Using JMRI Operations

A Worked Example

This document contains the complete set of blog postings I made in the Model Railroad Hobbyist magazine web site. The original blog postings and subsequent forum discussions can be found at the following URLs:

Part 3 - http://model-railroad-hobbyist.com/node/10989
Part 4 - http://model-railroad-hobbyist.com/node/11058
Part 5 - http://model-railroad-hobbyist.com/node/11211

Additional resources used in these posting include the JMRI web site, http://jmri.org/ and Lance Mindheim’s blog, http://www.lancemindheim.com/blog.htm

I am also very grateful to Joe Fugate, publisher of Model Railroad Hobbyist magazine for host my blog and permitting me to combine the postings into one PDF for distribution.

David Haynes

January 14, 2013
Part 1
In http://model-railroad-hobbyist.com/node/10669 - recent posting on this forum - rclanger suggested that a column on using JMRI would be a good addition to MRH. I replied that I would really like to see some worked examples of using JMRI operations.

Over the holiday period, I decided to dig into JMRI operations a lot more and that I would post my discoveries along the way as my own ‘worked example’. So, bear with me folks, this is really me going through a learning curve and documenting it along the way!

To start, I needed a good but simple example to work with. With the key values of ‘good’ and ‘simple’, I knew that Lance Mindheim would probably have something I could use. He has been advocating simple track designs for operations for a while now. So, I found a good idea in his blog posting from http://www.lancemindheim.com/blog.htm September 17, 2012.

I like this example because it has only one industry (a bakery) but a variety of cars (hoppers, tank, box) and only one train to service it.

This blog entry assumes that you have read the JMRI operations tutorial and web pages and are mostly familiar with filling in the various forms.

Starting Small
The Operations menu in JMRI indicates the order of the steps you should take when starting out, namely: Settings, Locations, Cars, Locomotives, Routes and Trains.

Settings
I set the railroad a name of ‘Lance Mindheim – Bakery’, set the trains to travel East/West and check the box next to “Add Operations Menu to Main Menu”.

Locations
The first thing I did was analyze track plan in Lance’s blog. In JMRI terms, we have a location named ‘Bakery’ that can accommodate up to 10 cars – 1 grain hopper, 4 tank cars and 5 box cars. Assuming each car is a maximum of 50 feet, the spur must be longer than 500 feet. I’ll make it 600 feet for now.
I added the “Bakery” location as follows:

The JMRI Operations document recommends adding two interchanges when starting out. Since the bakery is serviced by a ‘turn’ train (one that leaves a yard, services some industries and then returns to the yard), I will set up the interchange as the cassette mentioned in Lance’s blog post.

Since, the recommendation is for two interchanges, I will model that by having two interchange tracks in my cassette.

If you have a hyphen followed by a number in a name in JMRI, the hyphen and number and any following text will not show up in the reports or switch lists. For example, the name ‘Cassette-1’ will show up as ‘Cassette’ in the switch lists.

I added the ‘Cassette’ location as follows:
I added the ‘Diesel’ rolling stock to this location because I want the train engine to arrive on the cassette.

**Cars**
To start simply, I will have one car – the Grain Hopper available. I will add it to the Cassette-1 track and set it to Loaded.

**Locomotives**
I will have one locomotive – a diesel – also located on the Cassette-1 track.

**Routes**
The route is very simple: it starts from Cassette, travels west to Bakery and then travels east to Cassette. I will call this the ‘Bakery Turn’.

**Trains**
Finally, I can set up a train to run along the Bakery Turn route.
Generating the Train Manifest

Now, I can try to generate a train manifest! Before I do, however, I want to check the ‘Build Reports’ and ‘Preview’ boxes so that I can see what actions JMRI operations is performing.

I click on the ‘Build’ button. The button changes from ‘Build’ to ‘Preview’ so that I may look at the build report and manifest generated. Pressing the ‘Preview’ button presents two new windows: the “Train Build Report” and the “Train Manifest”. Looking at the Train Manifest first, it looks like JMRI Operations did what I wanted.
It says to pick up the grain hopper from the Cassette and drop it off at the Bakery but, wait a minute! What engine are we supposed to use? Maybe the Train Build Report will tell me something.

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Train Manifest Bakery Turn Job

Manifest for train (CSX 751) Bakery Turn Job
Valid 12/29/2012 07:13

Scheduled work at Cassette, departure time 00:00
[ ] Pick up ALNX 3960059 HopGrain 52' Blue L from Cassette
Train departs Cassette Westbound with 1 cars, 36 feet, 91 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Set out ALNX 3960059 HopGrain 52' Blue L to Bakery
Train departs Bakery Westbound with 0 cars, 0 feet, 0 tons

Train terminates in Cassette
It says that the train does not require any locomotives. Not exactly what I had in mind... The ‘Edit Train’ form has a section named ‘Optional train requirements’ where the number of locomotives is currently set to 0. Let’s set that to one and see what happens.

In the ‘Trains’ form, select the radio button labeled ‘Reset’ and then select the ‘Reset’ action for the train. This will reset the Function to ‘Build’.

If I didn’t want JMRI to assign an engine to this train, I could omit this step.
That’s more like it. The engine is picked up from the Cassette and returned to it at the end.

Now that the preview looks good, it’s time to tell JMRI that I have moved the cars. I select the ‘Move’ radio button in the Trains form and then click on the ‘Move’ Action for this train.

The train is now reported to be ‘In route’…

I push the ‘Move’ Action button again…

The train now has no cars. Where did the cars go? Checking the Cars form shows me the following:

So, the grain hopper has been dropped off at the Bakery.

