WHERE TO CARRY A LOAD

The best option for you depends on your bicycle

by Jan Heine

If you want to start a lively discussion, ask a group of bicycle tourists how best to carry a load. Front rack versus rear? Wheel-top racks versus low-riders? What about trailers? Are backpacks okay? Every solution has fervent adherents, each has its detractors, and all can be made to work — if you're willing to put in some time. In this column, we'll look at the underlying physics to help you determine the best way to carry your load.

Let the bike carry the weight

Backcountry hikers have no alternative but to carry backpacks. On a bike, there is no need to burden your body. Let your bike carry your luggage. One possible exception is technical off-road terrain where a light bike can be easier to maneuver and carrying a backpack may make sense.

How a bicycle stays upright

Where should you put the weight on the bike? Let's look at how a bicycle is balanced by moving the ground contact patch from side to side, so it stays underneath the center of gravity. If the bike starts leaning to the left and the center of gravity no longer is over the wheels (Figure 1), you move the wheels to the left until they are back under the center of gravity of the bike. You constantly do this when you ride, even though you hardly notice on most bicycles. When you want to turn, you reverse the process: by moving the wheels away from the center of gravity, you get the bike to tilt over until it leans into the curve. (Throughout the curve, you move the wheels in relation to the centrifugal forces and gravity to keep the bike leaning as you desire.)

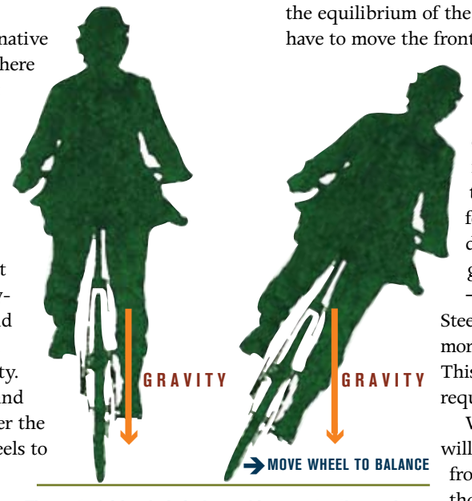

Figure 1: A bicycle is balanced by constantly moving the wheels to keep them under the center of gravity.

Front versus rear versus trailer

There are two reasons why a front load is inherently easier to balance than a rear load or a trailer.

– Time lag: when you turn the handlebars on a moving bicycle, you move the front wheel to the right or the left. The rear wheel then follows. Thus, the rear wheel reacts more slowly to your input than the front wheel. When a front load gets off-balance, you simply move the front wheel to that side to restore the equilibrium of the bike. To balance a rear load, you first have to move the front wheel, then wait until the rear wheel follows, which in turn restores the equilibrium of the bicycle. With a trailer, balancing your load requires one additional step: You move the front wheel, wait for the rear wheel to follow, then wait for the trailer to follow. The longer your correction is delayed, the more the load will have gone off-balance.

– Effect of steering corrections: Steering corrections affect a front load more directly than they do a rear load. This means that balancing a front load requires smaller steering corrections.

When you ride through a puddle, you will see that the tracks of the (steered) front tire are much more wiggly than those of the (trailing) rear wheel. (For the same reason, trucks with trailers need to make wide turns, because the trailer will cut across the corner in a straighter line than the truck.)

When your front load moves one inch to the side, you need only to move the front wheel by one inch to correct your center of gravity. However, when the rear load shifts by one inch, you need to move the front wheel further, perhaps two inches, to get the rear wheel to move an inch and be centered.

All this means that in principle, a front load is easier to balance than a rear load. And a rear load is still easier to balance than a trailer. As a side effect, a front load reduces the strain on your already over-stressed rear wheel. The symmetric front wheel is actually much stronger than the asymmetric rear wheel, yet it carries only a third to half the weight on most bicycles.

