A Primer for
Narrow Gauge and Short-line Operations

Barry J. Cott

Acknowledgements

I would like to acknowledge the contributions of many people to the development of this primer:

- Joe Fugate's writing on train handling was a prime motivator to get started on the primer;
- Bruce Chubb's "How to Operate Your Model Railroad" initiated my interest in realistic operations some twenty years ago, and is still as valuable today as it was then;
- Dave Husman and Chris Galka both assisted with discussions around manual dispatching methods;
- Tony Koester's articles on car forwarding systems have shown me the importance of this component of realistic operations;
- Dave Clune's and Dave Adams' work on operations for narrow gauge railroads have also been a great inspiration;
- Eric Hansmann reminded me about the importance of typical narrow gauge and shortline passenger operations;
- Simon Leigh pointed out that the conductor could also be the main contact with the dispatcher;
- Linda Sand wrote with some additional car blocking rules.

Contact

If you have comments or suggestions for the primer, you can contact me via my website at http://www.stationstudios.ca/pmtco. My current e-mail address will be available there.

Introduction

I'm keenly interested in recreating prototypical operations on my Pakesley Mill & Timber Company. As such, I have been developing a comprehensive primer introducing operations appropriate for a 1920's era short line railroad like the Key Valley Railway, on which I have based the PM&TCo. There has been much written recently about realistic operations. However, very little of this information has been compiled into a single document for model railroads of this era. Please see my website at www.stationstudios.ca/pmtco for more details on both the Key Valley Railway and the PM&TCo.

From my research, the following operational characteristics would apply to the prototype Key Valley:

- All freight trains would be run as extras.
- Some level of passenger service would be appropriate (one or two return runs per day), with train times typically coordinated with the arrival of a CPR passenger train at Pakesley and with the steamship at Lost Channel.
- Only a small number of trains would be active at any one moment (typically the maximum would be two to three).
- Communications with the dispatcher would be via a telephone system strung alongside the mainline.
- Dispatching would be done via verbal/written train orders using manual block stations.
- Train crews would line their own turnouts.
- Train crews would makeup their own consists.

These same characteristics would apply to many narrow gauge and short line railroads from the late 1800's to the 1940's.

My goal is to use these characteristics as guideline to develop an operations scheme for the PM&TCo that is close to the prototype in feel but still enjoyable to operate. I must stress that the choices I have made are not the only way of doing things, and others may prefer a different car forwarding or dispatching scheme. However, I am trying to strike a number of balances, the most important being the balance in work across the various operating positions.

The operating schemes I've developed place specific requirements on layout design. They are:

- The layout design should permit an operator to follow his or her train around the layout in a straightforward manner. This encourages a linear design methodology.
- The use of walkaround throttles is almost mandatory.
- The use of Digital Command Control (DCC) is encouraged to eliminate the need for throwing unprototypical block switches.
- Turnout controls are located on the layout fascia right in front of the desired turnout.
- A telephone system to communicate between the dispatcher and the train crew is preferred.

None of these assumptions are very restrictive to today's layout designers and most members of the Layout Design Special Interest Group (LDSIG) would say they are all necessary on a state-of-the-art layout design.

My basic plan is to have two-person train crews plus a combined dispatcher/freight agent role. The dispatcher will be responsible for determining what trains will be run and what switching activities each train will perform. This will hopefully keep the dispatcher busy, since the number of meets and passes on such a small railroad will be few.

I've broken the primer down into several sections for readability; however, most sections are highly interrelated and it would do the interested reader well to look at all sections at least once.

- Roles (the operating roles on the PM&TCo)
- Systems (the physical systems that are in place to support operations)
- Operation Cycle (the steps in performing one shift of operations)
- The Dispatcher (the activities of the dispatcher)
- The Train Crew (the activities of the train crew)

A Word of Caution

It should be noted that, as of late 2003, the primer is still in development and subject to change. The weakest section is probably around the dispatcher and his control of train movements.

Roles on the PM&TCo

Given the relative small size of PM&TCo, I will keep the operating crew at one to five people in total.

My current plans are to have the following roles during an operating session:

- One dispatcher/traffic manager
- One or two train crews of one or two people

This would allow me to keep up to 5 people busy which is probably as many as the layout could comfortably hold.

The Dispatcher Role

There is a lot of evidence from prototype logging and short-line railroads that the dispatcher must have tracked what cars needed to be moved and where empties were needed and then would schedule train movements to make it all happen. Input to the dispatcher would have come from clerks at the various locations on the railroad (e.g. sawmill, logging camps).

I'd like to recreate this style of operation for my layout, so that the dispatcher role would have some meat to it. Since the PM&TCo would typically have only two or three trains operating at an one time, a straight dispatcher role would be relatively boring.

My plan is to produce, at the beginning of an operating session, a list of all the car movements that need to be completed during the operating session. The dispatcher would then be responsible for scheduling enough trains and developing their switch lists to make it happen. I'll use clearance cards, Form 19's, etc. to ensure the train crew knows exactly what to do. One advantage of this approach is that I can scale the car movements for the number of operators available for the session. I plan on generating the car movements list (i.e. recreating the clerk's role) with a combination of car cards and a computer-based system.

So not only is the dispatcher arranging meets and tracking the progress of the trains, he is essentially generating a new timetable every session. Throw in a couple of passenger runs that need to make a connection with the standard gauge railway at Pakesley, and I think the dispatcher role on the PM&TCo would be a pretty interesting one.

Detailed information about the dispatcher role is available below.

The Train Crew Role

The train crew roles will be typical of most model railroad operations. I would like to use two-person train crews (an engineer and a conductor) whenever possible.

Detailed information about the train crew is available below.

Systems Used to Operate the PM&TCo

All train movements should be a result of the need to move traffic along the railway so a car forwarding system should be an integral part of any operations plan.

I've looked into many different ways of generating traffic and have decided to use a combination of car cards, switch lists and computer systems. It sounds complicated but in fact most people used to typical model railroad operations will have no problem with the system.