Notice that the train has not terminated its journey. Press the ‘Move’ action button again.
Now the train is terminated. Checking the Locomotives form shows me the following:

<table>
<thead>
<tr>
<th>Number</th>
<th>Road</th>
<th>Model</th>
<th>Type</th>
<th>Len</th>
<th>Consist</th>
<th>Location</th>
<th>Destination</th>
<th>Train</th>
<th>Mvsx</th>
<th>Set</th>
<th>Edit</th>
</tr>
</thead>
<tbody>
<tr>
<td>5233</td>
<td>CSX</td>
<td>GP35</td>
<td>Diesel</td>
<td>56</td>
<td>Cassette (Cassette-2)</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

So, in summary, I have created two locations: Bakery and Cassette, loaded the Cassette with an engine and a grain hopper car, created a route between the Cassette and the Bakery and then scheduled a train to run over the route.

The train picked up the loaded grain hopper and dropped it off at the Bakery and then returned the engine to the Cassette.

**Part 2**

In this posting, I want to expand on the previous work by adding more car types to the mix. The bakery is capable of handling 1 grain hopper, 4 tank cars and 5 box cars.

But before I get into that, I want to make sure that the grain hopper is being routed as I expect. In the last blog posting, I had the train pick the car up from the cassette and drop it off at the bakery. So, I run the train again and examine the generated manifest.

```
Train Manifest Bakery Turn Job - 1 - December 30, 2012 6:58 AM

Manifest for train (CSX 751) Bakery Turn Job
Valid 12/30/2012 06:58

Scheduled work at Cassette, departure time 00:00
[ ] Pick up CSX 5233 GP35 from Cassette
Train departs Cassette Westbound with 0 cars, 60 feet, 130 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Pick up ALNX 396059 HopGrain 52' Blue E from Bakery
Train departs Bakery Westbound with 1 cars, 116 feet, 160 tons

Scheduled work at Cassette, estimated arrival time 00:11
[ ] Set out ALNX 396059 HopGrain 52' Blue E to Cassette
[ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette
```

This looks good. The train picked up the now empty grain hopper and returned it to the cassette.

Notice that the grain hopper state was changed from ‘loaded’ to ‘empty’. This is an automatic function when a car is dropped off on a spur track. If the car had been ‘empty’ when it was dropped off, its state would have been changed to ‘loaded’.

**Spur tracks will change the load state of a car. Interchange, yard and staging tracks will not.**

I use the Move Action button in the Trains form to move the empty grain hopper to the cassette.
To make sure that all is working well, I schedule the train to run again and examine the manifest.

**Train Manifest Bakery Turn Job**

Valid 12/30/2012 07:03

- Manifest for train (CSX 751) Bakery Turn Job
- Scheduled work at Cassette, departure time 00:00
  - [ ] Pick up CSX 5233 GP35 from Cassette
  - Train departs Cassette Westbound with 0 cars, 60 feet, 130 tons
- No work at Bakery
- Scheduled work at Cassette, estimated arrival time 00:08
  - [ ] Set out CSX 5233 GP35 to Cassette
  - Train terminates in Cassette

The train has no work! That’s not what I was expecting at all. So, I take a look at the Train Build Report:

**Train Build Report Bakery Turn Job**

Built on 12/30/12 7:03 AM

- JMRI version 3.2-r21862
- Build report detail level Normal
- Build report detail level Detailed
- Build report detail level Very Detailed
- Train Build Options
- Allow local moves when car has a custom load
- Allow cars to travel from origin to terminal
- Location (Cassette) requests 5 moves
- Location (Bakery) requests 5 moves
- Location (Cassette) requests 5 moves
- Route (Bakery Turn) requests 7 cars and 15 moves
- Train (CSX 751) services locomotive types:
  - Diesel
- Train requires a single locomotive, model 0 road 0
- Search Tor 1 loco(s), model 0, road 0, departing (Cassette), destination (Cassette)
- Loco (CSX 5233) road (CSX) model (GP35) type (Diesel)
- at location (Cassette, Cassette-1) destination (Cassette)
- Loco (CSX 5233) assigned destination (Cassette, Cassette-1)
- Done assigning locomotives to train (CSX 751)
- Train (CSX 751) services car types:
  - Boxcar, HopGrain, Tank Food
- Remove cars not serviced by this train:
- ExClude car (ALNX 396059) previously set out by this train at interchange (Cassette, Cassette-2)
- Found 0 cars for train (CSX 751)
- Train does not require caboose when departing (Cassette)
- Train does not require car with FRED
- Requested cars (7) for train (CSX 751) the number available (0) building train!
- Location (Cassette) requests 5 pick ups, 5/5 moves are available
- Partial 0/5 cars at location (Cassette) assigned to train (CSX 751)
- Location (Bakery) requests 5 pick ups, 5/5 moves are available
- Partial 0/5 cars at location (Bakery) assigned to train (CSX 751)
- Partial 0/7 cars
- Build for train (CSX 751) took 16 mSec
One of the rules when using an interchange is that a car that was dropped off by one train may not be picked up by the same train.

**Interchanges are used to exchange cars between trains.**

So, it looks like I have a couple of choices:

1. I could create a second train to operate on the same route.
2. I could use something other than an interchange to model the cassette.

I don’t want to schedule another train for this simple bakery turn job. I don’t think that’s how a real railroad would do things. So, I look at my other options.

JMRI Operations supports four major track entities: spurs, interchanges, yards and staging.

I used a spur track at the bakery. Spur tracks accept picking and dropping cars and will toggle the car state between empty and loaded.

The interchange track is not doing what I want.

A yard track is used to hold cars until they have been assigned to trains. Yard tracks will not toggle the car state between empty and loaded.

A staging track is used to hold a complete train that has been assembled beyond the modeled layout. Staging tracks will also not toggle the car’s load state.

