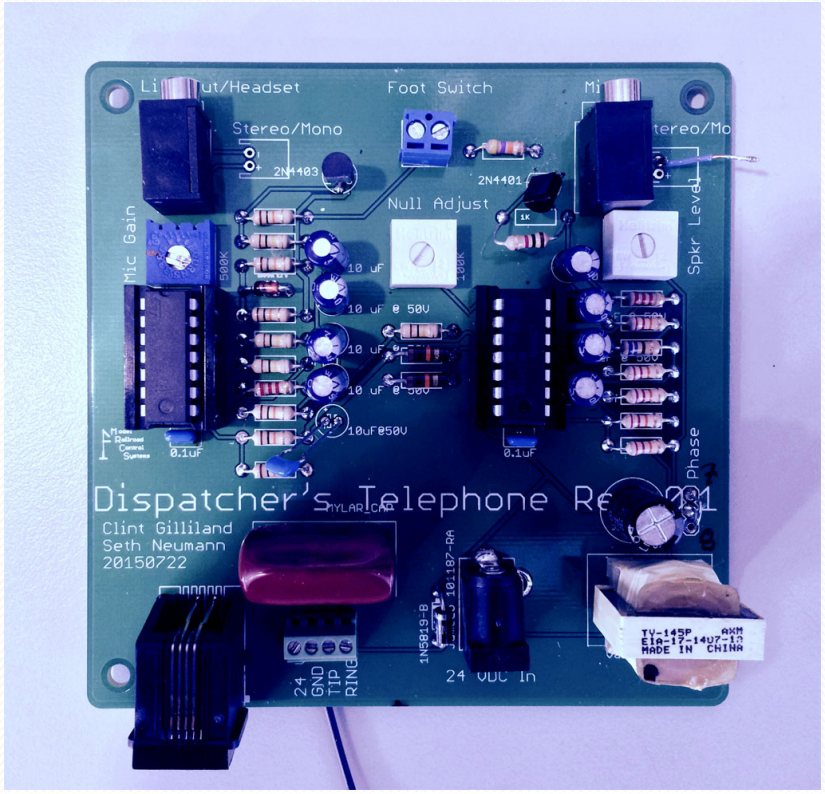


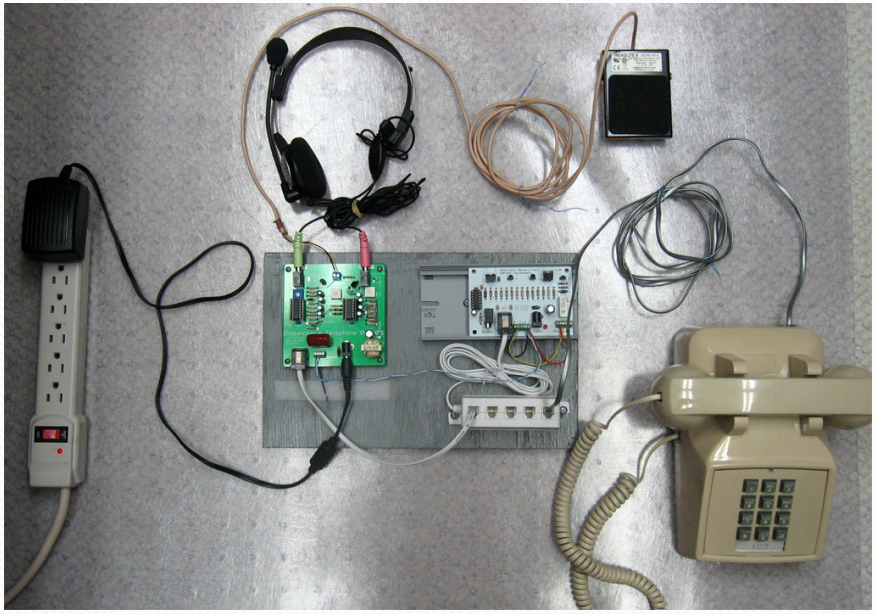
Photo of Engineering Prototype

- Separate adjustments for outbound mic volume, speaker volume and for the amount "break-in" traffic is muted when the DS is talking.
- Operates from filtered 24V, includes a 2.5mm barrel jack for a (user supplied) 24V wall wart or can tap power from any handy filtered 24 VDC source
- Does not load the line, so the "off hook" contacts from an associated EBF31A or 31A KTU will indicate when stations are off hook
- Mic in and line level out to speaker/headset output on 3.5mm jacks screw terminal connection for (user supplied) footswitch
- RJ11 Modular and screw connections for telephone line
- Compatible with 24V and 48V phone systems
- Output phase switch to optimize speaker levels, especially when adjusting "break-in" level
- Multiple boards may be used on one system
- Transmission direction is controlled by the footswitch: "Stomp to Talk" operation

MRCS Dispatcher/Operator Board

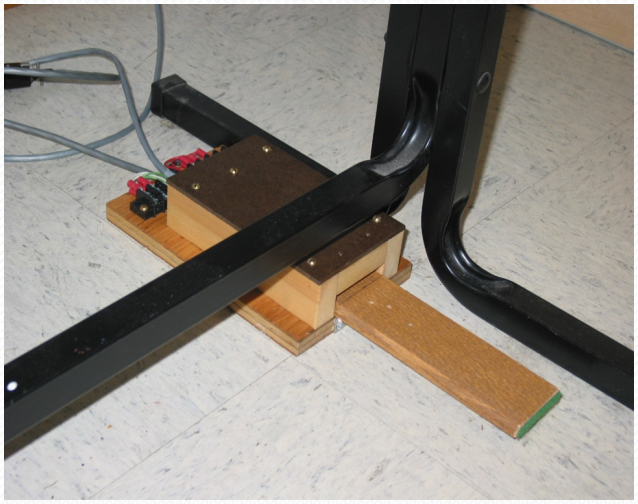
Replacement of Commercial pre-Amp and discrete parts with a single board – saves on cables, power supplies, interconnects. Note dynamic mic, powered computer speakers

Same board, different application: Here we use a computer headset (good ones start at $9.95) and a footswitch. Noise cancellation is pretty common on these headsets. This is great for an operator in an aisle!



Dispatcher Foot Switch

