The Tech Model Railroad Club Operations Scheme

There are many different systems for operating a model railroad. Some people operate their railroads to replicate the train schedule of a particular time and place, or to faithfully copy the complicated process and paperwork of real railroading. Our goal at the Tech Model Railroad Club is to have fun running trains, so our system is designed to be as simple and flexible as possible. The main challenge of our system is switching cars, an interesting puzzle for MIT engineers.

How it Works

The Tech Nickel Plate or TNP is a railroad which runs from Gifford City on Massachusetts’ Atlantic coast, through the Berkshires to Tuckerton in the Hudson valley. While a certain amount of through-freight and passenger traffic moves over the line, much of the railroad’s activity is driven by the various businesses along their main line which ship by rail. These customers have remained loyal to the TNP and avoided truck shipping mainly because of the deplorable state of roads in Massachusetts.

The TNP is a business whose job is to get carloads of materials where they are needed, when they are needed. Each of the railroad’s on-line customers—Coca Bubblie, Anderson Lumber, Shortz Electronics, and others—order shipments of raw materials by rail and sometimes send their finished products by rail as well. When one of the TNP’s customers requests a carload of something, it’s the railroad’s job to get that car to them and to take it back when they want it taken away.

The action in our operating scheme is driven by “delivery cards,” (fig. 1) each of which represents a demand by a customer to deliver or pick up a rail car. Each delivery card has a pocket for a “car card,” (fig. 2) which contains the data of the particular car being used to fill that demand. Every time a cycle of delivery and pick-up has been completed, the car card is separated from the delivery card and a new car of an appropriate type is chosen for the next delivery. This keeps individual cars from retracing the same path through the layout every time.
Fig 1: delivery card front and back

Fig 2: car card front and back
Following a Freight Car

Let's follow a freight car on one cycle through the layout. The fuel oil tank car CHVX 287078 starts out in the staging yard, representing all the other railroads in North America. The staging yardmaster has its car card and a stack of delivery cards representing unfilled orders.

Picture 1: Unassigned Car
The tank car is assigned to a delivery request from the Burns Coke & Oil company for a tank of fuel oil and is put into a block of four to seven cars ready to enter TNP track from the west. The green “delivery” side of the delivery card indicates what type (and often, what subtype) of car should be delivered. The staging yard master matches this type against the car cards for available cars and puts the two together.

Picture 2: Assigned and Blocked
An eastbound through freight collects this block of cars at the staging yard and proceeds along the line to the nearest classification yard to Burns Coke & Oil, the Gifford City freight yard. Through freight trains operate continuously in both directions over the main line, carrying cars between staging and the freight yard(s). At each yard they stop to drop one cut of cars and pick up another, subject to the directions of the yardmaster. The cards are exchanged at this time as well. Cards always follow the cars they refer to, so they change hands several times. Road crews may carry delivery cards for their train in an attractive TMRC pocket protector.
At the freight yard the cut of cars is removed from the through freight and sorted by destination. The fuel oil tank is grouped together with other cars headed for industries in Middle Heights. The TNP is divided into ten areas, each of which is designated by a color code at the bottom of the delivery card. (These follow the pattern of resistor color codes so they’re easy to remember.)

<table>
<thead>
<tr>
<th>Color</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Gifford City</td>
</tr>
<tr>
<td>Brown</td>
<td>105th Street</td>
</tr>
<tr>
<td>Red</td>
<td>Killianport / Freight Yard</td>
</tr>
<tr>
<td>Orange</td>
<td>Middle Heights</td>
</tr>
<tr>
<td>Yellow</td>
<td>East Berkmannville</td>
</tr>
<tr>
<td>Green</td>
<td>Berkmannville</td>
</tr>
<tr>
<td>Blue</td>
<td>Sawyer</td>
</tr>
<tr>
<td>Violet</td>
<td>Burns</td>
</tr>
<tr>
<td>Grey</td>
<td>Broderick</td>
</tr>
<tr>
<td>White</td>
<td>Tuckerton</td>
</tr>
<tr>
<td>Pink</td>
<td>Staging East (returns)</td>
</tr>
<tr>
<td>Lt Blue</td>
<td>Staging West (returns)</td>
</tr>
</tbody>
</table>