**Thinking in Cycles**

In the real world, car loads are generated at one industry and consumed at another. There is a cycle set up between the suppliers and consumers of goods or materials. In the bakery turn, I have only modeled half the cycle. I need to model the other half.

That is, I have modeled a loaded grain hopper being shipped to the bakery and the empty be taken from the bakery but I have not modeled the grain hopper being refilled with grain.

Since I want the grain hopper’s state to be reset to loaded, I will need to use a spur track.

So, I change the Cassette location from using interchange tracks to spur tracks. Also since spur tracks can accept both dropping off and picking up of cars, I should only need one spur track.
I make sure that the grain hopper is set onto this new spur track and that its state is set to loaded. I also make sure that the locomotive is set onto the new spur track.

I run the train again.

Train Manifest Bakery Turn Job

Manifest for train CSX 751 Bakery Turn Job
Valid 12/30/2012 07:27

Scheduled work at Cassette, departure time 00:00
[ ] Pick up CSX 5233 GP35 from Cassette
[ ] Pick up ALNX 396059 HopGrain 52' Blue L from Cassette
Train departs Cassette Westbound with 1 cars, 116 feet, 221 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Set out ALNX 396059 HopGrain 52' Blue L to Bakery
Train departs Bakery Westbound with 0 cars, 60 feet, 130 tons

Scheduled work at Cassette, estimated arrival time 00:11
[ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette

This looks good. I run the train for a couple more cycles. The grain hopper is being loaded at Cassette and emptied at Bakery. This is just what I wanted.

Now, let’s see what happens if I add another car to Cassette. I decide to add a tank car.

I run the train.
This looks fine. JMRI found the two loaded cars at Cassette and shipped them to Bakery.

It also found the empties at Bakery and shipped them to Cassette.

So, I add all the other cars to Cassette.
And I run the train again.

### Train Manifest Bakery Turn Job

<table>
<thead>
<tr>
<th>Manifest for train (CSX 751) Bakery Turn Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid 12/30/2012 07:51</td>
</tr>
</tbody>
</table>

#### Scheduled work at Cassette, departure time 00:00
- [ ] Pick up CSX 5233 GP35 from Cassette
- [ ] Pick up CRGX 16226 Tank Food 50' Black L from Cassette
- [ ] Pick up CRGX 16534 Tank Food 50' Black L from Cassette
- [ ] Pick up CRGX 17899 Tank Food 50' Black L from Cassette
- [ ] Pick up BN 730297 Boxcar 50' Green L from Cassette
- [ ] Pick up BN 730936 Boxcar 50' Green L from Cassette

Train departs Cassette Westbound with 5 cars, 330 feet, 570 tons

#### Scheduled work at Bakery, estimated arrival time 00:04
- [ ] Set out CRGX 16226 Tank Food 50' Black L to Bakery
- [ ] Set out CRGX 16534 Tank Food 50' Black L to Bakery
- [ ] Set out CRGX 17899 Tank Food 50' Black L to Bakery
- [ ] Set out BN 730297 Boxcar 50' Green L to Bakery
- [ ] Set out BN 730936 Boxcar 50' Green L to Bakery

Train departs Bakery Westbound with 0 cars, 60 feet, 130 tons

#### Scheduled work at Cassette, estimated arrival time 00:23
- [ ] Set out CSX 5233 GP35 to Cassette

Train terminates in Cassette

Wait a minute. I had 10 cars at Cassette, why did JMRI only move 6 of them? I look at the Train Build Report.
Aha! The train is only able to handle 7 cars including the locomotives. So, it can only handle 6 freight cars but Cassette is only allowing 5 pickups, so only 5 cars may be moved.
On the next train, the other loaded cars are shipped to the Bakery.

Why didn't the train pick up the empties at the Bakery?

The clue is the line that reads “Train departs Bakery Westbound with 0 cars...”. Cassette is east of the Bakery, so JMRI will not add the Eastbound empties to the Westbound train.

To fix this, I added another Location to the Bakery Turn route to say that the Bakery Eastbound is now part of the route.

![Edit Route](image)

Now the train picks up empties at the Bakery and returns them to Cassette.

The manifests are getting to be larger now. I wonder if JMRI can help me in reading them. Under the “Tools” menu is an entry named “Manifest Print Options”. Selecting this causes a form to be displayed which has a great many options for the format of the generated Manifests and Switch Lists.

For the moment, I select that pick ups are displayed in red and set outs are displayed in blue.
So, in this blog entry I have managed to create a cycle between Cassette and Bakery that is serviced by one train and moves cars between those two locations. I have also added the full complement of cars required by the Bakery location and have made the manifests a bit easier for me to read.

Part 3
Lance Mindheim posted that he has been informed that the covered hopper that he had originally marked as being used for grain is probably used for plastic pellets instead. I plan to continue to use the grain hopper in this blog rather than re-edit the existing blogs. Feel free to change “grain hopper” to “plastic pellet hopper” if you want.

In the previous blog posting, I had managed to get JMRI to route 10 cars between Cassette and Bakery. This was good but two things bothered me:

1. The same cars were always routed to Bakery. For example, since there is only one grain hopper it was shuttled back and forth between Cassette and Bakery. I would like to mix that up a bit.
2. The cars moving into and out of the spur are the same block of 5 each time.
So, the first thing I will do is add some more cars into the mix at Cassette. To keep things simple, I will just add another grain hopper for now.

I build the Bakery Turn train.