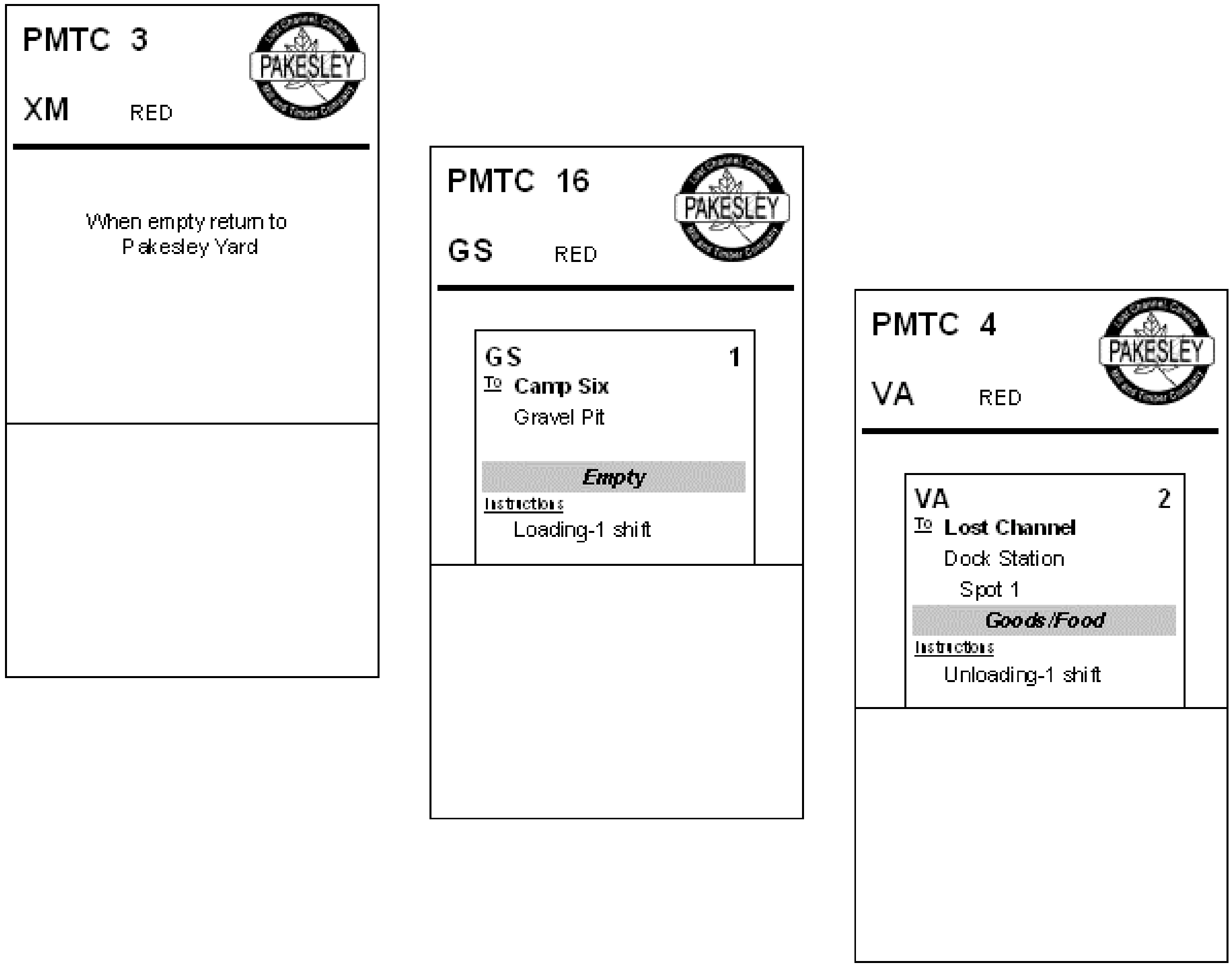
I've come to the realization as some others have as well that car cards are very good in establishing what overall car movements need to be made within an operating session. However, they are not so good in determining what activities individual train crews need to do. Therefore, I will be using handwritten switch lists developed by the dispatcher to instruct each train crew as to their activities. I believe that this will yield the best of both worlds between car cards and switch lists. Train crews will only be responsible for picking up or setting out car cards when they are switched in and out of their train.

More details on each of the components is given below.

Car Cards

A car card/waybill system will be used to keep track of where the car is in terms of its movement, loading and unloading. I am using Dave Husman's excellent freeware Car Card program (written in Access 97) for creating and maintaining the car card/waybill system. There is a Yahoo group called “CarCards” that has the latest versions of Dave’s program. (http://groups.yahoo.com/group/CarCards/)

What's nice about Dave's system is that it is customizable if you are familiar with Access. This allows some freedom in designing the layout of the car cards and waybills. For example, since all the cars on the PM&TCo are captive, there is no need for the "routing via" sections of Dave's waybills. I simply removed these fields for the waybill reports. I also added the PM&TCo to the upper right corner of car and engine cards.



Although Dave's program can do both 2 and 4 cycle waybills, I decided on using only 2-cycle waybills: one stop calling for the delivery of an empty car and the second stop for the movement of the load to its final location. Once the car reaches its second destination and has waited the appropriate number of session for unloading, the waybill is removed and the empty car card is used to establish its direction home. The reason for this will become obvious below.

Creating Demand for Cars

One area of the car card/waybill system that I'm not happy with is its predictability in car demands from the use of waybills. On a large layout, this is not much a problem; on a small layout like the PM&TCo, this predictability may be very noticeable.

Therefore, I have decided to build a system that more randomly generates demands for cars. I've extended the CarCard database by adding an extra field to the tblWaybill table that represents the probability that this waybill will be called for in this shift. I have taken this down to the Track level in Dave's database. Here's an example: the PM&TCo has a sawmill complex served by four tracks on which a single car may be spotted. Typically track #1 would require an empty flatcar be delivered; let's say this happens 3 out of 4 days and uses waybill #1. In addition, track #1 also requires an empty gondola 1 day in 5 to clean out sawdust on waybill #2. I can build up a lookup table in Excel and then by using a random number generator create that day's demand at that spot. Note that these demands do not have to add up to 100%; it can be possible that no car will be delivered.

Sawmill Track #1	
Empty Flatcar (Waybill #1)	0.75
Empty Gondola (Waybill #2)	0.20
No Call for a Car	0.05
Total	**1.00**

I have added a function that exports this tblWaybill table out of the CarCards database and into Excel spreadsheet form. In the spreadsheet, I have created a macro that takes the tblWaybill table and divides it up into the various spots. Then for each spot, a random number between 0 and 1 is generated and applied against the table above. If the random number is 0.5, then an empty flatcar is required at this spot using waybill #1. If the random number is 0.99, there is no demand for cars at that spot for that session.

The advantage of such a system is of course that you can have many more waybills designed for different and unique moves available and yet their frequency of being used will be very low and controllable.

The full spreadsheet has one of these lookup tables for each industry spot. Putting in different random numbers in each lookup table makes sure that things are truly random.

I've created a consolidated report called the "Car Order List" that lists all possible spots and which car/waybill combination is required to be delivered during the next session.

MANUFACTURER OF LUMBER PRODUCTS

HARDWOODS & SOFTWOODS

THE PAKESLEY MILL & TIMBER COMPANY

Car Order List - April 22, 1922

Deliver Empty Cars to:	For Following Loads:
GS Camp Six Gravel Pit	Gravel \ Ballast 52

The dispatcher gets a "Car Order List" at the start of every session. I could generate a new report just before each operating session, but may just create 31 and number them 1 to 31. I'll then just use the current day of the month to select the appropriate delivery list. Or I'll just run off a hundred of them and work through them sequentially. Seasonal operations could be included by developing different versions of the spreadsheet for different traffic patterns. There are a lot of opportunities available in this system. It would also work well with the mole concept of staging now becoming more popular.

Car Card Boxes

Each major location on the layout will have a car card box. Car card boxes are set up as follows: one slot for setouts, one slot for hold two sessions, one slot for hold one session, and one slot for pickups.

Unlike many other model railroads, the car card boxes are mostly for the use of the dispatcher/traffic manager and not the train crew. The train crew uses the handwritten switch list to guide its work. The train crew's involvement with car cards is only to drop the car card into the setout slot when the car is set out and to pick up the car card from the pickup slot when the car is picked up.

