

Adapted from
"The Weight Factor"
 by Jim Blackburn and Jim Gentes

Fore or Aft? High or Low?

*Where to Put the
 Weight on Your Bike*

Darryl Skrabak

Last year Jim Blackburn Touring Performance Products of Campbell, California, introduced a new "low-rider" front wheel rack with panniers located in a novel position: at either side of the front axle, several inches lower than usual.

Simultaneously with the introduction of the rack, the Blackburn firm issued a brochure which described tests leading to development of the new rack, and which challenged conventional American concepts on how touring gear ought best to be carried on a bicycle. It challenged French and Asian concepts, too.

We asked California correspondent Darryl Skrabak to look into these claims. Here is his report.

You would think that by now all the basic stuff of bicycle engineering had been sorted out. After all, they've been making bicycles for well over 100 years. And bicycles are so simple. You can merely look at one and figure out how it works.

That's what you would think.

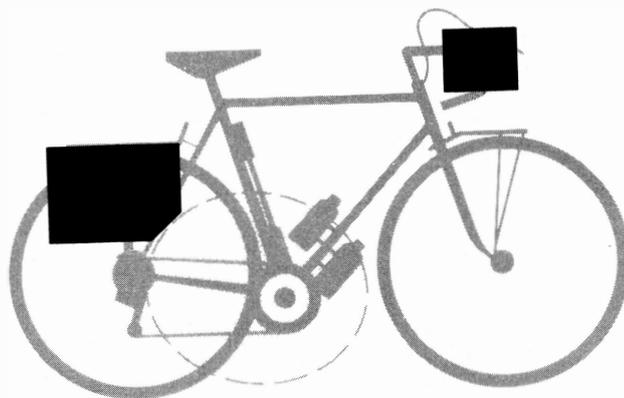
That's what Jim Blackburn thought, too. Blackburn is the California industrial designer who, in 1975, looked at an imported bike rack about to be marketed by a friend. "I can make a better one than that," Blackburn told his friend.

This turned out to be an unintentionally portentous statement. Blackburn, fresh from collecting a second college degree, anticipated a career as a design consultant. Today Jim Blackburn is America's — and perhaps the world's — leading source of quality, lightweight racks. The 30-employee Blackburn firm churns out some 300,000 bicycle racks, bottle carriers, and associated touring items annually. This manufacture is carried out not far from the garage where Blackburn's first

Our goal was to find the optimum weight position for maximum touring performance and safety. Characteristics considered were: high speed stability; standing and hill climbing stability; cornering ability; and how well the bicycle tracked. Proper heel-to-

bag clearance was always a consideration. Testing was a general nature; different bicycles may give some variance to our results.

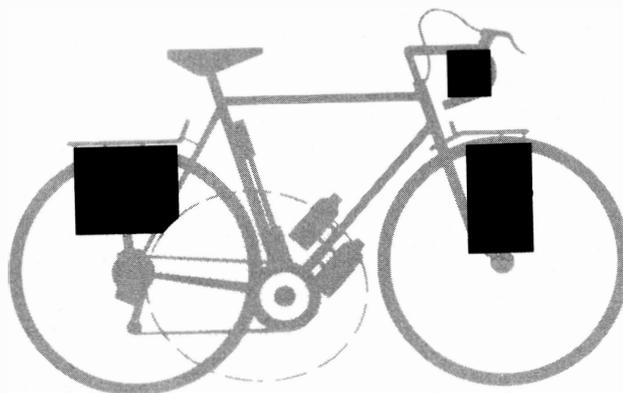
The following four tests were the most interesting.



Test 1

Large rear panniers with a large handlebar bag. No front carrier. With this, the most common combination, most of the weight is behind the rear wheel center axis. This

combined with a large, heavy handlebar bag, tends to create front wheel shimmy. The only way we could control this load was to ride slowly. We could not conduct the downhill test.



Test 2

Equal weight in front and rear panniers. Small handlebar bag. This system has become more popular recently. In our test

the handling remained very solid despite a tendency to oversteer with 40 pounds of weight up front. The results of this test were much better than those of test 1.

bicycle rack was assembled on the now-familiar pattern of bent and welded aluminum rods.

Since that first garage-built rack, the Blackburn rear carrier has remained basically the same — although with numerous subtle changes, resulting in a gradually improved product.

The process of evolutionary improvement is one which Blackburn views as compatible with the history of bicycle design itself. The history is an example, Blackburn says, of what designers call “vernacular design.” Although bicycle historians labor to establish which individuals — ranging back to Leonardo and beyond — made which particular contributions to bicycle development, from an industrial designer’s view the bicycle wasn’t designed so much as it evolved inevitably. And while it has undergone considerable refinement, the basic “safety bicycle” (as it was called) has remained unassailed for a century.

An appreciation of this history makes a designer of bicycle products respectful of tradition. When better products are made, they will usually be further developments of traditional ones.

Usually.