- Use a period phone style switch
- Use the switch from your resistance soldering rig with an AC relay
- Use an inexpensive commercial footswitch (MRCS)
- Make one



Powered Speakers

WECo 100F

WECo 106B

- Vintage Telco style 100F, 106, or 107 speakers, or use powered computer speakers (be sure to use a blocking capacitor) or a small amplifier and any speaker you have handy.
- MRCS boards provide a buffered output.

Common Equipment

- Power Supply – 24VDC regulated, a (250mA regulated) wall wart will work
- A “Battery Feed” source. These are balanced chokes found in classic telephone circuits or electronic equivalent
- Amplifiers for DS (microphone/speaker) or a pair of relays and a buzzer.
- Connecting blocks, wire etc.

What is “Battery Feed?”

- Power
- DC v. AC
- What is “impedance?” (Z)
  - Think of it as AC resistance
  - A component (usually a choke coil) can have low DC R but high AC Z!
  - These have become scarce over the years, perhaps as a result of this clinic. MRCS offers an electronic equivalent

Battery feed alternatives

- Battery feed relay (24 or 48V)
- Audio Freq chokes
- Retard coil (2A, 31A, 401A KTUs,)
- Telco style Intercom
- Electronic Battery Feed Board
- PBX is not recommended

The goal is to have a relatively low DC Resistance (to power the phone) while keeping the impedance (AC resistance) at voice frequency as high as possible so we don't lose speech energy through the power supply (so we can hear).

