Sometimes 35 is faster than 60

Signals and Speed Considerations

One of the things you'll want to think about in designing your route is track speed and the effect signaling can have on it. Another factor is distance between signals. Placed correctly, signals can help keep your trains moving well. Placed incorrectly, they can hamper traffic flow. In this tutorial we'll discuss some of the issues involved and look at an example from a real Trainz route.

You're familiar with the typical green=go, red=stop indications signals have, along with their various combinations of caution signals, but I'd like to begin with are the speed restrictions signals can have in the Trainz world.

In the Trainz world, a caution signal usually means slow to half speed and prepare to stop at the next signal. *Usually*, but not always. The amount the train slows depends on the posted track speed. If the track speed is 40mph (or the equivalent in metric) or more, train speed is indeed restricted to half the posted speed. For example, if the track speed is 60mph, the train will slow to about 30mph under caution.

That's pretty simple. But…if the track speed is 35mph or less, the train will *not* reduce speed, but will continue at the posted speed. (I'm not suggesting this is prototypical, of course, but that's the way it works in TRS2006.)

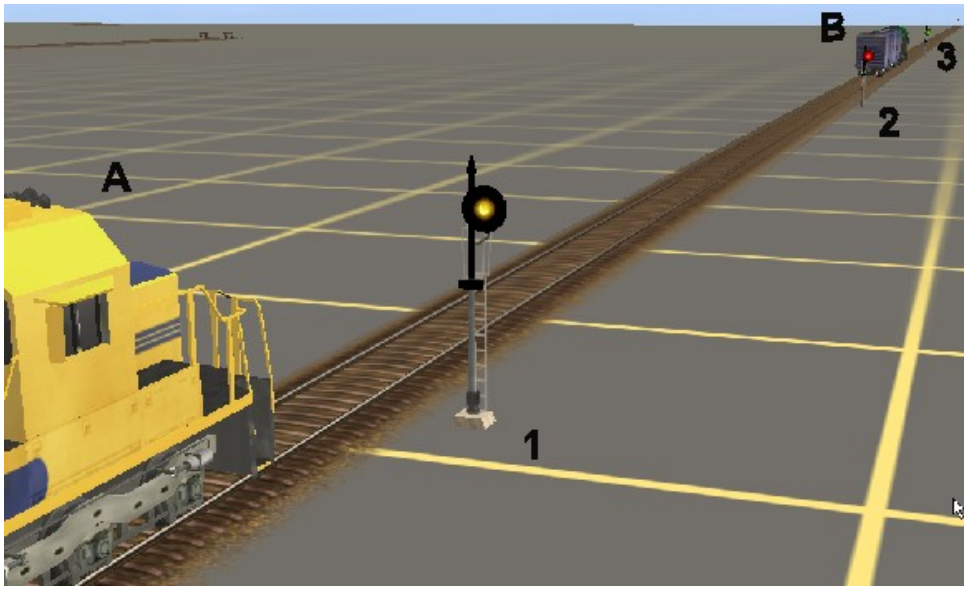
Given a yellow signal, then, a train on a track with a posted 35mph speed will run at full speed, but same train on a 60mph track will only run at 30mph. That's when 35 is faster than 60!

In fact, the situation is even worse if the track speed is 40. In that case, the restricted speed is only 20. So if you have a section of 40mph track that is likely to get a frequent caution signal, consider making the track speed 35 instead of 40, so the train will run at 35, even under caution. Get the idea?

I'll more to say about that in a few minutes, along with a real-life example from my Midwest Central route.

A caution signal can have a major impact on train movement. If we have a mainline track speed of, say, 60mph, the train will slow to 30mph under caution, like we said. But, more importantly, the train will remain at half speed until it reaches the next clear signal—even if that signal is five *miles* away.