Following this line of thinking nearly led Blackburn to stick his foot into a very awkward bucket. It also led his firm into a modest research project, the conclusions of which will interest touring bicyclists, and any others who need to carry goods on their bikes. The research also leads to other conclusions:

- that bicycles are deceptive in their apparent simplicity;
- that engineers and scientists do not yet, after 100 years, understand fully how bicycles work.
- that (any suitably large number) Frenchmen and Asians are wrong.

Blackburn’s Departure

The route to these conclusions was inadvertent. In 1980 Blackburn, having got his manufacturing operations humming after a move into new, larger quarters, resumed the search for product improvements. His attention turned to the low-position front and rear panniers seen on some touring bikes in France, and in photos of bikes the Japanese supply for the Asian touring market.

Here was a way of carrying gear on a bike which ought to offer significant advantages over the conventional American handlebar bag and rear pannier rig. Low panniers lower the center of gravity. That has a good effect on any vehicle. And however accepted by the French and Japanese, low-position panniers had somehow escaped introduction to Americans. Blackburn resolved not to neglect this marketing opportunity further.

Front and rear “low-rider” pannier rack designs were worked up. It wasn’t easy. Providing sufficient rigidity was a problem, especially with the rear rack. In order to clear a rider’s pedaling feet, low-mounted rear panniers had to be located farther back, almost entirely behind the rear axle. That meant the rack structure had to be cantilevered rather far behind most of the bicycle frame.

But it is the designer’s work to solve such difficulties, and so sure was Blackburn that the new racks would work well — as they seemed to in around-the-block spins — that production planning proceeded while a few prototypes were made up for final field testing. One prototype set of front and rear low-riders was lent to Terry Shaw, owner of Shaw’s Lightweight Cycles, a local shop.

Shaw, about to embark on a tour of the Northwest coast, replaced his conventional Blackburn racks with the prototypes the night before boarding a flight to Portland. After his first ride with the new racks at the Portland airport, he wished he hadn’t.

“As soon as I got on the bike, there were incredible stability problems,” Shaw says. “It would develop a shimmy at low speeds. I had to go across the Longview Bridge, which is narrow, loaded with trucks, and windy. On a weaving, unstable bike, that was an experience, I’ll tell you.”

As the tour progressed, Shaw experimented with repacking. Gradually he shifted weight to the front panniers. By trip’s end he was loading about 90 percent of his gear into the front bags. This produced a stability as impressive as the initial instability.

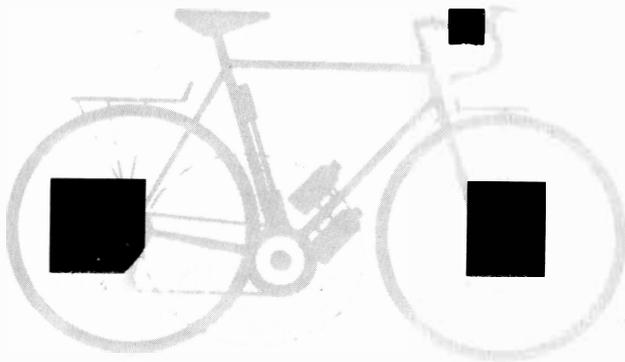
Back in San Jose, Shaw told Blackburn he was onto a good thing with the front rack, but that the rear was terrible. Blackburn was skeptical. What about the Japanese and French? Shaw produced his bike, packed it, and sent Blackburn off on a ride. Convinced, Blackburn put the entire low-rider project on hold.

Back to the Drawing Board

Then he sat down with his design assistant, Jim Gentes, to figure out what had gone wrong. They decided that a failure of basic design analysis had occurred. They knew how to make good racks. What they didn’t know was much about where cargo ought to be carried on a bicycle.

So Gentes was assigned to research the question. First he searched the literature. He read the standard texts, Sharp and Whitt/Wilson, and studied articles in scholarly, technical magazines like *American Physics* and *Journal of Applied Mechanics*. Gentes discovered what other students of bicycle design have before him: that the way bicycles — and motorcycles — steer and handle defies easy

TRAVEL

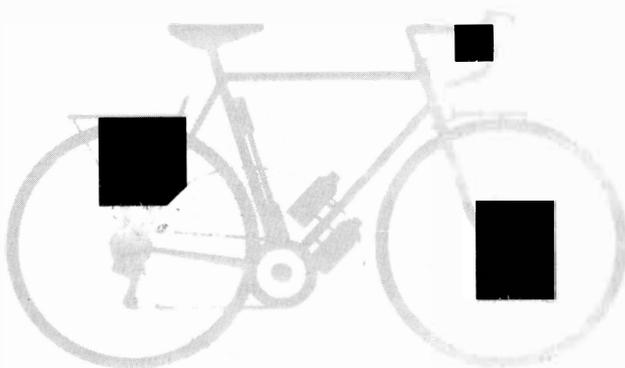


Test 3

Weight carried low on both front and rear panniers. Small handlebar bag. To gain necessary heel clearance, rear bags must be placed behind the rear wheel center axis, which causes a whipping action. Also, the carrier must be heavier, being structurally larger, yet it cannot be as rigid. Each rotation of the crankarms creates an

oscillation that is difficult for the rider to compensate for.