Train Manifest Bakery Turn Job  - 1 -  January 2, 2013 3:03 PM

Lance Hindheim  -  Bakery

Manifest for train (CSX 751) Bakery Turn Job
Valid 1/2/2013 15:03

Scheduled work at Cassette, departure time 00:00
[ ] Pick up CSX 5233 GP35 from Cassette
[ ] Pick up CRGX 16534 Tank Food 50' Black L from Cassette
[ ] Pick up CRGX 17899 Tank Food 50' Black L from Cassette
[ ] Pick up CNX 110328 HopGrain 52' Red L from Cassette
[ ] Pick up BN 730352 Boxcar 50' Green L from Cassette
[ ] Pick up BN 730936 Boxcar 50' Green L from Cassette
Train departs Cassette Westbound with 5 loads, 0 empties, 332 feet, 573 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Set out CRGX 16534 Tank Food 50' Black L to Bakery
[ ] Set out CRGX 17899 Tank Food 50' Black L to Bakery
[ ] Set out CNX 110328 HopGrain 52' Red L to Bakery
[ ] Set out BN 730352 Boxcar 50' Green L to Bakery
[ ] Set out BN 730936 Boxcar 50' Green L to Bakery
[ ] Pick up CRGX 16226 Tank Food 50' Black E from Bakery
[ ] Pick up CRGX 16944 Tank Food 50' Black E from Bakery
[ ] Pick up ALNW 396039 HopGrain 52' Blue E from Bakery
[ ] Pick up BN 730447 Boxcar 50' Green E from Bakery
[ ] Pick up BN 730485 Boxcar 50' Green E from Bakery
[ ] Pick up CSX 5233 GP35 to Cassette
Train departs Bakery Eastbound with 0 loads, 5 empties, 332 feet, 276 tons

Scheduled work at Cassette, estimated arrival time 00:42
[ ] Set out CRGX 16226 Tank Food 50' Black E to Cassette
[ ] Set out CRGX 16944 Tank Food 50' Black E to Cassette
[ ] Set out ALNW 396039 HopGrain 52' Blue E to Cassette
[ ] Set out BN 730447 Boxcar 50' Green E to Cassette
[ ] Set out BN 730485 Boxcar 50' Green E to Cassette
[ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette

The red grain hopper is picked up and sent to Bakery. So, I build and move the train a few more times.
Wait! I have two grain hoppers being sent to Bakery but Bakery only has one spot for a grain hopper. How am I going to enforce the spot types on the spur?

Maybe I need to model each spot type as a separate spur. So I set it up at the Bakery location.

There are a couple of things to note about this entry.

The name is “Bakery-1-HO-Grain”. The “HO-Grain” is so that I know that this spur is supposed to handle grain hoppers only.
Remember that JMRI will ignore all text preceded by a hyphen and a number (including the hyphen and the number). So, for all the reports and manifests, this spur will be known as “Bakery”.

The length is a bit longer than the length of the cars expected. JMRI adds a bit to the car length when calculating so making this a bit bigger helps. If it is too small, the Train Build Report will tell me about that.

I have indicated that this spur will only accept ‘HopGrain’ cars.

If I wanted to model ‘off-spot’ situations, I could make the grain hopper spur capable of handling two cars (logically) and set a schedule wait on the second grain car. See Part 5 for more on schedule waits.

I will add spurs for the tank and box cars in a similar fashion.

I named the box car (XM) spur without a specific goods suffix since I want many things to arrive and depart in boxcars.

Time to run the train again but, first, make sure that any cars that were on the old Bakery spur are relocated to new spurs and that the loads are correct.

This is the train manifest after the first train.
The red grain hopper is picked up from Bakery and dropped at Cassette, so Cassette has two loaded grain hoppers.

On the second build, the red grain hopper is picked up and sent back to Bakery. This is good because even though Cassette had two loaded grain hoppers, it only selected one to ship.

On the third build, the red grain hopper is picked up at Bakery and returned to Cassette.

The red grain hopper is cycled between Cassette and Bakery and the blue grain hopper stays at Cassette.

Time to look at the Train Build Report again!
So, JMRI found both grain hoppers in Cassette and then found a spur at Bakery for the red grain hopper. When it came time for the blue grain hopper, the spur at Bakery was already full.

This is an important discovery. JMRI processes the cars in the order they are found when the cars are located on a spur.

*This ‘discovery’ turned out to be incorrect. Check out the next posting for details.*

I’ll look at ways to have both grain hoppers show up at Bakery in my next blog post.

**Part 4**

Since I posted Part 3 of this blog series on JMRI Operations I have learned that my interpretation of how JMRI selects cars for populating trains was not correct. I had inferred that JMRI was simply selecting the cars to use based on the order it found them in the database. A posting by RSeiler suggested that, in fact, the list was ordered based on the number of moves the car had previously made. The number of moves is shown in a column in the cars form.

I reset all the car moves to zero using the **Tools -> Roster -> Reset** menu option on the cars form and tested this. RSeiler is correct. After I had reset the car moves, the red and blue grain hoppers were sent to Bakery alternately.
For the record, I was going to use a solution that involved inserting a Yard between Bakery and Cassette and introducing a Cassette Turn train to move cars between Yard and Cassette and modifying the Bakery Turn train to run between Yard and Bakery. This also gives the desired result of alternating cars from a pool of cars. The only “trick” was that there had to be separate Yard tracks for East and West bound traffic so that a car from Bakery would not be returned to Bakery from the Yard.

Benny and dkramer suggested using an interchange instead of a yard which also has possibilities. I didn’t test this because the spur to spur solution came up and is simpler and, I think, more elegant.

That’s the great thing about doing a worked example in a forum. People suggest alternatives and a better result often emerges. Thanks to everyone who made suggestions.

To recap, I now have a train that runs a Turn job between Cassette and Bakery. Bakery has differentiated spurs so that I don’t get more train cars of a specific type (e.g. grain hoppers) than I have spots at the industry. The Bakery Turn job will also select the cars to include in a train based upon the open spots at Bakery, the type of car allowed in the spot and the number of moves the car has taken relative to all other cars of the same type.