Switch Lists

Because the traffic patterns may vary a lot on the PM&TCo, the dispatcher may have to get creative with the number and activities of the trains that need to be run to get all the necessary car movements to be completed within the shift. Therefore, I felt that a handwritten switch list would be the best way for the dispatcher to direct the activities of each train crew.

I've created a two-sided switch list in Word that has a setout side and a pickup side. The dispatcher who knows all the car movements required within the shift will draw up the switch list for each train. The train crew will then receive a package including the switch list and the car cards for the cars currently in the train as it leaves staging.

The Pakesley Mill & Timber Co.

The Pakesley Mill & Timber Co.

Date: April 22, 1922
Engine: 6
Conductor: Griffin

Set-Out List

	Car No.	Destination	Track/Spot
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3	3	Pakesley	Yard
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
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17			
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27			
28			
29			
30			

Pick-Up List

	Car No.	Destination	Track/Spot
Pakesley (PK)			
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3			
4			
5			
6			
7			
8			
9			
10			
Camp Six (CS)			
1			
2			
3			
4			
5			
Cole Lake (CL)			
1			
2			
3			
4			
5			
Lost Channel (LC)			
1	3	Pakesley	Yard
2			
3			
4			
5			
6			
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9			
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The Operating Session

One full pass through the operating cycle will be called a 'shift' on the PM&TCo. Typically two shifts would make up an operating session, although more shifts may be added to extend the session. Breaks will be held between each shift to allow the train crews and the dispatcher to "go to beans".

The Shift Operating Cycle

The steps over a shift are as follows:

1. At the beginning of every shift, the dispatcher goes to all locations on the layout and then advances all car cards as per the waybill rules.
2. At each location, the dispatcher lists all cars ready for movement (i.e. all cars that are now in the pickup slot) on the shift car movement list.
3. The dispatcher receives the car order list for the shift and assigns specific empty cars to the waybills called for on the car order list. These cars are then added to the shift car movement list. At this point, this list should have all of the required car movements for the shift on it.
4. The dispatcher then starts to allocate cars to trains and trains to crews.   Typically, there will be one or more "standing" orders for trains per shift. For example, demand for flatcars at the Lost Channel sawmill will be large enough to require a train per shift to service its needs alone. The dispatcher can add or delete trains as necessary to meet the demands.
5. The dispatcher issues a clearance form and a form 31 for each train.
6. The dispatcher also writes up a switch list for each train indicating the car movements to be carried out by the train crew. The car cards for the cars in the train at the start of the run will also be included in this package
7. The train gets staged. Either the dispatcher or the train crew will work the staging system to build the train.
8. The dispatcher turns over the clearance form, form 31, switch list and car cards to the train crew. The train crew signs the form 31.
9. The train crew takes the train onto the layout proper and performs their switching activities as per the switch list. The dispatcher must be called for permission when entering or leaving the mainline. When a car is set out, the appropriate car card is placed in the set-out slot; when a car is picked up, the appropriate car card is picked up by the conductor.
10. The shift ends when all scheduled trains have been run.

The Dispatcher Role

This section outlines the activities of the dispatcher.

The Reality

The dispatcher on a small railway like the Key Valley Railway must likely managed both the car traffic and the timing of trains.

Approximating Reality

On the PM&TCo, the dispatcher will perform two major activities:

1. Traffic Management
2. Dispatching of Trains

Communications between Crew and Dispatcher

Telephone systems were fairly standard in the 1920's as the means of communication between the dispatcher and the train crew. In most cases, these telephones were located trackside in phone boxes placed at appropriate places like passing siding entrances. Engineers should stop their engines alongside the trackside phones for initiating discussions with the dispatcher. A fully operating telephone system, while expensive, would heighten the realism.

Typical Tasks

There are several tasks that the dispatcher will be performing on a regular basis, and in a particular order. All dispatchers must be familiar with all of them.

Task	Details
Turning Waybills	Gives the rules as to how waybills on car cards are turning to generate most of the required car movements for the shift.
Car Order List	How to take the car order list, assign cars to waybills, and complete the "Shift Car Movement Report".
Scheduling	How to assign cars to trains and trains to crews from the information on the "Shift Car Movement Report".
Giving Clearance	Before a train can proceed from the yard to the mainline, the dispatcher must give clearance to the train crew.

Next Task: Turning Waybills

Waybill Turning Rules

The dispatcher will use the following rules to update the waybill status at the beginning of the shift. These actions are performed at all car cards boxes across the PM&TCo.

1. Move all cars in the hold slots down one shift, with those cards now at zero going into the pickup slot.
2. Take all car cards in the setout slot and flip the waybill. Then drop each card into the appropriate hold slot. For example, a waybill with the comment "Loading Time = 1 shift" would go directly in the pickup slot. A waybill marked "Loading Time = 2 shifts" would go into the Hold One Shift slot.
3. Any car that is now in the pickup slot and is at its final waybill destination (cycle 2) has its waybill removed.
4. The details of all cars now in the pickup slot are recorded by the dispatcher on the "Shift Car Movement Report"

Using the examples in the car card graphic, assuming the car card for car #3 is in the pick-up slot at Lost Channel, and the car card for car #4 is in the pick-up slot at Pakesley, the Shift Car Movement report would look like the following after this step:

MANUFACTURER OF LUMBER PRODUCTS

HARDWOODS & SOFTWOODS

THE PAKESLEY MILL & TIMBER COMPANY

Shift Car Movement List: April 22 1922

Deliver Cars to:

No.	Type	Location	Industry	Destination	Industry	Track/Spot
3	XM	Lost Channel	Dock 1	Pakesley	Yard	
4	VA	Pakesley	Warehouse 2	Lost Channel	Dock	1

Next Step: the Car Order List

Car Order List

The car order list holds all of the new demands for traffic for the shift. It is generated offline by an Excel spreadsheet, but represents the calls from various locations around the PM&TCo for car movements. An example car order list follows:

MANUFACTURER OF
LUMBER PRODUCTS

HARDWOODS &
SOFTWOODS

PAKESLEY

THE PAKESLEY MILL & TIMBER COMPANY

Car Order List - April 22, 1922

Deliver Empty Cars to:	For Following Loads:
GS Camp Six Gravel Pit	Gravel \ Ballast 52

In this case, there is only one new order for April 22, 1922: a gondola is required at Camp Six for a load of ballast.

Assume that general service (GS) gondola # 16 is empty and sitting in Pakesley yard. The dispatcher assigns #16 to this particular movement by inserting waybill #52 in gondola #16's car card. The dispatcher also adds #16 to the Shift Car Movement report, which will now look like:

MANUFACTURER OF
LUMBER PRODUCTS

HARDWOODS &
SOFTWOODS

THE PAKESLEY MILL & TIMBER COMPANY

Shift Car Movement List: April 22 1922

Deliver Cars to:

No.	Type	Location	Industry	Destination	Industry	Track/Spot
3	XM	Lost Channel	Dock 1	Pakesley	Yard	
4	VA	Pakesley	Warehouse 2	Lost Channel	Dock	1
16	GS	Pakesley	Yard	Camp Six	Gravel Pit	

If for some reason no car of appropriate type can be found to fill the order, the car order is added to the next shift's car order list. If the waybill cannot find, then assume that the order is a duplication of the previous order and ignore it.

