We covered this issue to some extent in our April edition (Careers, ‘Axle Weights and Staying Legal’), but it seems I was a little off the mark in my theory for loading to legal maximums. Ray Camball of Trailmobile Canada called me to say that while I was on the right track, I was wrong in simply suggesting that drivers parcel out the load and place so much here and so much there. He kindly agreed to help out in providing a more precise approach to the exercise.

So, with Ray’s help and perspective, we’re going to take another look at axle weights here. And for clarity’s sake, we’ll be using American axle-weight limits in most of our examples. Some Canadian examples appear in the chart on p34/35.

Axle-weight violations are costly, and they do affect a carrier’s safety ratings in many jurisdictions. But there are other aspects to the issue as well, like equipment spec’ing and vehicle handling characteristics, to name just a couple.

Trailer makers use weight-distribution software to calculate axle weights under different payload and vehicle configuration conditions when engineering trailers. It’s easy to load a truck right to the pound in a computer simulation, but it’s a bit tougher to eyeball the load to the legal maximum. With the help of Trailmobile Canada’s Ray Camball’s, we’ll explain how to load for better axle-weight distribution. Knowing how to load could save you a bit of dough on your next trip across a scale or when spec’ing your next truck or trailer.

In aviation, this exercise is called the ‘weight and balance’ calculation. It’s the art and science of properly distributing the weight of the passengers and their baggage on an aircraft. You can’t, for example, put all the passengers in the front of the plane because you’d never get the nose to lift for take-off.

Despite your best efforts in getting legal before you leave the dock, these folks keep a pretty close eye on how well you do this part your job. Forewarned is forearmed, and we’re not talking about whether or not the lights are on. Learn to load the wagon properly.

Where weight is placed on a trailer can also make an incredible difference, like 5000 to 10,000 lb in lost payload capacity in a worst-case scenario, Camball says.

You might think that distributing the weight evenly from front to back in the trailer will balance the weight borne by the drive and trailer axles, but that’s usually not the case. Placing the load on the trailer in such a way as to split the weight evenly on either side of the trailer’s mid-point will usually result in a larger portion of the load’s total weight being borne by the trailer axles. Knowing where to ‘center’ your load on the trailer can make all the difference between a legal load, and an overweight fine.

Axle-Weight Analysis
Before we start mapping out load placement, it would be worth looking at some of the factors that affect payload capacity and weight distribution. Trailer kingpin placement is one of the more significant ones. You’ll have probably noticed that multi-axle trailers have shallow pin placements, 24
in. or so, less in some cases, while the lead trailer of a set of B-trains tends to have a deeper kingpin setting – commonly around 42 in., with some as deep as 60 in. or more.

The shallow setting causes more of the weight to ride on the trailer axles, which is desirable in a tri- or quad-axle application. The deep setting on a B-train lead is designed to keep the weight on the tractor and off the center axle grouping. Often, the pup has a very shallow setting, intended also to keep the weight off the center axles by letting the pup tandem do most of the work. This is especially true in the case of a seven-axle train, while it’s not so much of an issue with the eight-axle combinations.

“The 36-in. kingpin setting typical of 53-ft trailers is a compromise, and a throwback to the era of 48-ft trailers. The 36-in. pin worked well with the 48-footers, but the 53-footers really should have a 42-in. pin setting,” Camball says. “When 53-ft trailers were introduced, a few jurisdictions had old regulations on their books limiting the kingpin to 36 in. and we pretty much decided to live with that rather than go through a long and tedious process of convincing them to change their rules. Now we have to compromise by placing the center of the payload (weight-wise) ahead of the center line of the trailer to overcome the effects of the ‘wrong’ kingpin setting.”

By loading ahead of center, you remove weight from the trailer axle and place it toward the front where, by sliding the fifth wheel forward, you can shift weight off the drives and onto the steer axle.

There are obvious limits to the weight one can stuff onto a trailer; your payload will be dictated by the gross combination weight (GCW) limit minus the tare weight of the truck and trailer. This creates pressure to maximize payload by spec’ing the absolute lightest unit possible – using fewer crossmembers or vertical posts, for example, or spec’ing a lighter pick-up plate, etc. But by making better use of your existing carrying capacity, Camball says you can often get away with spec’ing a heavier and more durable tractor-trailer combination.

To gain a better understanding of how much weight you’re actually hauling, and how that weight is distributed on the axles, every load should be weighed on an axle scale. You might find that you typically run light on the steer axle, light on the drives, but heavy on the trailer. This would suggest the weight is sitting too far back in the trailer. If you’re heavy up front and light on the back, the weight might be too far forward. The difference between the lightly loaded axe and its maximum carrying capacity is lost payload potential that could be accommodated by simply rearranging the freight. Being aware of how the weight is distributed ‘naturally’ is the first step toward learning how to position the weight where it should be to stay legal and to maximize capacity.