So far, the cars being shunted only have loads of ‘L’ and ‘E’ representing the default cars states of ‘Loaded’ and ‘Empty’ respectively. If I wanted to, I could just increase the list of car types to include all the particular combinations needed.

Let’s take the tank cars for example. Up until now, I have been using the car type ‘Tank Food’ to represent all the tank cars at Bakery. Instead, I could define new tank car types – Tank Fructose, Tank Maltose, Tank Sucrose, Tank Corn Syrup 100, etc. – and use those to create a greater variety of tank cars at Bakery.

In fact, this is the approach Arthur Houston recommends.

I am not such a fan of this approach for a couple of reasons:

1. It ties the car and load together forever. Think of boxcars. They may carry many different loads in their lifetimes. If I assign a box car to the ‘Boxcar Cereal’ car type. Then that car cannot carry, say, baked goods.
2. It complicates the setting up of locations and spurs in that the number of types of rolling stock that must be managed.

It does, however, mean that I will not have to consider schedules and custom loads at this point.

But, what the heck! This is supposed to be a learning exercise, so Schedules and Custom Loads ahoy!
Any reasonably complex industry will receive and ship a number of different loads. Take the Bakery for example. The following table describes just some of the commodities it could receive and send:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Car Type</th>
<th>Receive/Ship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable oil</td>
<td>Tank</td>
<td>Receive</td>
</tr>
<tr>
<td>Maltose</td>
<td>Tank</td>
<td>Receive</td>
</tr>
<tr>
<td>Dextrose</td>
<td>Tank</td>
<td>Receive</td>
</tr>
<tr>
<td>Sugar</td>
<td>Box</td>
<td>Receive</td>
</tr>
<tr>
<td>Shortening</td>
<td>Box</td>
<td>Receive</td>
</tr>
<tr>
<td>White Flour</td>
<td>Hopper</td>
<td>Receive</td>
</tr>
<tr>
<td>Brown Flour</td>
<td>Hopper</td>
<td>Receive</td>
</tr>
<tr>
<td>Milk Powder</td>
<td>Box</td>
<td>Receive</td>
</tr>
<tr>
<td>Yeast</td>
<td>Box</td>
<td>Receive</td>
</tr>
<tr>
<td>Pie Fillings</td>
<td>Box</td>
<td>Receive</td>
</tr>
<tr>
<td>Baked Goods</td>
<td>Box</td>
<td>Ship</td>
</tr>
</tbody>
</table>

As you can see, Bakery has a high demand for many varied commodities and this is by no means a complete list.

So, how can I use JMRI Operations to model this activity? The first thing that comes to mind is that I have not divided the box car spur into receiving and shipping spots. The other spurs, for grain hoppers and tank cars, only receive cars.

I decide that Bakery will use three spots for receiving and two spots for shipping. I also want to change the tank car spur name to receive any type of Tank Food cars.

Now I am going to restrict my set of available cars to just the box cars while I work on this. I do this by using the ‘Set’ button in the Cars form to set all the other cars to have no location. I also set all the box cars to be located in ‘Cassette’. I’m also doing to change the color of the box cars so that I can see what is happening a bit easier. When I am satisfied with the results, I will return them to their true colors.
I want to start to develop the different loads (commodities) that each box car may contain. I look at the table I created above and see that box cars may contain the following loads: sugar, shortening, milk powder, yeast, pie fillings and nothing.

By ‘nothing’, I mean that the box car is empty when it is spotted at Bakery. I will use a load name of ‘MT’ to indicate an empty car. As I understand it, “MT” was railroader’s shorthand for just this.

I use the ‘Edit Boxcar Loads’ form (Cars -> Edit -> Load -> Edit) to add these loads to the selection of box car loads.
The list of available box car loads now looks like this:

Now that I have defined the box car loads, I need to indicate where those loads are to be shipped to at Bakery. I do this by editing the spur tracks at Bakery (only the box car ones for now) and creating schedules for them.

Schedules add an extra dimension to the operations model because they not only allow me to refine which loads and how many are to be received, they also let me define when or in what order goods are to be received. I will touch upon the when and what order more a bit later.

For now, I add a schedule for the receiving box car spots. I add an entry for each possible inbound box car load. I also set the schedule mode to ‘Match’. This will cause JMRI Operations to try to match as many inbound loads as possible. If I left the mode set to ‘Sequential’, JMRI would only use the load marked by the “Current” indicator “→”.

I have also set the ‘Ship’ load value to ‘MT’ as opposed to ‘E’. This will help later on.

Now I want to set up the shipping spurs. But wait! What load am I shipping from Bakery? I look at my Bakery commodities table as see that I want to ship “Baked Goods”. I need to add that to my set of loads for box cars.
Now I can finish editing the schedule for box cars shipped from Bakery.

![Train Manifest Bakery Turn Job]

I decide to build a Bakery Turn job to see how it goes.

<table>
<thead>
<tr>
<th>Train Manifest Bakery Turn Job</th>
<th>January 6, 2013 10:08 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lance Mindheim - Bakery</td>
<td></td>
</tr>
<tr>
<td>Manifest for train (CSX 751) Bakery Turn Job</td>
<td></td>
</tr>
<tr>
<td>Valid 1/6/2013 10:08</td>
<td></td>
</tr>
</tbody>
</table>

Scheduled work at Cassette, departure time 00:00
- [ ] Pick up CSX 5233 GP35 from Cassette
- Train departs Cassette Westbound with 0 loads, 0 empties, 60 feet, 130 tons
- No work at Bakery

Scheduled work at Cassette, estimated arrival time 00:12
- [ ] Set out CSX 5233 GP35 to Cassette
- Train terminates in Cassette

There is no work to do. What did I miss? What does the Train Build Report tell me?