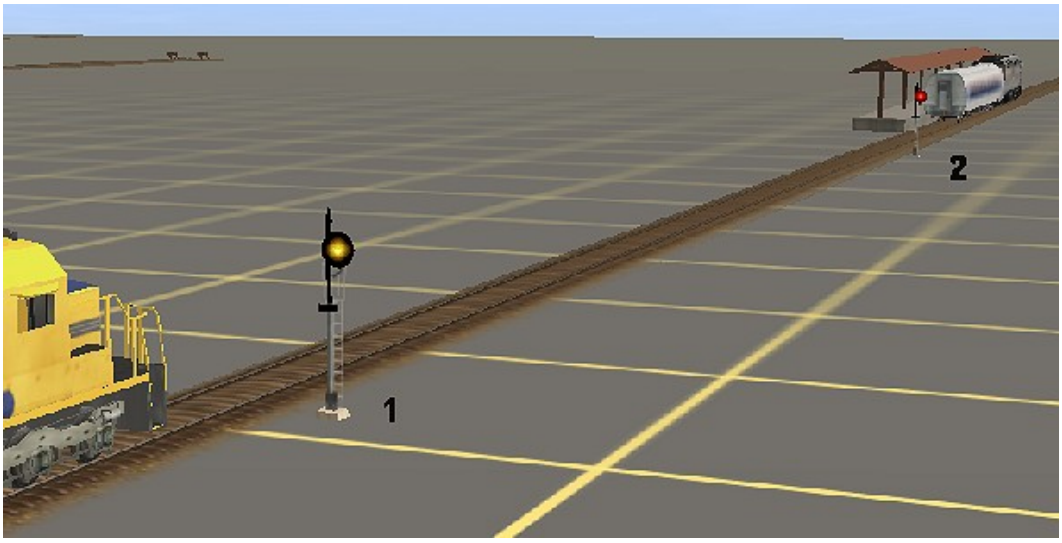
Consider the picture on the next page. Train A is following train B. As train A enters the block between signal 1 and 2, it has a caution signal, requiring A to run at half speed until it reaches signal 2.



Let's say the distance between signals 1 and 2 is two miles. Because it's under restriction, train A must run the whole two miles at restricted speed, even if train B leaves the block between signals 2 and 3.

Here's the point. If your signals are too widely spaced, a caution signal might cause a lengthy delay for a following train. Give careful consideration to the spacing of your signals. In congested areas where traffic is likely to be heavy, place signals closer together, to minimize long times under caution. In open country, where traffic is lighter, signals can be spaced further apart, but not too far apart.

One way we can help keep traffic moving is by using approach signals. Check out the picture below:



In the picture, we have a 60mph mainline track, with a freight train at signal 1 and a passenger train standing in the station on the other side of signal 2. The red signal is the “home” signal, protecting the rear of the passenger train. The yellow signal is called an “approach” signal, and it is designed to give advance warning to track conditions ahead.

Our goal in laying out the track section between signals 1 and 2 is to allow the freight train to run at full speed as long as possible. With that in mind, we want to place the approach signal as close to the station as we can, consistent with safe operating conditions.

How close? *The ideal distance is the stopping distance for your longest train at the posted speed limit*. If you typically run 20-car trains at 60mph along a track, the stopping distance is a far less than for 70-car trains at the same speed. You’ll have to experiment to determine how much space you need.

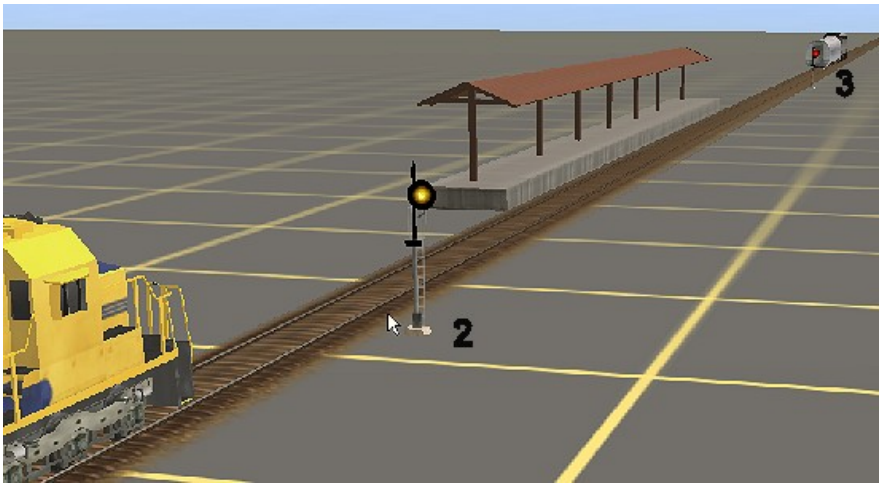
And don’t forget to allow for grades as well. If the track section is on a downhill slope, the stopping distance is increased…sometimes greatly. Ever tried to stop a 50-car train of loaded coal hoppers on a downhill grade?