While a few overweight tickets may prompt equipment buyers to lurch toward a lighter spec, simply learning to load the truck properly could be a wiser, less expensive alternative to the lighter spec.

Referring to the payload capacity chart on p. 34/35, the examples also illustrate how much payload capacity can be pulled out of two identical units just by loading them properly. As illustrated in example 13, switching from steel to aluminum wheels and hubs, going with low-profile tires, and skimping on the weight of the structural parts, wouldn’t make up one-quarter of the difference gained by just positioning the load forward a couple of feet.

The same applies to overweight fines: examine the tickets to see where you’re heavy, and adjust your loading strategy to overcome the problem. Of course, if you’re over gross, there will need to be some other adjustments made, which we can’t help you with.
The Balancing Act
When we talk about the center of the load, we’re of course referring to the point at which the load would balance — e.g., 23,000 lb at the front of the center point, and 23,000 lb to the rear of the center point. Of course, the weight center point might not be the actual middle of a row of pallets, especially if the load is mixed and of varying weights. But here’s where you earn your pay as a driver. You can make your life less complicated by arranging the load prior to filling the trailer so as to keep it as evenly balanced as possible.

If that’s not an option, err on the side of caution by loading the heavier pallets first, but try to maintain a maximum floor loading of about 900 lb per foot of trailer length. That would see two pallets loaded side by side, weighing a total of 3600 lb. This approach isn’t scientific, but it will give you a relatively even load from front to back.

Centering the Load — Centering the weight-center of the load over the center line of the trailer may seem to be the obvious way to go, but it usually results in overloaded trailer axles. Referring to lines 3, 4, 6, 12, and 13, you’ll see how centering the load would produce an overload condition on the trailer axle if the payload hadn’t been cut back way below normal.
The Hardware

The tractor-trailer itself will have an impact of weight and balance, of course, and at the bare minimum you should be aware of the empty (tare) weight of your unit. When you axle-weigh the truck empty, have the fuel tanks full, the truck equipped to run, and with the driver on board as this would likely be the heaviest you’ll ever get. Set the center of the trailer bogie to the 41-ft position and slide the fifth wheel to the appropriate position (8 in. ahead of center with a 50-in. set-back front axle, 12 to 14 in. ahead of center with a set-forward axle).

You’ll notice that the empty vehicle weights presented in the chart below vary only slightly, but the way the trucks are configured can affect payload by up to 10,000 lb.

Loading to the Rear — If you shift the center of the load weight back from the center line, the result will be an overload on the rear axles. This illustration shows space between the front wall of the trailer and the front end of the load. In real life, this could also represent lighter freight loaded in the nose, with heavier freight in the rear. Referring to line 16 of the chart, you can see that the payload has to be reduced by close to 10,000 lb because the rear axles are nearly maxed out.

Loading Ahead of Center — By shifting the load forward, you’re removing weight from the trailer axles, and placing it over the kingpin, which transmits weight to the tractor via the fifth wheel. The position of the fifth wheel dictates how the weight is divided between the drive and the steer axles. We know that the 36-in. pin setting is a bit shallow for the geometry of a 53-ft trailer. So we need to compromise by loading a little more weight into the nose of the trailer. Referring to the column that shows payload center-line placement, see how the farther forward the center of the load moves, the more the weight is shifted to the steer and drive axles.

Assumptions used for a 53’ tandem van and a tractor with the front axle 30’ from the front bumper:
Tractors with a front axle setback at 50” would need the fifth wheel at about 8” to 9” for full loads.

### Owner Operators Paid
- IRP Plates,
- Insurance
- Fuel Tax
- Tolls, Bridge Crossings,
- Fuel Surcharge and
- $1.01 Per Mile Plus Monthly Bonuses