Location (Cassette) requests 5 pick ups, 5/5 moves are available
Find destinations for (BN 730447) type (Boxcar) location (Cassette, Cassette-1)
Searching location (Bakery) for possible destination
Can't set out (BN 730447) to track (Bakery-3-XM-Receiving) due to schedule NO MATCH
Can't set out (BN 730447) to track (Bakery-3-XM-Shipping) due to schedule NO MATCH
Can't set out (BN 730447) to track (Bakery-1-HO-Grain) due to type (Boxcar)
Can't set out (BN 730447) to track (Bakery-2-TM) due to type (Boxcar)
Could not find a track for (BN 730447) at destination (Bakery)
Searching location (Cassette) for possible destination
Can't set out (BN 730447) to track (Bakery-3-XM-Receiving) due to schedule NO MATCH
Can't set out (BN 730447) to track (Bakery-3-XM-Shipping) due to schedule NO MATCH
Can't set out (BN 730447) to track (Bakery-1-HO-Grain) due to type (Boxcar)
Can't set out (BN 730447) to track (Bakery-2-TM) due to type (Boxcar)
Could not find a track for (BN 730447) at destination (Bakery)
Searching location (Cassette) for possible destination
Car (BN 730447) location is equal to destination (Cassette) skipping this destination
Could not find a destination for car (BN 730447)
Find destinations for (BN 730936) type (Boxcar) location (Cassette, Cassette-1)
Searching location (Bakery) for possible destination
Can't set out (BN 730936) to track (Bakery-3-XM-Receiving) due to schedule NO MATCH
Can't set out (BN 730936) to track (Bakery-3-XM-Shipping) due to schedule NO MATCH
Can't set out (BN 730936) to track (Bakery-1-HO-Grain) due to type (Boxcar)

Aha! The box car schedule cannot find any box cars that match my criteria. I forgot to set the loads for the box cars in Cassette.
I decide to set up the loads as follows:

<table>
<thead>
<tr>
<th>Car Color</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Sugar</td>
</tr>
<tr>
<td>Orange</td>
<td>Shortening</td>
</tr>
<tr>
<td>Purple</td>
<td>Pie Filling</td>
</tr>
<tr>
<td>Tuscan</td>
<td>MT</td>
</tr>
<tr>
<td>Yellow</td>
<td>MT</td>
</tr>
</tbody>
</table>

I reset and then build the Bakery Turn job again.

```
Train Manifest Bakery Turn Job - 1 - January 6, 2013 10:14 AM

Lance Hindheim - Bakery

Manifest for train (CSX 751) Bakery Turn Job
Valid 1/6/2013 10:14

Scheduled work at Cassette, departure time 00:00
    [ ] Pick up CSX 5233 GP35 from Cassette
    [ ] Pick up BN 730297 Boxcar 50' Green Sugar from Cassette
    [ ] Pick up BN 730352 Boxcar 50' Orange Shortening from Cassette
    [ ] Pick up BN 730447 Boxcar 50' Purple Pie Filling from Cassette
    [ ] Pick up BN 730485 Boxcar 50' Tuscan MT from Cassette
    [ ] Pick up BN 730936 Boxcar 50' Yellow MT from Cassette
Train departs Cassette Westbound with 5 loads, 0 empties, 330 feet, 570 tons

Scheduled work at Bakery, estimated arrival time 00:04
    [ ] Set out BN 730297 Boxcar 50' Green Sugar to Bakery
    [ ] Set out BN 730352 Boxcar 50' Orange Shortening to Bakery
    [ ] Set out BN 730447 Boxcar 50' Purple Pie Filling to Bakery
    [ ] Set out BN 730485 Boxcar 50' Tuscan MT to Bakery
    [ ] Set out BN 730936 Boxcar 50' Yellow MT to Bakery
Train departs Bakery Eastbound with 0 loads, 0 empties, 50 feet, 130 tons

Scheduled work at Cassette, estimated arrival time 00:27
    [ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette
```

Now that's more like it! I move and build a few more trains to see what happens.

On the next build, only the box car with the Pie Filling is returned MT to Cassette.

On the build after that, no work is to be done!

The Train Build Report contains this entry:

Location (Bakery) requests 5 pick ups, 5/5 moves are available
Find spur for car (BN 730936) custom load (Baked Goods) at (Bakery, Bakery-3-XM-Shipping)
Could not find a spur for car (BN 730936) custom load (Baked Goods)
Find destinations for (BN 730936) type (Boxcar) location (Bakery, Bakery-3-XM-Shipping)
JMRI could not find a spur that was demanding 'Baked Goods', so it could not move the car.

**Commodities shipped from one location must have a corresponding receiving location.**

I set up the Cassette location spur to receive the goods from Bakery by adding a schedule to the spur and reset and build the train again.

![Add Schedule for Spur Cassette-1](image)

**Train Manifest Bakery Turn Job**  
Lance Minheim - Bakery

Manifest for train (CSX 751) Bakery Turn Job  
Valid 1/6/2013 10:40

Scheduled work at Cassette, departure time 00:00
- Pick up CSX 5233 GP35 from Cassette  
Train departs Cassette Westbound with 0 loads, 0 empties, 60 feet, 130 tons

Scheduled work at Bakery, estimated arrival time 00:08
- Pick up BN 730297 Boxcar 50' Green MT from Bakery  
- Pick up BN 730352 Boxcar 50' Orange MT from Bakery  
- Pick up BN 730485 Boxcar 50' Tuscan Baked Goods from Bakery  
- Pick up BN 730936 Boxcar 50' Yellow Baked Goods from Bakery  
Train departs Bakery Eastbound with 4 loads, 0 empties, 276 feet, 482 tons

Scheduled work at Cassette, estimated arrival time 00:24
- Set out BN 730297 Boxcar 50' Green MT to Cassette  
- Set out BN 730352 Boxcar 50' Orange MT to Cassette  
- Set out BN 730485 Boxcar 50' Tuscan Baked Goods to Cassette  
- Set out BN 730936 Boxcar 50' Yellow Baked Goods to Cassette  
- Set out CSX 5233 GP35 to Cassette  
Train terminates in Cassette

When I build and move the train a couple of times, I see that only the MT box cars are being routed to Bakery. Looks like I need to fill in the ship values on the Cassette spur schedule.