Table 1: TNP Destination Color Code
The yardmaster’s job is to block cars by area destination. A really good yardmaster will use their knowledge of the track arrangement at the customer to put the cars in the most convenient order for deliveries. Usually, putting cars in the same east-to-west order as the customers’ sidings will work. Figuring out the very best arrangement of cars takes a certain amount of skill and familiarity with the layout.
A wayfreight is now created consisting of all the deliveries for Middle Heights and Berkmanville. This train will also pick up any cars in those areas which are ready to return. In general, a wayfreight will service every industry in one or two areas. The Killianport and Tuckerton areas are served directly from the nearby freight yard one industry at a time as deliveries are available.
The wayfreight delivers the tank car and picks up any cars ready to return to the freight yard, servicing each customer in the area before it heads back. Each time a car is delivered, its delivery card is flipped from the green “delivery” side to the red “pick-up” side. The car card is moved to the pocket on the pick-up side and turned so the number specified on that side is visible. That number specifies how long the car will remain at the customer as a number of “days” from 1 to 4. In this case, the delivery card specifies three days, so the car card is turned around so that (3) is showing. This means the tank car will return on the third wayfreight to come through. The wayfreight operator is responsible for checking each car in their zone and collecting any which have (1) showing. If a higher number is showing, they must leave the car and turn the car card down one number. If a siding becomes overcrowded, however, the wayfreight operator may remove cars early to make their delivery fit on the track.
The delivery card specifies that the fuel tank will remain at Burns Coke & Oil for three days, so the next two wayfreights to service the area leave it in place but turn the car card so the number showing decreases. The third wayfreight will see that the car is ready for pick-up and collect it.

Note that the delivery card is on the red pick-up side and the car card is showing (1), indicating that the tank car is ready to go back to the freight yard.
The tank car is taken back to the freight yard by this new wayfreight, where it is sorted into a block of cars headed eastbound to staging. Sorting pick-ups is much the same as sorting deliveries, except that the two destinations are “eastbound” (pink) and “westbound” (light blue).
The next eastbound through freight now stops in the freight yard. After delivering the cars it brought from staging, it collects the cut of cars headed for eastbound staging and takes them to the staging yard.
When the tank car is returned to staging, it is off the TNP again. Its car card is separated from the Burns Coke & Oil delivery card and shuffled into a stack until another demand for a fuel oil delivery comes up. The process of randomization allows the staging yard operator to use whichever cars are most conveniently at hand and to make adjustments to the traffic flow by adding or subtracting delivery cards from rotation.


Roles

The TNP operating scheme is designed to keep any number of operators busy, from one to at least a dozen. The density of traffic depends on the number of operators. The general rules for selecting your role on the TNP are:

1) What needs to be done?
2) What looks fun?

Most roles require only a little training, and any experienced TNP operator will be glad to help you learn. Real railroaders stick with the same job for years at a time, but we are free to move from one to another. To prevent confusion, though, try to keep locomotives from changing jobs in mid-operation.

Staging Yardmaster

The staging yardmaster simulates the process of rail cars being ordered by online customers and delivered from other railroads. The yardmaster will have a stack of unfilled delivery cards, a supply of freight cars, and the corresponding car cards. The yardmaster considers how full the freight yard is and what deliveries haven’t been made for a while, and selects a set of delivery cards to process next. It’s okay, even helpful, to be somewhat random so the other operators’ jobs are always a little different than before.

The yardmaster matches the car type requested on each delivery card with the car type on some car card, puts the car card in the delivery card’s pocket, and sets the freight car to leave staging from either the east or the west end of the yard, as indicated by the delivery card (on the green side, just beneath the customer name). The east end of staging is connected to Gifford City under the tower. The west end is connected to Berkmannville and Tuckerton through the helix.