The bottom line: Allow your drivers plenty of stopping room, but don’t put that approach signal a mile away if a quarter-mile is enough. Doing so only serves to delay your traffic unnecessarily.

Now take a look at the drawing below. The passenger train has departed the station, and the freight is waiting to proceed. What happens to the red signal?

It stays red, because the passenger train is still occupying the block following the signal. In fact, the signal will continue to stay red until the passenger train completely passes the *next* signal, even if that signal is five miles down the track.

So what can we do to allow the freight train to proceed? We place a third signal on the other side of the station, as in the picture below:



After the passenger train leaves the station block between signals 2 and 3, the AI will now see that block as clear. Accordingly, signal 2 will turn to yellow, allowing the freight train to proceed at restricted speed.

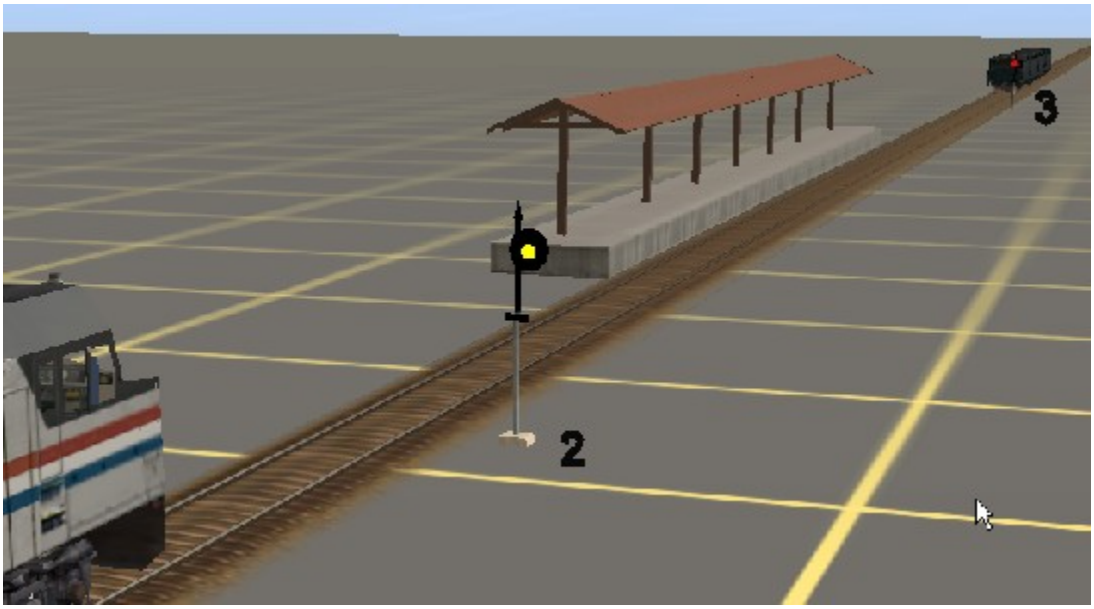
You might say, “What good is that? The freight train can’t move very far between signals 2 and 3.” That’s correct, but it *does* continue to move, and if the distance is a couple of thousand feet, the passenger train, now running at full speed, has a chance to increase it’s lead, perhaps enough the freight train will get at least a yellow by the time it reaches signal 3.

There’s another reason have signal 3 just beyond the station. Let’s say the situation is reversed, and the freight train is the one at the station.