Basic Phone System

Quan	Price	Description	Source	Ext'd	Note
6	$ 25	554 or 2554 Wall Set	Yard Sale	$ 150	*
1	$ 105	Electronic Battery Feed	MRCS	$ 50	
1	$ 30	66 Block and Bracket	Big Box	$ 30	**
1	$ 200	Dispatcher set as above	Various	$ 200	
1	$ 100	Misc Hardware & Wire	Big Box	$ 100	***
		Total		$ 530	

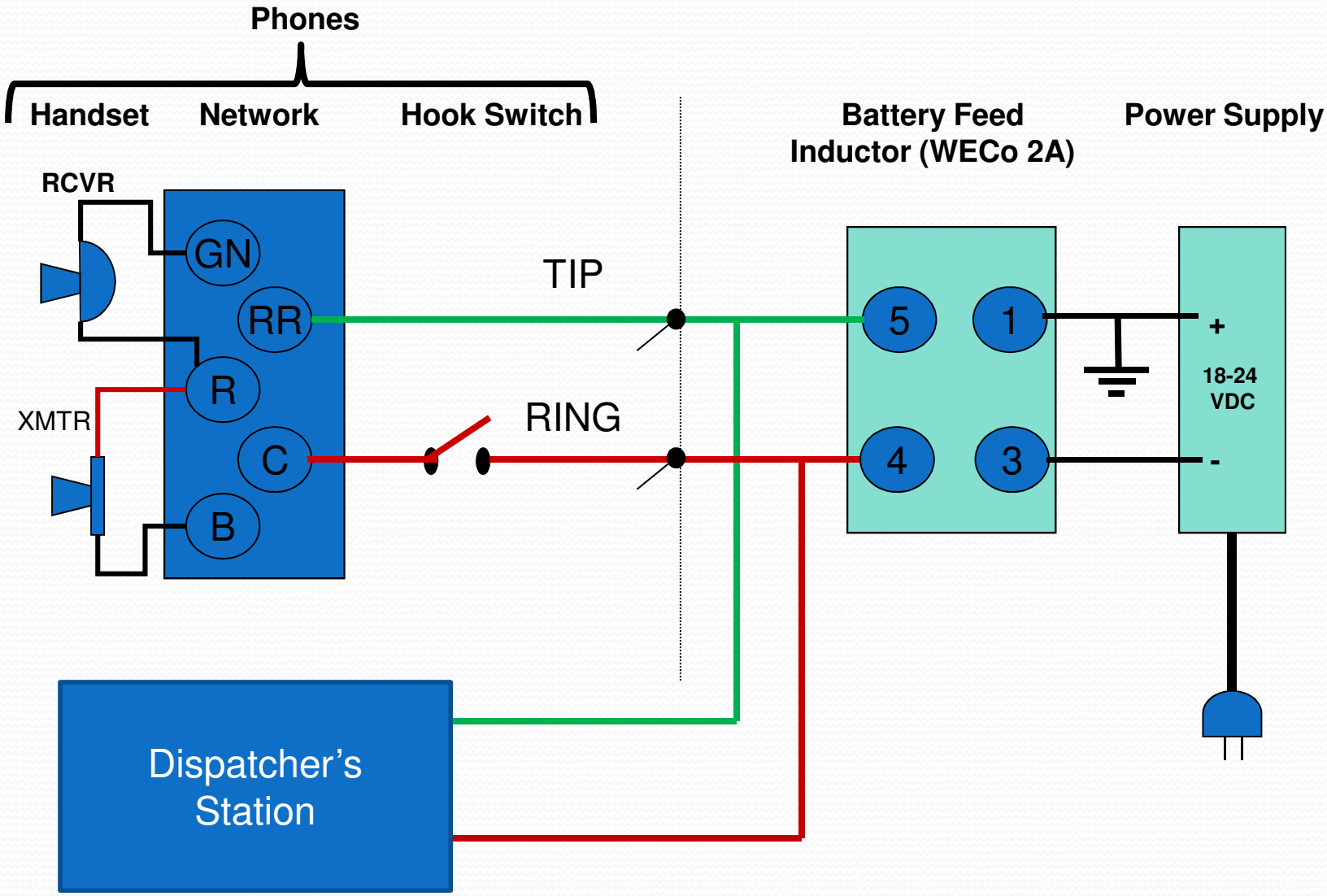
Notes:

* Should be available locally or eBay, or use inexpensive wired sets from Walmart etc. If you can't find them, contact me

** This is the phone style connecting block. The electrons won't mind if you use barrier strips – see my demo

*** I recommend phone style D rings for wire routing, but big cable clamps will work fine

Simple Phone System



Noise/Adequate Volume

- Use high impedance battery feed if possible
- Busy indicator to warn of conversation in progress (user discipline)
- Push-to-talk (PTT) and/or noise canceling handsets
- DO NOT use amplified handsets: they amplify the noise in the room, too!

Other

- Use Cat 5 ($0.10- 0.15/ft), has 4 pair, or CAT 3 (if you can find it) for station wiring
- In any case, use twisted pair, helps reject noise (leakage from DCC)
- Use terminal strips or telephone style 66 blocks for connections

Resources

- Antique phone collectors site
  - atcaonline.com/diagrams.html
  - Telephone Collectors International http://www.telephonecollectors.org/
- Model Railroad Control Systems http://www.modelrailroadcontrolsystems.com/
- Phoneco http://www.phonecoinc.com
- Graybar (Portland) (503) 249-1300 www.graybar.com
- Telephone Components http://www.telephonecomponents.com
- Hello Direct http://www.hellodirect.com/
- Jameco (www.jameco.com)

Print Resources

- My 3 Part Article in the OPSIG *Dispatchers' Office* *April through October 2011.* http://www.opsig.org

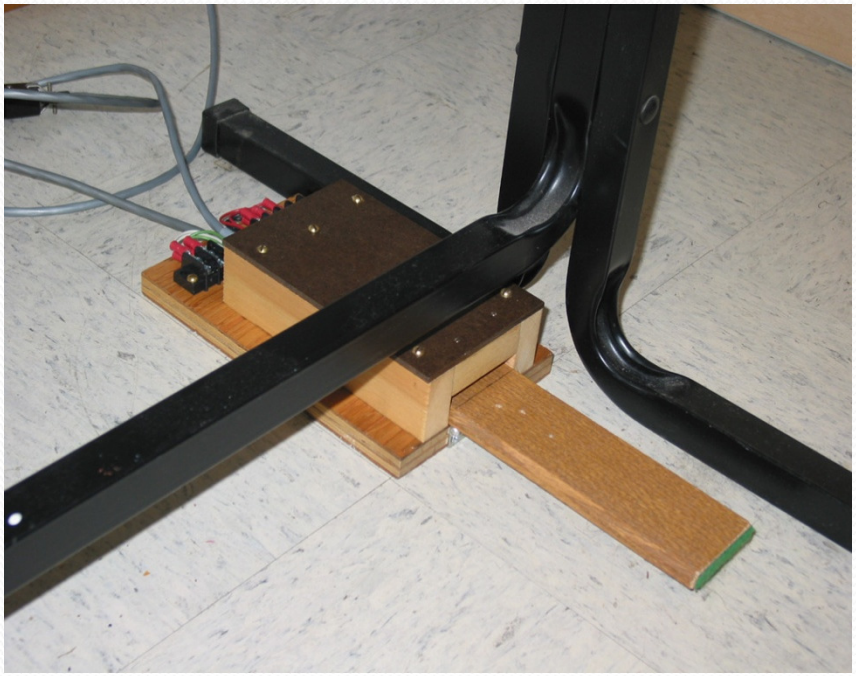
Back up and old

Special Thanks to:

- Mike Burgett
- Bruce Chubb
- Pat Flynn
- Tommy Holt
- Steph Kerman
- Napa Club
- Kermit Paul
- Ludwell Sibley