After all of the orders on the car order list have been filled by assigning them to cars, the shift car movement report should be complete.

Next Step: Scheduling

Scheduling

After the Shift Car Movement report has been prepared, the dispatcher then assigns car movements to trains and trains to crews.

The maximum length of any train of the PM&TCo is six 24' cars. This is the length of the shortest runaround track at Lost Channel. All engines on the PM&TCo roster are capable of pulling this number of cars across the line.

The priority for moving cars is as follows:

1. Passengers
2. Empty flatcars for the Lost Channel sawmill
3. Loaded flatcars for the Pakesley lumberyard
4. Loaded boxcars
5. Loaded log cars
6. Loaded gondolas
7. Loaded tank cars
8. Empties

Typically the demand for flatcars at the sawmill will be high enough to require a train a shift just to serve the sawmill. Additional trains can be run to handle the traffic over and above the lumber traffic.

Example

Let's start with the Shift Car Movement report developed on the last page:

MANUFACTURER OF
LUMBER PRODUCTS

HARDWOODS &
SOFTWOODS

THE PAKESLEY MILL & TIMBER COMPANY

Shift Car Movement List: April 22 1922

Deliver Cars to:

No.	Type	Location	Industry	Destination	Industry	Track/Spot
3	XM	Lost Channel	Dock 1	Pakesley	Yard	
4	VA	Pakesley	Warehouse 2	Lost Channel	Dock	1
16	GS	Pakesley	Yard	Camp Six	Gravel Pit	

To reiterate, there are only three car movements required for this shift:

- Gondola #16 needs to be picked up from the Pakesley yard and delivered to the gravel pit at Camp Six
- Ventilated Boxcar #4 needs to be picked up from the Pakesley warehouse track 2 and delivered to the dock at Lost Channel
- Boxcar #3 needs to be picked up from the dock at Lost Channel and returned to the Pakesley yard

These movements can easily be covered by a single train traveling from Pakesley to Lost Channel and then returning to Pakesley.

The dispatcher writes up the train order first:

FORM 31	THE PAKESLEY MILL & TIMBER COMPANY TRAIN ORDER NO. 1 April 22 19 22	FORM 31

TO C. AND E. Eng 6	AT: Pakesley
X	OPR M

Eng 6 Six run extra Pakesley to
Lost Channel and return

MADE Complete TIME 7:01 AM   Cott

Then the clearance card for the train is written:

THE PAKESLEY MILL & TIMBER COMPANY

CLEARANCE CARD

April 22 19 22

TO C. AND E. Extra 6	AT: Pakesley

ORDERS FOR YOUR TRAIN ARE:

FORM "19":

FORM "31": One

IF NO ORDER FORM 19 OR 31, ENDORSE "NONE" IN SPACE PROVIDED FOR ORDER NUMBERS.
DISPATCHERS MUST RETAIN A COPY OF THIS CLEARANCE.
THIS DOES NOT INTERFERE OR CONUTERMAND ANY ORDER YOU MAY HAVE RECEIVED.
CONDUCTORS MUST SIGN FORM "31" BEFORE ACCEPTING FROM DISPATCHERS.
CONDUCTORS AND ENGINEMEN MUST EACH HAVE A COPY AND SEE THAT THEIR TRAIN IS CORRECTLY DESIGNATED IN THE ABOVE FORM AND THAT THE NUMBERS OF ALL TRAIN ORDERS RECEIVED CORRESPOND WITH NUMBERS INSERTED ABOVE.

TIME 7:01 AM. Cott OPR.

Next, the dispatcher writes out the switch list:

THE PAKESLEY MILL & TIMBER CO.

Date: April 22, 1922

Engine: 6

Conductor: Griffin

Set-Out List

	Car No.	Destination	Track/Spot
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3	3	Pakesley	Yard
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THE PAKESLEY MILL & TIMBER CO.

Pick-Up List

	Car No.	Destination	Track/Spot
		Pakesley (PK)	
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3			
4			
5			
6			
7			
8			
9			
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		Camp Six (CS)	
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2			
3			
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5			
		Cole Lake (CL)	
1			
2			
3			
4			
5			
		Lost Channel (LC)	
1	3	Pakesley	Yard
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And finally the car cards for the cars in the train as it leaves staging are selected. In this case, because only Lost Channel is modeled on the current layout, the train is staged as if it has already made its required pickups and setouts when it arrives at Lost Channel. Therefore, the train as staged would consist of:

- Engine #6
- Ventilated Boxcar #4
- Caboose #01

The car card for #16 is dropped into the Camp Six car card box setout slot, indicating that it has been set out by Extra #6.

Therefore, only the car cards for car #4 and the caboose #01 would be given to the conductor.

We should expect the train to return to staging consisting of:

- Engine #6
- Boxcar #3
- Caboose #01

Next Step: Giving Clearance

Giving Clearance

The Reality

Given its relatively low traffic volume and its short mainline, train orders on the Key Valley were given verbally directly to the train crews via a telephone system. The verbal orders would give trains clearance to run from one point on the railroad to another.

The verbal orders make up the operational plan. Equally important is keeping a close tab of how well the train orders are being executed. On larger railroads, a station agent would be responsible for reporting to the dispatcher the time that every train passed the station. This process is called "on sheet reporting" (OS) and it permitted the dispatcher to keep track of the locations of all the trains in his area of control. From this, he could see if certain trains were falling behind schedule and if meets and passes had to be moved.

For a small railroad like the Key Valley, having manned stations along the mainline was not required given the short mainline and the relatively low traffic volume. Therefore, the train crew would do their own OS'ing. This would require the train crew to stop at the telephone at the various control points along the mainline and make contact with the dispatcher. For most operations, this slowed the overall operations down but gave the dispatcher to change his verbal orders.

Approximating Reality

Again, our model railroads have similar requirements to keep trains from colliding with each other. Therefore, we have reason to approximate the clearance procedures closely.

There are three general rules that all train crews must follow with respect to OS'ing and clearance:

1. Train crews must OS their location and receive clearance before leaving yard limits for the mainline.
2. Train crews must OS their location and receive clearance before leaving the station at the end of their current verbal order.
3. Train crews must OS their location before entering yard limits from the mainline.

We will assume that a telephone system is available for train-dispatcher communications. Typically, the OS and clearance conversations will occur one after another. The engineer starts by stating his train name, location and time:

Engineer: "OS Pakesley. Extra 2 at 10:03 a.m."

The dispatcher repeats the message to ensure it was heard correctly:

Dispatcher: "OS Pakesley. Extra 2 at 10:03 a.m."

The dispatcher then gives the verbal train order:

Dispatcher: "Extra 2 Permission Granted Pakesley to Lost Channel at 10:03 a.m."