![Add Schedule for Spur Cassette-1](image)

I still get only the MT box cars being shipped when I build the Bakery Turn job. Maybe I need to add the Destination too.
Success!

Train Manifest Bakery Turn Job - 1 - January 6, 2013 10:50 AM

Lance Mindheim - Bakery

Manifest for train (CSX 751) Bakery Turn Job
Valid 1/6/2013 10:50

Scheduled work at Cassette, departure time 00:00
[ ] Pick up CSX 5233 GP35 from Cassette
[ ] Pick up BN 730297 Boxcar 50' Green Sugar from Cassette
[ ] Pick up BN 730352 Boxcar 50' Orange Shortening from Cassette
[ ] Pick up BN 730447 Boxcar 50' Purple Pie Filling from Cassette
[ ] Pick up BN 730485 Boxcar 50' Tuscan MT from Cassette
[ ] Pick up BN 730936 Boxcar 50' Yellow MT from Cassette
Train departs Cassette Westbound with 5 loads, 0 empties, 330 feet, 570 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Set out BN 730297 Boxcar 50' Green Sugar to Bakery
[ ] Set out BN 730352 Boxcar 50' Orange Shortening to Bakery
[ ] Set out BN 730447 Boxcar 50' Purple Pie Filling to Bakery
[ ] Set out BN 730485 Boxcar 50' Tuscan MT to Bakery
[ ] Set out BN 730936 Boxcar 50' Yellow MT to Bakery
Train departs Bakery Eastbound with 0 loads, 0 empties, 60 feet, 130 tons

Scheduled work at Cassette, estimated arrival time 00:27
[ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette

I build and move the Bakery Turn job a couple of times and watch the box cars move between Cassette and Bakery as I would expect.

In the next part, I want to look at adding more box cars at Cassette to make sure I get a good mix of cars and to look at the effect of setting the hits and wait values in a schedule.

**Part 5**

In my last blog posting, I managed to get the box car traffic between Cassette and Bakery working the way I wanted it with a mixture of box cars and loads being dropped and picked up at Bakery. I had limited the number of box cars to five which matched the number of box car spots at Bakery.
Now I want to add more boxcars and restore the other traffic (covered hoppers and tank cars) to see how the mix of cars is handled. I start by adding the three more box cars (RBOX) and spotting the hoppers and tank cars at Cassette.

I build the Bakery Turn job and preview the manifest.

<table>
<thead>
<tr>
<th>Train Manifest Bakery Turn Job</th>
<th>-1-</th>
<th>January 13, 2013 5:28 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lance Mindheim - Bakery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manifest for train (CSX 751) Bakery Turn Job</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid 1/13/2013 05:38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheduled work at Cassette, departure time 00:00
- [ ] Pick up CSX 5233 GP35 from Cassette
- [ ] Pick up ALNK 396059 HopGrain 52' Blue L from Cassette
- [ ] Pick up CRGX 16225 Tank Food 50' Black E from Cassette
- [ ] Pick up CRGX 16534 Tank Food 50' Black L from Cassette
- [ ] Pick up CRGX 16944 Tank Food 50' Black E to Bakery

Train departs Cassette Westbound with 2 loads, 2 empties, 278 feet, 367 tons

Scheduled work at Bakery, estimated arrival time 00:04
- [ ] Set out ALNK 396059 HopGrain 52' Blue L to Bakery
- [ ] Set out CRGX 16225 Tank Food 50' Black E to Bakery
- [ ] Set out CRGX 16534 Tank Food 50' Black L to Bakery
- [ ] Set out CRGX 16944 Tank Food 50' Black E to Bakery
- [ ] Pick up BN 730297 Boxcar 50' Green MT from Bakery
- [ ] Pick up BN 730352 Boxcar 50' Green MT from Bakery
- [ ] Pick up BN 730447 Boxcar 50' Green MT from Bakery
- [ ] Pick up BN 730485 Boxcar 50' Green Baked Goods from Bakery
- [ ] Pick up DN 730936 Boxcar 50' Green Baked Goods from Bakery

Train departs Bakery Eastbound with 5 loads, 0 empties, 330 feet, 570 tons

Scheduled work at Cassette, estimated arrival time 00:39
- [ ] Set out BN 730297 Boxcar 50' Green MT to Cassette
- [ ] Set out BN 730352 Boxcar 50' Green MT to Cassette
- [ ] Set out BN 730447 Boxcar 50' Green MT to Cassette
- [ ] Set out BN 730485 Boxcar 50' Green Baked Goods to Cassette
- [ ] Set out BN 730936 Boxcar 50' Green Baked Goods to Cassette
- [ ] Set out CSX 5233 GP35 to Cassette

Train terminates in Cassette

This looks pretty good but I want to also build a schedule for the tank cars since they are most likely carrying different types of sweeteners – corn syrup in different grades, maltose, dextrose, fructose, etc.
So, I reset the build and create the tank car schedule and add the new load types to the Tank Food cars.

Then, I add a schedule for the tank cars to the Bakery.

I will leave the schedule mode at ‘Sequential’ for now to see what happens. I need to load up the tank cars in Cassette next.

I’m going to not set the destination track at Bakery to see what JMRI does.