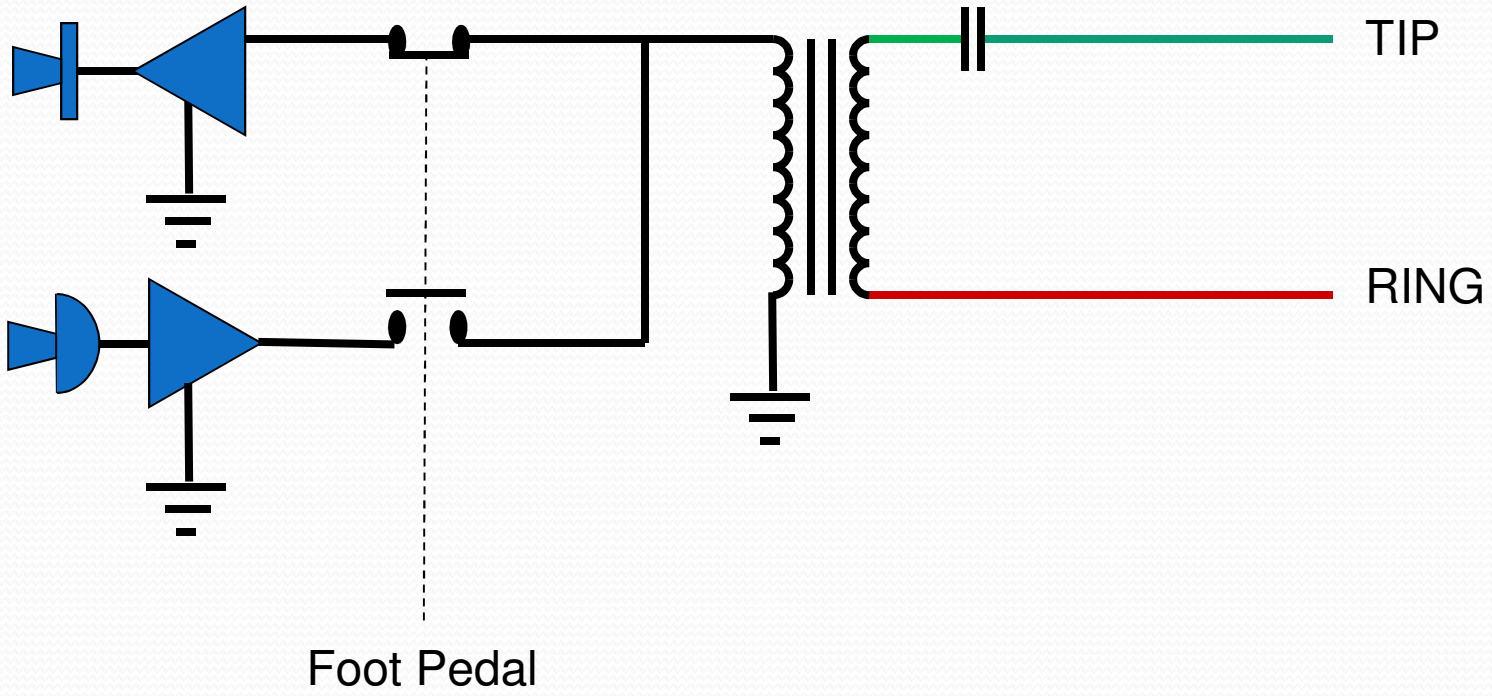
Foot Switch Options

WECo Type 2A/ MRCS



Dave Adams made this

Dispatcher Arrangement



Large System Issues

- Have more stations (5 – 20)
- More phones off hook as crews tend to call in every time they see a red signal
- More phones means more ambient noise and less volume – combining loss
- Traditional phones don't work well with > 4 off hook – Communications Discipline!
- Systems with active combiners and amplification work better with large numbers of phones off hook
- Contact me if you are interested

Simple Phone System