In the picture above, the passenger train is stopped at the signal. Now let's say the coal train departs the station area, as in the picture below:

Notice that even with the freight train gone, the passenger train is still stuck by red signal number 2, even though the track into the station is obviously clear. Without signal number 3 on the other side of the station, the passenger train will be stuck at #2 signal, until the freight train clears signal #4, far down the track.

With signal 3 in place, as shown in the picture below, once the freight train passes signal 3, the passenger train gets a yellow and can enter the station.



Now those of you pretty sharp with signals will have noticed that signal #2 is a USA-05, and as such it is a *permissive* signal, meaning that a train is permitted to pass red at restricted speed, provided it comes to a complete stop first on reaching the signal. Under these conditions, on a Trainz route a manual driver could pass the signal after stopping and then pull into the station. (AI-controlled trains, though, will not pass a permissive.)

The permissive signal would seem to eliminate the need for signal 3, but that's not the case. Here's why: Even though a manually controlled train *could* enter the station on a red signal, when it gets ready to leave it is still under restriction. There's no signal in sight to tell the driver if the track ahead is clear. He would have to proceed at restricted speed all the way to the next signal, no matter how far away that might be.

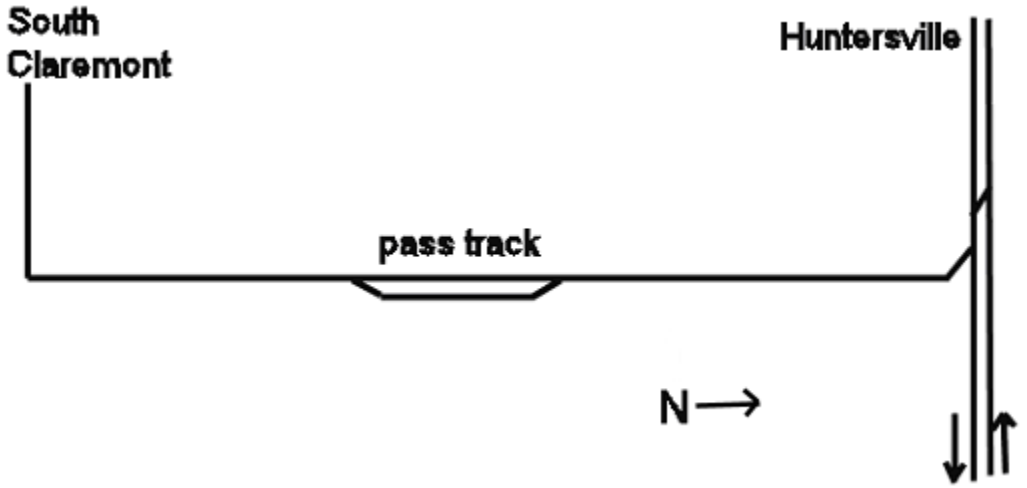
By having signal 3, if the block past that signal is clear, the passenger train could depart the station as soon as it's ready. Get the idea?

A real Trainz example:

I come up with the idea for some of these tutorials based on my experiences trying to get the Trainz AI work the way I think it should. In the following example, you'll see a good example of how you're sometimes forced to choose between the lesser of two "evils" in designing your signal system and setting your track speeds.

In Release 2 of my Midwest Central route, I have a branch line from South Claremont to Huntersville. It's a 5-mile stretch of single track, with a pass track long enough for about 30 cars near the middle.

For this example, I'll direct your attention to the northern half of the line, the two miles from the end of the pass track to the main line at Huntersville. Here's a diagram, with a couple of pictures on the next page:



Pardon the rain. ☺ The picture on the left is the north end of the pass track, with the Amtrak train just short of the signal. The right picture is where the South Claremont branch joins the main line just east of Huntersville.

The main line is double track, with the eastbound traffic coming toward you on the left hand track. (Reminder: We're in the USA, for those of you overseas.) Westbound traffic is on the right track, going away from you.

Trains coming from South Claremont join the main line from the lower left, and from there take the crossover at B to get to the westbound track.

Here's the problem, and the reason I wrote this tutorial. Because trains from South Claremont have to take the crossover, the signal at A is *always* red until just before a train reaches it, even if the track ahead is clear.