Finally, I will set the load on some of the tank cars in Cassette.
I build and preview the Bakery Turn job:

```
Train Manifest Bakery Turn Job - 1 - January 13, 2013 6:05 AM

Lance Mindheim - Bakery

Manifest for train (CSX 751) Bakery Turn Job
Valid 1/13/2013 06:05

Scheduled work at Cassette, departure time 00:00
[ ] Pick up CSX 5233 GP35 from Cassette
[ ] Pick up ALN 396059 HopGrain 52' Blue L from Cassette
[ ] Pick up CRGX 16226 Tank Food 50' Black Corn Syr 100 from Cassette
Train departs Cassette Westbound with 2 loads, 0 empties, 170 feet, 309 tons

Scheduled work at Bakery, estimated arrival time 00:04
[ ] Set out ALN 396059 HopGrain 52' Blue L to Bakery
[ ] Set out CRGX 16226 Tank Food 50' Black Corn Syr 100 to Bakery
[ ] Pick up BN 730297 Boxcar 50' Green MT from Bakery
[ ] Pick up BN 730352 Boxcar 50' Green MT from Bakery
[ ] Pick up BN 730447 Boxcar 50' Green MT from Bakery
[ ] Pick up BN 730485 Boxcar 50' Green Baked Goods from Bakery
[ ] Pick up BN 730936 Boxcar 50' Green Baked Goods from Bakery
Train departs Bakery Eastbound with 5 loads, 0 empties, 330 feet, 570 tons

Scheduled work at Cassette, estimated arrival time 00:33
[ ] Set out BN 730297 Boxcar 50' Green MT to Cassette
[ ] Set out BN 730352 Boxcar 50' Green MT to Cassette
[ ] Set out BN 730447 Boxcar 50' Green MT to Cassette
[ ] Set out BN 730485 Boxcar 50' Green Baked Goods to Cassette
[ ] Set out BN 730936 Boxcar 50' Green Baked Goods to Cassette
[ ] Set out CSX 5233 GP35 to Cassette
Train terminates in Cassette
```

It looks like setting the schedule mode to ‘Sequential’ has caused only one tank car to be delivered. Since Bakery has four tank car slots, this is not really what I want. I reset the train build and set the schedule mode to ‘Match’.
That looks better.

So far, every car is fully loaded or unloaded at Bakery within a single turn. That is, a loaded car is unloaded by the time the next train arrives. What if I want some loads to take a little longer?

According to the JMRI operations help file, this is what the ‘Wait’ column in the schedule is for. The wait number is the number of trains before the car is available. I will test this by setting the wait value on the tank cars to two.

Building a number of Bakery Turn jobs show that the tank cars are only being moved from the Bakery on every second train.

I’m going to add a schedule for the grain hopper as well. I add the loads ‘Wheat’ and ‘MT’ to the grain hopper car type and then create a simple schedule.
I also make the corresponding change to the Cassette schedule.

At this point, I would probably give serious consideration to re-casting the Cassette spur as three different spurs (Cassette-HO, Cassette-TM, Cassette-XM) so that I could manage the schedules at a finer grain. For now, the single spur is enough.

To test everything so far, I reset all my cars as follows:
The following table shows the traffic generated between Cassette and Bakery over a number of Bakery Turn jobs.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Bakery Drop Off</th>
<th>Bakery Pick Up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HO</td>
<td>XM</td>
</tr>
<tr>
<td>1</td>
<td>Wheat</td>
<td>Pie Filling, Shortening, Yeast, MT</td>
</tr>
<tr>
<td>2</td>
<td>Corn Syrup 100, Dextrose, Fructose</td>
<td>MT</td>
</tr>
<tr>
<td>3</td>
<td>Wheat</td>
<td>Milk Powder, Pie Filling, Sugar, MT</td>
</tr>
<tr>
<td>4</td>
<td>MT</td>
<td>MT, MT, MT, Baked Goods</td>
</tr>
<tr>
<td>5</td>
<td>Wheat</td>
<td>Shortening, Sugar, Sugar, MT</td>
</tr>
<tr>
<td>6</td>
<td>Corn Syrup 100, Corn Syrup 200, Corn Syrup 100</td>
<td>MT</td>
</tr>
<tr>
<td>7</td>
<td>Wheat</td>
<td>Milk Powder, Sugar, Shortening, MT</td>
</tr>
<tr>
<td>8</td>
<td>MT</td>
<td>MT, MT, MT, Baked Goods</td>
</tr>
<tr>
<td>9</td>
<td>Wheat</td>
<td>Shortening, Sugar, Sugar, MT</td>
</tr>
<tr>
<td>10</td>
<td>Corn Syrup 100, Corn Syrup 200, Dextrose</td>
<td>MT</td>
</tr>
</tbody>
</table>

This looks like a pretty good mixture to me. I could change the covered hopper load to more types of grain products: Durham, Semolina, Soft, Hard, etc. and add wait times to the Cassette spur schedule to mix up the traffic even more.
This is the last blog posting I plan on doing for this worked example. I have come a long way since loading JMRI onto my computer and wondering if it was really what I wanted to use instead of car cards.

For me, the answer has been a resounding ‘Yes’! JMRI has presented me with the tools I need to use for my switching operations and there is still much more to explore – yards, blocking, aggressive builds – the list continues to grow.

Before I conclude, I’d like to thank all the developers of JMRI – especially Dan Boudreau – for creating such a good, free program and answering my beginner questions in the JMRI forum. I’d also like to thank Lance Mindheim for advocating that complex operations do not require a lot of industries or track. Consider that, by move 9 above, I will have had to deal with nine cars and probably twice as many pull-push operations at the Bakery. At switching speeds, that would easily take an hour of time to complete.

Finally, I would like to thank the members of the MRH forum (and MRH for hosting this blog) who have offered comments and suggestions. Keep ‘em coming guys!