When a through freight comes into staging, the yardmaster removes the cars that the train brought from the freight yard and attaches four to seven new deliveries that are headed in the same direction as the through freight—westbound from the east end or eastbound from the west end. (The staging yardmaster may need to call the freight yardmaster to find out how many new cars the freight yard is ready to receive.) The yardmaster hands the delivery cards to the through freight engineer and sends the train out. Next, the yardmaster separates the delivery and car cards for the cars that were just returned and shuffles them into the stack.
Through Freight Engineer

Through freights ensure there is continuous action out on the main line during an operating session. An engineer waiting for a wayfreight assignment can run a through freight on a lap around the layout to pass the time. Through freights also perform the vital function of delivering fresh cuts of cars to the freight yard and removing those headed off the TNP (to staging). A through freight stops at each freight yard along its route to exchange cuts of cars. When inside yard limits, through freight engineers should obey the instructions of the yardmaster. Typically there is one through freight running in each direction, though they may not be running at all times. If not enough operators are available, one through freight can carry the cars headed in both directions.

Freight Yardmaster

The freight yardmaster’s job consists of “blocking” the randomly shuffled cars that come into the freight yard into groups all headed for the same destination. This job is facilitated by the color codes on the lower flap of the delivery cards (see table 1). Deliveries for the same area will all have the same color code.

The most straightforward way to block cars is to collect cars for each destination in a different yard track. New deliveries are pulled onto the switching lead and the last car is pushed into the track for its destination, then the rest of the cars are pulled back and the process is repeated until everything is sorted. Eventually there will be enough cars for one destination to make a wayfreight which can be sent out.

Further sorting can make the wayfreight engineer’s job much easier. There’s a certain amount of strategy and skill involved in this. In general, it helps to put the cars in the same east-to-west order as they will have when delivered. Experience as a wayfreight engineer is helpful. Some industries are easiest to switch in the outbound direction while others are easiest to switch in the inbound direction (because of the direction the sidings are pointed), and the cuts of cars can be arranged accordingly. In some places it is possible for the wayfreight engineer to break the train and switch cars from the middle, while in others cars must be switched from the end because of grades or a busy main line. There are few convenient places for a wayfreight engineer to rearrange a train once it leaves the freight yard. By thinking ahead, the freight yardmaster can arrange the cars in a train so they will require minimal rearrangement out on the road. In
short, the freight yardmaster can make a wayfreight crew’s job relatively painless or very, very difficult.

There are either one or two yardmasters per yard. A well-coordinated pair of yardmasters, each working from one end of the yard, can sort cars very quickly. Other tasks of the yardmaster include giving directions to trains delivering and picking up cars, and getting locomotives for outbound wayfreights.

**Wayfreight Engineer**

Wayfreights make deliveries and pick-ups at customers along the line. The freight yardmaster will prepare a train consisting of cars all bound for customers in the same area. The wayfreight engineer may obtain an engine from the yardmaster or hostler. The wayfreight then enters the mainline (getting permission from the dispatcher if necessary) and travels to the area where it will make its deliveries.

There already will be some cars at the customers in the area that the wayfreight services, and to make room for deliveries the first task is to figure out which cars need to be picked up. Notice the circled numbers on the car cards (figure 2). Normally, a (1) is showing. If you turn the card upside-down, a (2) is visible. The numbers (3) and (4) are on the back. These numbers indicate how long a car should remain at the customer. Any car card showing a (1) is ready for pick-up. The wayfreight engineer should collect these cars. All the other cars will be collected by future trains. The engineer should turn each of their car cards down one number. Thus, all of the (2) become (1) for the next wayfreight to collect, all of the (3) become (2), and so on.

As the engineer makes deliveries, each delivery card should be flipped from the green side to the red “pick up” side. The car card goes in the pocket on the red side, and is turned so the number indicated by the delivery card is showing. Because of the semi-random scheduling of deliveries, once in a while an engineer will find that there’s not enough room in the siding to hold all of the deliveries, even after the pick-ups have been removed. In that case, start picking up additional cars early until there is enough room. It helps to collect cars of the same type that you are delivering in this situation.