### Company Teams Paid
- .48 Per Mile
- Plus Monthly Bonuses
- Group Insurance
- RRSP Contributions
- 24/7 Dispatch

### NEW Trucks Arriving
**Late June**

<table>
<thead>
<tr>
<th>Tractor weight (fuel/driver)</th>
<th>Fifth wheel ahead C/L (in)</th>
<th>Trailer weight (lb)</th>
<th>Bogie C/L from kingpin (ft)</th>
<th>Payload weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 19600</td>
<td>11</td>
<td>14800</td>
<td>41</td>
<td>56900</td>
</tr>
<tr>
<td>2 19400</td>
<td>12</td>
<td>14800</td>
<td>41</td>
<td>57100</td>
</tr>
<tr>
<td>3 19600</td>
<td>12</td>
<td>14800</td>
<td>41</td>
<td>54300</td>
</tr>
<tr>
<td>4 19600</td>
<td>12</td>
<td>14800</td>
<td>37</td>
<td>45800</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 19600</td>
<td>12</td>
<td>14800</td>
<td>41</td>
<td>41500</td>
</tr>
<tr>
<td>7 19600</td>
<td>13</td>
<td>14800</td>
<td>41</td>
<td>45200</td>
</tr>
<tr>
<td>8 19600</td>
<td>12</td>
<td>14300</td>
<td>41</td>
<td>45600</td>
</tr>
<tr>
<td>9 19600</td>
<td>13</td>
<td>14300</td>
<td>41</td>
<td>45800</td>
</tr>
<tr>
<td>10 19600</td>
<td>13</td>
<td>15100</td>
<td>41</td>
<td>45000</td>
</tr>
<tr>
<td>11 19200</td>
<td>14</td>
<td>14300</td>
<td>41</td>
<td>46300</td>
</tr>
<tr>
<td>12 19200</td>
<td>14</td>
<td>14300</td>
<td>41</td>
<td>42000</td>
</tr>
<tr>
<td>13 19200</td>
<td>14</td>
<td>14300</td>
<td>37</td>
<td>36900</td>
</tr>
<tr>
<td>14 19600</td>
<td>14</td>
<td>14300</td>
<td>38</td>
<td>45000</td>
</tr>
<tr>
<td>15 19200</td>
<td>14</td>
<td>14300</td>
<td>37</td>
<td>46300</td>
</tr>
<tr>
<td>16 19200</td>
<td>14</td>
<td>14300</td>
<td>41</td>
<td>36900</td>
</tr>
</tbody>
</table>
This chart takes empty-unit weights, potential payload, load placement, and fifth-wheel placement into account when calculating loads for steer, drive, and trailer axles. Camball’s computer simulations are based on straight mathematical calculations and have been proven time and time again by field-testing and real-world customer experience as long as the weight and measurement info is provided correctly.

Unfortunately, the only method of determining actual axle loads, short of using a computer program, is trial and error. Camball’s modeling will work only if your truck is exactly like the one he uses in the illustration, and if the load is the same weight. However, the principles used in the examples he has provided can serve as accurate templates for similar loads you may be carrying.

Let’s look at a few examples of how even a minor deviation can produce dramatic results. Compare lines 13 and 15: the units weigh the same, the fifth-wheel placement is the same, and trailer bogies are both centered at 37 ft. The steer- and drive-axle weights on line 13 are both way below maximum, but the trailer axle is loaded right to 33,978, because the load was positioned too far to the rear. In line 15, the load center is placed 67.5 in. ahead of center, shifting a lot of weight to the tractor axles. The trailer axles are actually slightly lighter.

In a less dramatic example, compare lines 12 and 13. Everything is the same, except the bogie position — line 12 is stretched out to 41 ft, while line 13 is shortened to 37 ft. Both loads are positioned at center, yet line 12 could be loaded 5100 lb heavier if the bogie was pulled back.

Now, let’s compare lines 11 and 12. Everything is the same except the load position: line 11 is centered 26 in. ahead of the van center line, while line 12 is sitting dead center in the middle of the trailer. By leaving the load that far to the rear, the trailer axles max out at 33,977, leaving the drive and steer axles well under maximum. Push the load center forward, as in line 11, and you move the weight off the trailer axles and onto the other axles. The gain for having moved the load just a couple of feet ahead is 4300 lb.

Before loading a trailer, following these guidelines, you’ll need to stake out the mid-way point of the van before you decide how far ahead of center to place the load. If there isn’t enough room between the load centerline and the nose of the trailer, double-stacking pallets in the nose would produce the same effect as extending the load four feet ahead of the front wall of the trailer. If you need empty space (weight) in the nose of the van, as you might in the front of a B-train pup, stand a couple of empty pallets on end to brace the load against the front wall.

There are certain rules of thumb you can safely stick to, assuming a modest-wheelbase tractor with a 53-ft van using a 36-in. kingpin. Brand of equipment is irrelevant, provided that spacing and...
spreads, tare weights, and kingpin placement are the same:

♦ When running a tractor with a 30-in. front-axle position, keep the fifth wheel about 12 in. ahead of center;

♦ When running a tractor with a 50-in. front-axle position, keep the fifth wheel about 8 in. ahead of center;

♦ Keep the trailer bogies at the 41-ft mark;

♦ In the U.S., the center of the payload should be at least 24 in. ahead of the center of the van;

♦ In Canada, the center of the payload should be at least 28 in. ahead of the center of the van;

♦ Because you gain some flexibility in the front by sliding the fifth wheel, vans should be loaded with the center of the payload anywhere from two feet to five feet ahead of the center of the van.

We said from the start that one could load almost to the pound using a computer program. Eyeballing it can be substantially less accurate, but if you stick to the principle Ray Camball has shared with us, you’ll be able to get closer than you think. You’ve still got a bit of room to slide on either end, and you can manage your fuel levels to reduce weight even further. Call it an art, a science, or a pain in the butt, weight and balance is something we have to deal with, and the penalties can be substantial. If a cash fine isn’t enough, try walking several dozen 100-lb bags of onions from the back of the trailer to the front to redistribute the weight. That’ll learn ya, real quick.)