The engineer too repeats the message to ensure it was heard correctly:

Engineer: "Extra 2 Permission Granted Pakesley to Lost Channel at 10:03 a.m."

At Lost Channel, Extra 2 will be moving off the mainline and in the Lost Channel yard. Therefore, Engine 2 Extra must OS their arrival at Lost Channel:

Engineer: "OS Lost Channel. Extra 2 at 10:33 a.m."
Dispatcher: "OS Lost Channel. Extra 2 at 10:33 a.m."

To set up a meeting of two trains, the dispatcher would give one train permission to travel up to the meet location and indicate that the siding should be taken for the other train:

Engineer: "OS Pakesley. Extra 2 at 10:03 a.m."
Dispatcher: "OS Pakesley. Extra 2 at 10:03 a.m."
Dispatcher: "Extra 2 Permission Granted Pakesley to Camp Six. Take Siding for Extra 6. At 10:03 a.m."
Engineer: "Extra 2 Permission Granted Pakesley to Camp Six. Take Siding for Extra 6. At 10:03 a.m."

In this situation, the dispatcher is expecting Extra 2 to reach Camp Six before Extra 6. Of course, the progress of Extra 2 is blocked until Extra 6 passes Camp Six, so any delay in Extra 6 will further delay Extra 2. Extra 2 must OS at Camp Six:

Engineer: "OS Camp Six. Extra 2 at 10:25 a.m."
Dispatcher: "OS Camp Six. Extra 2 at 10:25 a.m."

The conversation between the dispatcher and Extra 6 would be:

Engineer: "OS Lost Channel. Extra 6 at 10:45 a.m."
Dispatcher: "OS Lost Channel. Extra 6 at 10:45 a.m."
Dispatcher: "Extra 6 Permission Granted Lost Channel to Pakesley at 10:45 a.m."
Engineer: "Extra 6 Permission Granted Lost Channel to Pakesley at 10:45 a.m."

Since the Extra 2's next destination is Lost Channel, Extra 2's crew must receive clearance to proceed past Camp Six. The appropriate time to request clearance in this situation is after Extra 6 has cleared Cole's Siding:

Engineer: "Extra 2 at Camp Six 11:01 a.m."
Dispatcher: "Extra 2 at Camp Six 11:01 a.m."
Dispatcher: "Extra 2 Permission Granted Camp Six to Lost Channel at 11:01 a.m."
Engineer: "Extra 2 Permission Granted Camp Six to Lost Channel at 11:01 a.m."

The Train Crew

This section outlines the activities of the train crew.

The Reality

The train crew of a 1920's era short-line or narrow gauge probably consisted of at least five people:

1. The Engineer
2. The Fireman
3. The Head-End Brakeman
4. The Conductor
5. The Brakeman

The engineer operated the locomotive. The fireman's responsibility was to ensure that the locomotive was supplied with sufficient fuel at all times. The conductor was in charge of the train and its paperwork. The two brakemen had a multitude of jobs from throwing switches to uncoupling cars to providing manual braking when needed. The flagman was responsible for flagging the end of the train for protection.

Approximating Reality

On a model railroad, keeping people occupied is important. For narrow gauge and short-line operations where engineer positions can be in short supply, two-person crews not only increase the number of roles but also work much better for running trains in a more prototypical manner than having one person do all the jobs.

One person takes role of the **engineer**, which includes the job of the head-end brakeman. The other person takes the **conductor** role, which includes the jobs of brakeman and flagman. The engineer takes the throttle for the engine. The conductor is actually in charge of the train and is responsible for planning switching moves, uncoupling cars, and keeping the train's paperwork in order. Both crew members are involved in throwing turnouts, depending whether the turnout to be thrown is closer to the front or rear of the train.

Depending on the railroad, one of the two positions would be responsible for the communications with the dispatcher. On the Key Valley, it appears that the engineer was responsible, so the primer allocates this role to the engineer.

Positioning a Two-Person Crew

Stationed in the caboose, a real conductor cannot see the track ahead of the train. Therefore, the model conductor should refrain from walking ahead or behind the train, and should keep his eyes on the train from the vintage point of the caboose to ensure all is well.

Similarly, a real engineer can seldom see much of the train behind him, unless on a curve. Therefore, the model engineer should stay in proximity of his engine and should resist the temptation to scan the length of the train for problems. In addition, he should only watch the track just ahead of the engine; walking ahead of the engine to get an early view of the next town is discouraged.

Both the engineer and the conductor are also encouraged to think about their movements on the ground should they be required to leave the train to throw turnouts or to uncouple cars. For example, when approaching a turnout that needs to be thrown, the engineer should stop the train ahead of the turnout. He should then mentally make the image of stepping down from the engine and walking over to the switch stand. He can then throw the turnout and mentally return to the engine. He then pulls the train through the turnout only to stop the train again when the last car has cleared the turnout to allow the conductor to re-align the turnout. The conductor likewise is encouraged to mentally make the image of stepping down from the caboose and walking over to the switch stand. These mental pauses give a much better pace to the operations and make our noticeably short mainlines seem longer than they are.

To summarize, the engineer is encouraged to position himself alongside the engine at all times. The conductor should position him alongside the caboose during transit, and to position himself at his current location when on the ground.

Communications between Engineer and Conductor

The two-way radio was a long way off in the 1920's, so communications between the engineer and the conductor had to rely on more primitive methods. Face-to-face discussions were often required at the beginning of a run so that an overall plan could be agreed upon by both the engineer and the conductor. Once on the way though, hand signals were preferred over face-to-face discussions because no time was lost in walking the train by the conductor.

A set of hand signals appropriate for model railroads was developed by Bruce Chubb and are illustrated below. Crews should be encouraged to use hand signals at all times, unless they are prepared to mentally walk the length of the train for a discussion.

Communications between Crew and Dispatcher

Telephone systems were fairly standard in the 1920's as the means of communication between the dispatcher and the train crew. In most cases, these telephones were located trackside in phone boxes placed at appropriate places like passing siding entrances. Engineers should stop their engines alongside the trackside phones for initiating discussions with the dispatcher. A fully operating telephone system, while expensive, would heighten the realism.

Typical Tasks

There are several tasks that train crews will be performing on a regular basis, and in a particular order. Train crews must be familiar with all of them.

Task	Situation
Crew Call	The paperwork needed to be understood by the train crew when called by the dispatcher to run a train.
Hand Signals	Communication amongst the crew was typically done with hand signals.
Assembling the Train	Guidance on switching within yard limits and car blocking.
Brake Test	Whenever a train is added to or broken up, the train crew must ensure that the train is safe for mainline travel.
Getting Clearance	Before a train can proceed from the yard to the mainline, the train crew must receive clearance from the dispatcher.
Water Stops	The train crew must ensure that water is taken on for the engine on a regular basis.
Tying Up	The activities performed upon the completion of the train's run as specified by the dispatcher.

Next Task: the Crew Call

The Crew Call

The Reality

On the prototype, a crew is assigned to or "called" to run a specific train. The activities of the train and its relationship to other trains operating on the same mainline are set at the time of the crew call.