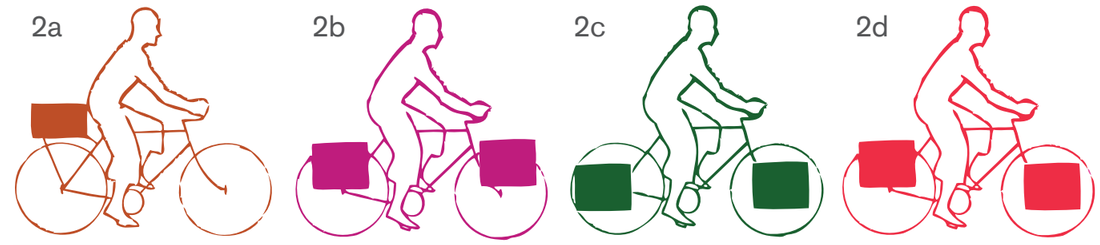

Figure 2: In 1946, Daniel Rebour drew the different load placements on a touring bike. Nothing has changed since then.

Real-world bicycles

Does that mean every bike should carry its load on the front wheel? Not quite: a front load does introduce a new set of variables, because it directly affects the steering of the bicycle.

There is no space in this column to get into the details of trail, wheel flop, inertia of the load, the influence of tires, and more. (We treated these subjects at length in *Bicycle Quarterly* Volume 5, Number 3.) Suffice to say that the effect of the front load on the steering can be harnessed to make a bicycle handle better with a front load than without, but only if the bike's geometry is suitable for a front load. Such a touring bike, fully loaded, handles as well as a good racing bike, whether cornering hard, riding no-hands (not recommended, of course), or climbing out of the saddle.

Most touring-bike manufacturers appear to have only a limited understanding of bicycle geometry. The geometries of most production touring bikes copy the "relaxed angles" of old British touring machines, which were designed for a rear load. Such a "rear-loading" bike will handle poorly with a heavy front load. Similarly, a heavy rear load on a front-loading bicycle also will impair the handling.

Front and rear load

For a tour that includes camping, most riders carry four panniers, and the question becomes not where to place the panniers, but how to distribute the load. How do you find out whether you have a front-loading or rear-loading touring bike? Experiment by riding laps around the same course, including straightaways, curves, climbs, and descents. For the first lap, put most of your weight in the rear panniers. For the second lap, switch the panniers around so the front ones are heavier. Repeat until you get a feel for the handling with each configuration. Back-to-back experiments like this allow you to find out which configuration works best for you and your bicycle.

Trailers

Despite their theoretical disadvantages, trailers offer versatility, especially for riders who do not have a touring bike. A trailer can be hitched to (almost) any bicycle. Some geometries work better with trailers than others. Insist on a test ride before buying a trailer to see whether it works with your bike. Tandems, with only half as many panniers per person as single bikes, also can benefit from trailers. However, even a lightweight trailer can add 10 pounds to your setup when compared to a set of good racks.

High versus low load

A lower center of gravity makes the bike easier to balance. The reason is simple geometry. For a lean of one degree, a lower load moves not as far sideways as a higher load. This means that the wheels don't need to move as far to become centered under the lower load.

Rack-top bags (Fig. 2a) sit much higher than necessary. In addition, most are supported only at the bottom, which means that much of the weight is free to wiggle from side to side. (A handlebar bag at least has a top support.) If you use a rack-top bag, put as little weight as possible inside, and place heavy items at the bottom.

Panniers (Fig. 2b) lower the center of gravity significantly. For many years, panniers were the standard solution for carrying touring loads. Starting in the 1930s, some French builders experimented with low-rider racks that place the bags even lower (Fig. 2c).

On the front, low-rider racks not only lower the load further, but they also place it further back and thus closer to the steerer axis of the bicycle. This reduces the inertia of the load, making the handlebars easier to turn than with a wheel-top rack.

On the rear, it is difficult to lower the load, because it interferes with your heels as you pedal. You can shift the load backwards, but this exacerbates problems associated with rear loads. I have used bikes with front and rear low-riders, but this set-up worked well only if most of the load was in the front panniers, and only light items were carried on the rear. With such a setup, cornering is improved due to the very low center of gravity and evenly distributed weight, but the panniers must be packed carefully to avoid putting too much weight behind the rear axle. For most riders, rear low-rider racks are not worth the trouble.

Conclusion

A front load is inherently easier to balance than a rear load, but few of today's touring bikes are designed for a heavy front load. The optimal solution for most bikes on paved roads is a combination of front low-riders with rear panniers on a wheel-top rack (Fig. 2d).

Experiment and determine which weight distribution works best for your bicycle. AC

Jan Heine is editor of Bicycle Quarterly, *a magazine about the culture, technology, and history of cycling. More information and back issues can be found at www.bikequarterly.com.*