Do you see the implications of this? With the signal at A always red, the signal in front of the passenger train will *always* be yellow, forcing the Amtrak train to run the whole two miles from the pass track to the main line under caution.

And "under caution" means half speed, doesn't it? So, even though the track will support a faster speed, I've set the speed limit to 35 for this section. Remember why? Because with a track speed of 40, a caution will force the train to run at 20 for the whole two miles. By setting the track speed to 35mph, the train can run at 35 instead of 20.

As you work on your own route, keep this example in mind, and look for places to streamline your traffic flow.

Before we close, I want to mention an important caveat to what we've discussed here, especially as it relates to approach and departure signals. In the examples we've talked about, the trains are moving in one direction only. If traffic is moving in both directions, then the rules are different, and the approach/departure signal concept may lead to traffic jams.

Consider the following example. The blue dots represent signals facing trains running left to right. The green dots represent signals facing trains running right to left. Notice that signals 2 and 3 represent the approach and departure signals we discussed earlier, and the dark rectangle is the station.

Before I go further, let me introduce a general signaling rule that everyone new to surveyor should follow. There are always exceptions, of course, and we'll talk about some of those in a bit, but here's the rule:

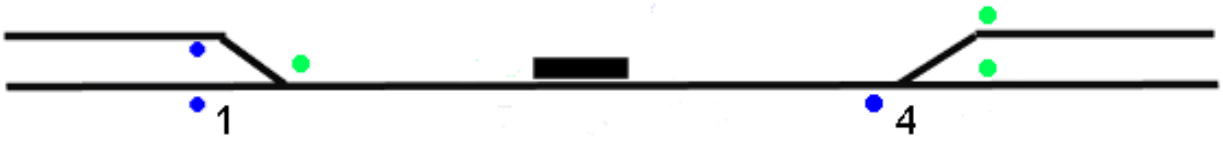
If a section of single track is used for two-way traffic, do not place any signals between the junctions at each end, no matter how long the track is.

In this case, the rule says not to use signals 2 and 3 when traffic runs in both directions. Here's why: Any time you have signals along a single track, it's possible for trains to enter from both directions at the same time. If they do, they'll meet somewhere in the middle, the classic "cornfield meet" situation. Even if they stop without running into each other, both trains will be trapped facing each other and neither can escape without one of them backing up.

The rule does not apply to signals placed near the end of the block, facing the turnout, such as the blue signal near switch 4 and the green signal just to the right of switch 1. These signals generally work. Let's say we have a train in the block between switches 3 and 4. Let's also say we have a second train on the lower track to the right of signal 4. The two trains will certainly meet at signal 4, but in this case the train in the 3-4 block has a way of escaping, by using the pass track. Do you see the difference?

Now having made a big deal of the rule, there are times when things don't work like they should. In fact, a visit to the forums will reveal many examples of bugs in the Trainz AI.

As I was writing this tutorial, I spent more than eight hours trying to come up with a signaling scheme for single track that I was happy with. I couldn't. All I can say is the diagram below works *most of the time*.



If you're new to Surveyor, I suggest you follow the design above. The blue dots at signal 1 and the green dots at 4 are all xx-04 signals. The green dot at 1 is an xx-02 and the blue dot at 4 is a xx-02L, since it's a left divergence. (Since this map is USA-based, the signals are placed to the right of the track.)

One of the reasons I really like my double track mainline in Midwest Central is that many of these signaling issues go away. You just set directional arrows to keep the traffic on the correct track, and the approach and departure signals work fine. If you're creating a fictional route, consider the double track idea. If, of course, you're modeling a real-life single track line, then things becomes more complicated, and you just have to deal with the problems of single track signaling.

I'll have more to say about my adventures in signaling in a future tutorial.

Conclusion

In this tutorial, we've looked at track speeds and the effect caution signals can have on them. We also talked about distances between signals and how approach signals and departure signals can help keep your traffic moving.

We also introduced some important rules newcomers should follow.

I hope you've found this information useful.

Chuck
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