A small railroad like the Key Valley probably did not have a timetable, so all trains were typically operated as extras. Therefore, there was no set location of meets and passes, nor even any set list of trains other than one or two passenger trains. Therefore, the crew call is vitally important.

The key documents issued by the dispatcher to the train crew are:

1. The Clearance Card
2. The Train Order (Form 31)
3. The Switch List

The clearance card gives the train crew permission to travel. The train order, typically executed on a Form 31, gives specific instructions as to the starting and ending stations in the train's run. The switch list denotes which cars are to be moved by this train and to where.

Approximating Reality

We have similar crew calling requirements when operating our model railroad: each train crew must know where the train is going and what activities must be carried out. Therefore, we will approximate the crew call very closely.

There will four key documents issued by the dispatcher to the train crew on the PM&TCo:

1. The Clearance Card
2. The Train Order
3. The Switch List
4. The Set of Car Cards for the train

Clearance Card

When the dispatcher calls a crew to run a train, he will provide the train crew with a clearance card, permitting the train to travel:

THE PAKESLEY MILL & TIMBER COMPANY

CLEARANCE CARD

April 22 19 22

TO C. AND E. Extra 6	AT: Pakesley

ORDERS FOR YOUR TRAIN ARE:

FORM "19":

FORM "31": One

IF NO ORDER FORM 19 OR 31, ENDORSE "NONE" IN SPACE PROVIDED FOR ORDER NUMBERS.
DISPATCHERS MUST RETAIN A COPY OF THIS CLEARANCE.
THIS DOES NOT INTERFERE OR CONUTERMAND ANY ORDER YOU MAY HAVE RECEIVED.
CONDUCTORS MUST SIGN FORM "31" BEFORE ACCEPTING FROM DISPATCHERS.
CONDUCTORS AND ENGINEMEN MUST EACH HAVE A COPY AND SEE THAT THEIR TRAIN IS CORRECTLY DESIGNATED IN THE ABOVE FORM AND THAT THE NUMBERS OF ALL TRAIN ORDERS RECEIVED CORRESPOND WITH NUMBERS INSERTED ABOVE.

TIME 7:01 AM. Cott OPR.

Note that the clearance card refers to a written train order (a Form 19 or Form 31). The Forms 19 and 31 define the train movement instructions.

Form 31

A Form 31 typically consists of the following:

- The date and time of the train order
- The engine to be used in the train
- The stations at the start and end of the train's run

For example, the following would be an example of a train order for a run from Pakesley to Lost Channel and back. Note the use of the word extra in the order to denote a non-timetabled train.

FORM 31	THE PAKESLEY MILL & TIMBER COMPANY TRAIN ORDER NO. 1 April 22 19 22	FORM 31

TO C. AND E. Eng 6	AT: Pakesley
X	OPR M

Eng 6 Six run extra Pakesley to

Lost Channel and return

MADE Complete TIME 7:01 AM Cott

Both the engineer and the conductor must acknowledge the receipt and reading of the train order.

Switch List

The dispatcher will also give the train crew the switch list for the train, indicating all the cars that must be moved by this train. From the switch list, the conductor must determine what switching activities must be carried out over the course of the train's run. A typical switch list would look like the following:

The Pakesley Mill & Timber Co.

The Pakesley Mill & Timber Co.

Date: April 22, 1922

Engine: 6

Conductor: Griffin

Set-Out List

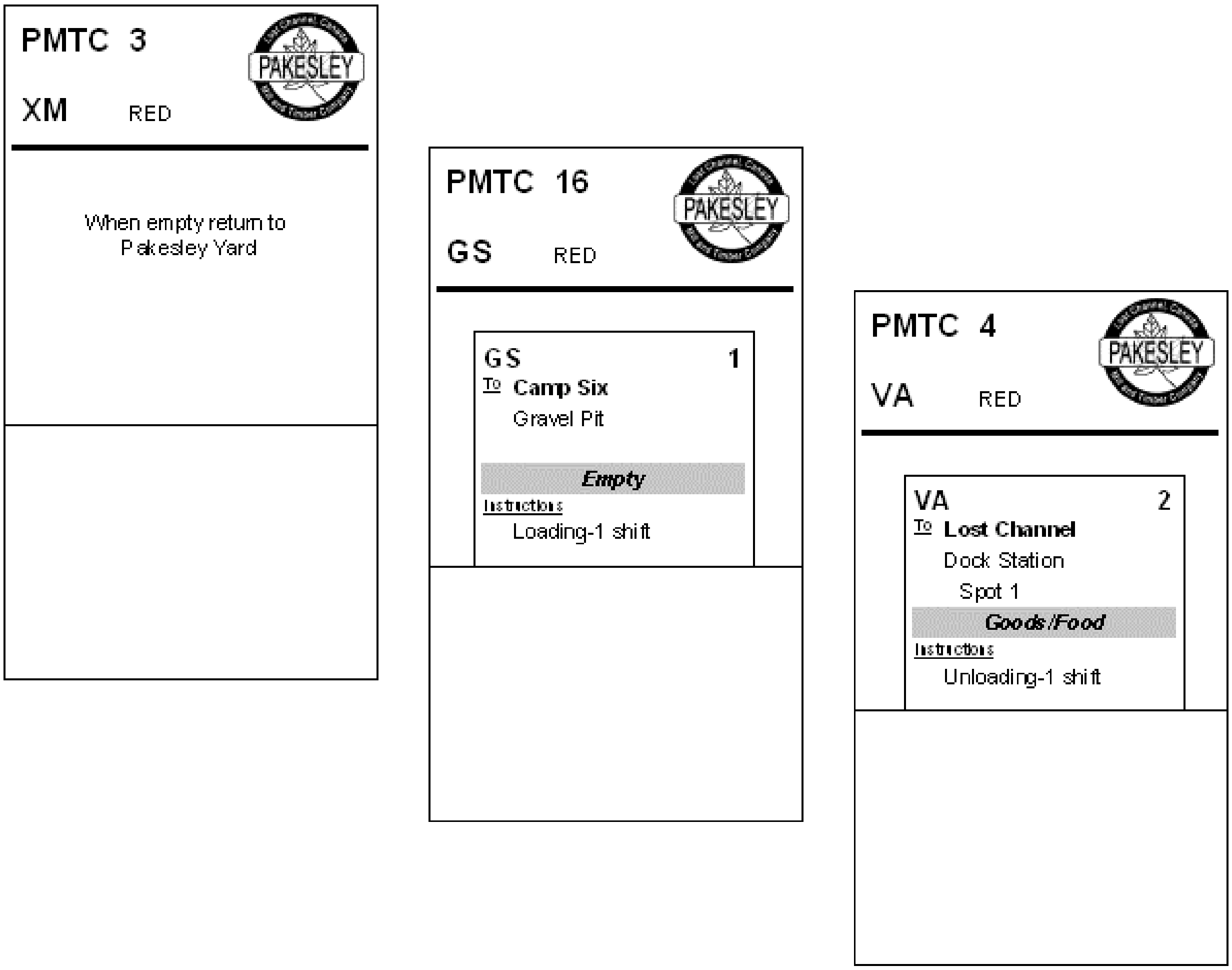
	Car No.	Destination	Track/Spot
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3	3	Pakesley	Yard
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Pick-Up List

	Car No.	Destination	Track/Spot
		Pakesley (PK)	
1	16	Camp Six	Gravel Pit
2	4	Lost Channel	Dock 1
3			
4			
5			
6			
7			
8			
9			
10			
		Camp Six (CS)	
1			
2			
3			
4			
5			
		Cole Lake (CL)	
1			
2			
3			
4			
5			
		Lost Channel (LC)	
1	3	Pakesley	Yard
2			
3			
4			
5			
6			
7			
8			
9			
10			

Car Cards

The last pieces of paperwork required by the conductor are the car cards for the cars in the train. The conductor will drop off the car cards for cars set out by the train and pick up the car cards for any cars picked up by the train.