Now the wayfreight consists of all the cars that have been picked up from the customers in its assigned area. The engineer brings these back to freight yard, pausing at the yard entrance to get permission from the yardmaster. After this, the engineer’s job is over. The engine is taken back to the engine yard and “dropped out” of the computer system.
Most wayfreight jobs are performed as described above, but a few areas are treated differently. Customers next to the freight yard(s) are served directly out of the nearest yard, so the train only needs to service one of them at a time. These customers can be serviced by the freight yardmaster or a dedicated engineer. Some areas such as the Standard Hydrocarbon plant or Sawyer may be serviced by an engine which is kept at that location. In this case, a through freight will leave the deliveries on a nearby siding and collect the pick-ups from the same location when they are ready. Otherwise, the operation is the same.

**Brakeman**

When new or guest operators are handling a train, it’s a good idea for an experienced operator to follow along as “brakeman.” The brakeman is mainly there to make sure the new engineer learns the ropes, but can also assist by verifying that switches are properly aligned and that the paperwork (set of car cards) is in order.

**Dispatcher**

If enough trains are operating to create the potential for conflicts, an experienced operator should serve as dispatcher to control traffic flow. The computer terminal in the tower is ideal for a dispatcher, since it was designed with that job in mind. The dispatcher should have a view of the whole system on hand, and road crews should call the dispatcher for permission to move across the main line. The system of telephones located under the layout is very handy for this purpose. Dial “0” to reach the tower. If few trains are moving at any time, a dispatcher is not necessary.

**Hostler**

Hostlers move and service locomotives in engine service facilities. Depending on the rate at which wayfreights are being assembled, it may be easier to have a dedicated job for fetching locomotives from the engine yard and returning them there. If there are two freight yardmasters, one of them could perform hostler duties as needed.
Passenger Train Engineers

The scheduled arrival and departure of passenger trains up and down the line is quite a different mode of operation from local freight handling. Passenger operations are outside the scope of this system, but if an appropriate schedule is in place, passenger operations can provide additional opportunities for several more people. If passenger trains are operating, all freight trains should be run as unscheduled extras and a dispatcher is definitely necessary.
**Set Up and Take Down**

The operating system is designed for “pick-up” sessions, meaning that an operating session can be halted at any point and the cars and cards left where they are until the next session. Card pockets on the fascia make it easy to leave cards in place.

At the beginning of each operating session, begin by checking the car cards against the cars that are in each location. Once the cars in the staging yard have been verified, the staging yardmaster can begin work. Once the cars in the freight yard have been verified, the freight yardmaster can begin work. Other operators should walk around the layout and verify the cars in each customer’s siding. Discrepancies should be resolved by swapping the cars or the car cards.

If the car cards must be put away at the end of an operating session, for instance in anticipation of an impending open house, then placing the cards from staging, the freight yard, and the customers in three separate baggies will speed up the process of matching the cards to the cars at the beginning of the next session. Lumping all the cars at customers into one bag is okay because each customer’s name is on its delivery cards.

**Solo Operation**

It is possible to hold an operating session by oneself simply by stepping through each of the jobs in the same order they were encountered when we followed a car around the layout. Begin in the staging yard by assembling a block of cars headed for the freight yard, then take them there on a through freight. Leaving the through freight on the arrival track, sort the cars in the freight yard as yardmaster. Run one or more wayfreights to service some of the on-line customers. Finally, sort the cars returned by the customers and take a cut of them back to staging on the through freight and re-shuffle the cards for another round. It takes a couple hours to go through this process each time, and it provides a lot of operational variety.
Making new Car and Delivery Cards

Templates for car and delivery cards can be found under /home/TMRC/operations on the computer in the club room. The files are Powerpoint slides, so only the text needs to be changed. Car cards require a photo of the car to make identification easier. There is a special TMRC photo booth available which slips over a staging track and has a slot for an overhead light and a scale rule background to measure the length of the car.

For delivery cards, there is a spreadsheet for computing how many to make for each car type. In brief, round up the average number at the customer and the average number in transit, then add those together. There’s a judgment call to be made about whether a car should enter and exit from the east or the west. Some goods, such as produce, almost always come from west of Massachusetts and the empties should return there. Others, such as wood and paper products from Maine and New Hampshire or fuel oil from a seaport, would more often come from the east. Deliveries can also be designed to enter from the east and exit to the west, or vice versa. As long as the number of cars in these two groups balances, there’s no problem.