Next Task: Hand Signals

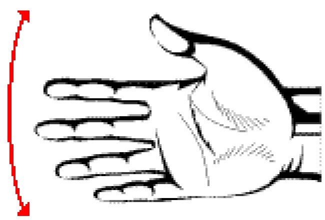
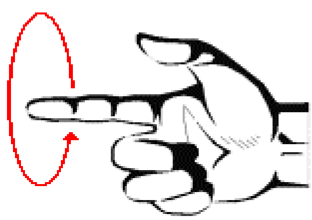
Hand Signals

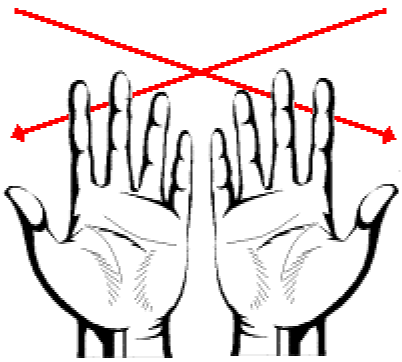
The Reality

In the 1920's, all communication amongst the train crew were done face-to-face or via hand signals, since radio systems were a long way off in the future.

Approximating Reality

The following hand signals are based on a set developed by Bruce Chubb in his book "How to Operate Your Model Railroad", and are scaled-down versions of prototype hand signals. They are designed to be used by the brakeman to communicate desired movements to the engineer.

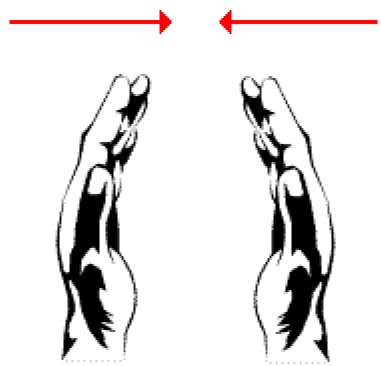
	**Go Forward** *Use: In switching* Hand moved up and down about the wrist. Speed of motion represents desired locomotive speed.
	**Go Backward** *Use: In switching* Hand with pointed finger moved in circle. Speed of motion represents desired locomotive speed.



Stop

Use: For general stopping

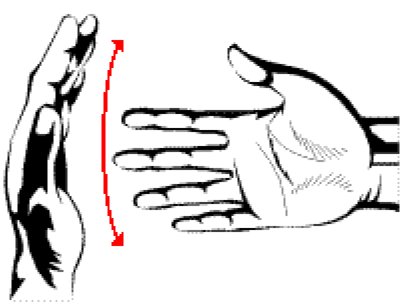
Flat hands are waved across each other.



Controlled Stop

Use: For coupling and uncoupling

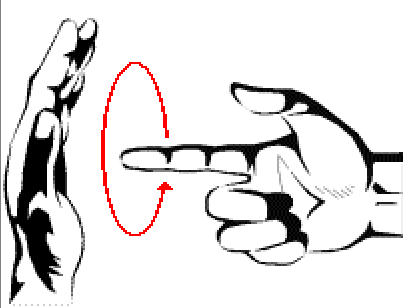
Hands brought together at a speed so as to touch at the exact desired stopping or coupling point. Distance between hands is maintained equal to distance between cars to be coupled.



Inch Forward

Use: To take up slack or to move short distances.

Combination of "Go Forward" signal with one hand, while the other shows remaining distance to travel equal to space between hand and fingers.



Inch Backward

Use: To take up slack or to move short distances.

Combination of "Go backward" signal with one hand, while the other shows remaining distance to travel equal to space between hand and fingers.

	**Highball** *Use: All switching complete and/or train cleared to proceed.* Thumb and forefinger form a circle.

Next Task: Assembling the Train

Assembling the Train

The Reality

Within yard limits, the movement of trains is treated differently than on mainline trackage. As we will see in the Getting Clearance section, all train movements on the mainline are governed by the dispatcher. Furthermore, the dispatcher also handles the movements of trains leaving and entering yards.

In contrast, trackage within yard limits is regarded as free and not under direct supervision of the dispatcher. "Yard Limit" signs are posted to mark the limits within which the train crew must confine their operation, and they warn trains leaving the mainline to be on the lookout for other trains. The establishment of yard limits frees the dispatcher from having to schedule all movements within the yard. Meets between trains within yard limits are informally set up between train crews.

Movement within yard limits is also restricted in speed. Yard speed is determined by restricted speed rule which is limited to half the range of vision and not exceeding 20 MPH. Movement through switches not mentioned in the timetable or rulebook is limited to 10 MPH. The track on the diverging route of switches is also 10 MPH. Safe coupling speed is 4 MPH maximum. The safe speed for getting on and off moving equipment is 10 MPH.

Knowing that they are free to move about within yard limits, the train crew can prepare to assemble their train.

Approximating Reality

Movement within Yard Limits

Given the discussion above, it is easy to apply the prototype rules to operating a model yard:

1. Movement through turnouts is limited to 10 mph.
2. Movements where simulated crews would be get on/off moving equipment is limited to 10 mph.
3. Maximum coupling speed is 4 mph.
4. Movements in the yard not otherwise covered above require a speed allowing ability to stop movement within half of visible range and not to exceed 20 mph.

Switches

Switches should always be left lined to the mainline. Switch controls on the PM&TCo are either marked with red/white bands or yellow/white bands. The red/white bands indicate a switch that lies on the mainline. For these controls, white marks the direction of mainline and red the spur. The yellow/white bands indicate the switch is not on the mainline. White marks the preferred direction of the switch and yellow the secondary.

All crews must leave switches lined to the white direction whenever switching is complete in an area.

Car Blocking

Blocking of the train (i.e. the order of the cars in the train) is at the discretion of the conductor. Usually loads are blocked ahead of empties. Cars carrying hazardous materials (such as fuel) may not be blocked within 2 cars of the locomotive or caboose.

If less-than-car-load (LCL) freight is indicated on the switch list, the indicated boxcar should be positioned directly behind the engine, so that the head-end brakeman can load and unload the freight at the appropriate station stops.

Building Trains in Staging

Because most of the PM&TCo outside of Lost Channel is handled by staging, the initial building of the train will require using the cassette staging system. Most often this activity will be handled by the dispatcher.

Next Task: Brake Testing

Brake Test

The Reality

Whenever cars are added to and removed from a train, the train crew must ensure that the new consist is ready for safe movement along the mainline. Typically, this requires the crew to walk the train in both directions, checking for proper coupling of cars, and ensuring all cars are sitting on the track properly.

In addition, prototype train crews are required to perform a brake test to ensure that the braking system is performing properly. This involves draining and pumping the air through the brake system, while the rear-end crew watches that the changes registered properly on the caboose air gauge.

Approximating Reality

With a two-person train crew, we can simulate this type of train preparation activity to a high degree using Joe Fugate's 'tug' test. I have adapted Joe's test to incorporate hand signals.

Engineer: Prepare for the test by dialing up the appropriate engine number on the throttle.

Conductor: Walk the train both directions, in one direction checking the coupler height between cars and, on the return direction, making sure all cars are on the track. Inform the engineer that both tests have been passed via the "Highball" hand signal. If the train fails either test, the conductor is to inform the engineer who will in turn contact the dispatcher for further instructions. Typically this will involve setting out the problematic car.

Once the conductor has walked the train and the consist has passed both the coupler and derail tests, the crew will conduct a brake test.

Engineer: Test the throttle by pulling the coupler slack out of the first few cars, then reverse the train and push it until the caboose or last car just barely begins to move.

Conductor: Inform the engineer that the test is good once the caboose starts to barely move backwards via the "Highball" hand signal. If the train fails the brake test, the conductor is to inform the engineer who will in turn contact the dispatcher for further instructions.

Engineer: Stop applying power when the Highball signal is observed. Throw the direction switch back to forward.

The train is considered checked and safe for mainline operation at this point. However, the train crew must still receive clearance to move onto the mainline.

Next Task: Getting Clearance

Getting Clearance

The Reality

Given its relatively low traffic volume and its short mainline, train orders on the Key Valley were given verbally directly to the train crews via a telephone system. The verbal orders would give trains clearance to run from one point on the railroad to another.

The verbal orders make up the operational plan. Equally important is keeping a close tab of how well the train orders are being executed. On larger railroads, a station agent would be responsible for reporting to the dispatcher the time that every train passed the station. This process is called "on sheet reporting" (OS) and it permitted the dispatcher to keep track of the locations of all the trains in his area of control. From this, he could see if certain trains were falling behind schedule and if meets and passes had to be moved.

For a small railroad like the Key Valley, having manned stations along the mainline was not required given the short mainline and the relatively low traffic volume. Therefore, the train crew would do their own OS'ing. This would require the train crew to stop at the telephone at the various control points along the mainline and make contact with the dispatcher. For most operations, this slowed the overall operations down but gave the dispatcher to change his verbal orders.

Approximating Reality

Again, our model railroads have similar requirements to keep trains from colliding with each other. Therefore, we have reason to approximate the clearance procedures closely.

There are three general rules that all train crews must follow with respect to OS'ing and clearance:

1. Train crews must OS their location and receive clearance before leaving yard limits for the mainline.
2. Train crews must OS their location and receive clearance before leaving the station at the end of their current verbal order.
3. Train crews must OS their location before entering yard limits from the mainline.

We will assume that a telephone system is available for train-dispatcher communications. Typically, the OS and clearance conversations will occur one after another. The engineer starts by stating his train name, location and time:

Engineer: "OS Pakesley. Extra 2 at 10:03 a.m."

The dispatcher repeats the message to ensure it was heard correctly:

Dispatcher: "OS Pakesley. Extra 2 at 10:03 a.m."

The dispatcher then gives the verbal train order:

Dispatcher: "Extra 2 Permission Granted Pakesley to Lost Channel at 10:03 a.m."

The engineer too repeats the message to ensure it was heard correctly:

Engineer: "Extra 2 Permission Granted Pakesley to Lost Channel at 10:03 a.m."

At Lost Channel, Extra 2 will be moving off the mainline and in the Lost Channel yard. Therefore, Engine 2 Extra must OS their arrival at Lost Channel:

Engineer: "OS Lost Channel. Extra 2 at 10:33 a.m."
Dispatcher: "OS Lost Channel. Extra 2 at 10:33 a.m."

To set up a meeting of two trains, the dispatcher would give one train permission to travel up to the meet location and indicate that the siding should be taken for the other train:

Engineer: "OS Pakesley. Extra 2 at 10:03 a.m."
Dispatcher: "OS Pakesley. Extra 2 at 10:03 a.m."
Dispatcher: "Extra 2 Permission Granted Pakesley to Camp Six. Take Siding for Extra 6. At 10:03 a.m."
Engineer: "Extra 2 Permission Granted Pakesley to Camp Six. Take Siding for Extra 6. At 10:03 a.m."

In this situation, the dispatcher is expecting Extra 2 to reach Camp Six before Extra 6. Of course, the progress of Extra 2 is blocked until Extra 6 passes Camp Six, so any delay in Extra 6 will further delay Extra 2. Extra 2 must OS at Camp Six:

Engineer: "OS Camp Six. Extra 2 at 10:25 a.m."
Dispatcher: "OS Camp Six. Extra 2 at 10:25 a.m."

The conversation between the dispatcher and Extra 6 would be:

Engineer: "OS Lost Channel. Extra 6 at 10:45 a.m."
Dispatcher: "OS Lost Channel. Extra 6 at 10:45 a.m."
Dispatcher: "Extra 6 Permission Granted Lost Channel to Pakesley at 10:45 a.m."
Engineer: "Extra 6 Permission Granted Lost Channel to Pakesley at 10:45 a.m."

Since the Extra 2's next destination is Lost Channel, Extra 2's crew must receive clearance to proceed past Camp Six. The appropriate time to request clearance in this situation is after Extra 6 has cleared Cole's Siding:

Engineer: "Extra 2 at Camp Six 11:01 a.m."
Dispatcher: "Extra 2 at Camp Six 11:01 a.m."

Dispatcher: "Extra 2 Permission Granted Camp Six to Lost Channel at 11:01 a.m."
Engineer: "Extra 2 Permission Granted Camp Six to Lost Channel at 11:01 a.m."

Next Task: Water Stops

Water Stops

The Reality

Steam locomotives consume a lot of water while in operation, so it is important that the train crew make regular stops to refill their tenders.

Approximating Reality

Water towers are located at several locations along the PM&TCo and all trains must stop for water after working in a town with a water tower. On the modeled layout, there is a water tower just to the east of the Dock siding in Lost Channel. Therefore, all trains working Lost Channel must stop here for a timed watering stop.

Next Task: Typing Up

Tying Up

The Reality

On the KVR, an engineer and conductor would work on the same engine all day and probably make several runs. At the end of the run as stated on their order, they would most likely return to the office for further instructions. Furthermore, they would also be responsible for fueling and watering their engine at this time.

Approximating Reality

The dispatcher is to be informed when the run of a train as given on the train order has been completed.

The key activity involved with tying up to ensure the paperwork for the train has been turned over to the dispatcher. In particular, the car cards must be turned over to the dispatcher for proper filing of car cards in the staging area.

Again, because most of the PM&TCo modeled as staging, end of run activities like caring for the engine will not occur.