Placing weight low in front is much easier. After trying several positions, we found that low and centered in the wheel works best for front weight. Overall, the low front/low rear combination does not handle well; we don't recommend it.



Test 4

Standard position for rear weight with low front weight. Small handlebar bag. Medium size panniers mounted as far forward as possible on the rear carrier, and medium size bags mounted low on the front forks in the center of the wheel, gave by far the best handling with heavy weight.

The bicycle responds slower this way than it does with no weight at all, but in most cases is actually more stable. The result is similar to increasing the fork rake or head angle. Heel clearance is maintained, and no frame whip was noted. Downhill runs were safe, and steering felt secure.

Recommendations

Of the 17 combinations tested, only two met our standards. Number 2, with medium size panniers in front and rear, works

well. Number 4, with medium size rear bags held at regular height and as far forward as possible, combined with medium size bags held securely in the low middle of the front wheel, was the best system.

mathematical analysis. In this respect bicycles are like boomerangs. People know how to make them. But scientists have a hell of a time trying to explain what makes them work.

Recently, Gentes learned, some attempts have been made to develop mathematics to describe more exactly the factors affecting motorcycle stability and handling. The results are formidable, being what engineers dryly refer to as "rather complicated equations."

Almost no mention in the literature was made of what Gentes was concerned with, the placement of weight. But it did offer models to emulate. When mathematical theory failed, scientists resorted to experiment. Via methodical trial-and-error, they rode and observed bicycles, and even if they didn't understand exactly why things happened, they reported as best they could on how they happened.

So Gentes and Blackburn elected to experiment. They would try every practical placement of weight on a normal touring bike, and find out what worked best.

Their test rig, built by Gentes, consisted of Blackburn's 23-inch touring bicycle fitted with sheets of plywood on either side of both wheels, plus racks as necessary. Touring packs could be shifted quickly to any location on the plywood, like workshop tools on a pegboard.

Panniers, rear packs, and handlebar bags were gathered. Mounting them in various configurations, Gentes took a series of test runs through a short, low-speed slalom course, recording his times and his impressions of bike behavior.

As a test rider and performance analyst, Gentes was ideally suited. Like Blackburn, he is a graduate of the San Jose State industrial design program. He is also a former national junior cyclocross champion, and he has competed in Europe. "I know how a good bike is supposed to handle," he says.

To exaggerate handling effects, the test bags were deliberately overloaded. Panniers carried 20 pounds of sand each. Handlebar bags, when used, carried 25 pounds, adding to a total of 80 pounds on most test runs. In the less stable test configurations, the overloading provoked serious, and sometimes unmanageable handling deficiencies.

(Caution: Jim Blackburn does not recommend 80-pound loads. Tourists', except John Rakowski around-the-world types whose requirements are unusual, should reduce luggage weight to no more than 40 pounds, Blackburn says.)

The tests confirmed Shaw's conclusions about low rear-mounted panniers located behind the rear axle: weight carried there was unwieldy. But tests also indicated a popular touring accessory: the large handlebar bag.

Indeed, handlebar bags comprise half the sales of some American touring ac-

cessory manufacturers. They are convenient repositories for things tourists want ready to hand, and a means to "get weight up front."

Moving weight forward seems a good idea. If all the weight of touring gear is placed at the rear in conventional panniers and atop the rack, the center of gravity of the entire load resides slightly behind the rear wheel center. This geometry produces a levering action that, on a heavily loaded bike, almost lifts the front wheel when the rider isn't aboard. Restoring balance by transferring some of the load to the front wheel would have obvious benefits.

Test Results

But this is not true if the load goes into a handlebar bag, Gentes found. "This was one of the worst configurations," he says. Conventionally mounted front panniers were much better, he reports. And low-mounted front panniers were better still.

After the slalom tests, Gentes made higher-speed runs on steep, winding Shannon Road in Los Gatos. Some of the least stable setups, including those using a large handlebar bag, were eliminated from the high-speed test series, as Gentes was a willing test rider, but not a foolhardy one. Even so, some of the runs down Shannon were tight-lipped, brakes-on-all-the-way affairs.

The high-speed test series was considered important — and not merely from supposition. One of the papers on motorcycle analysis had indicated that significantly different forces may affect handling at high speeds. In some cases a machine with innocuous low-speed characteristics may provide a disaster at increased velocity.

After the tests, Blackburn and Gentes assembled their findings into a succinct, illustrated article. This they published, not in a technical journal, but in a brochure, where it is more accessible to bicyclists. Copies may be obtained from bicycle dealers or directly from Jim Blackburn Touring Performance Products, 75 Cristich Lane, Campbell, CA 95008; 408/371-0992.

Some quibbles may be made with the brochure text. It announces, in bold type, that "the bicycle is stable only because of the rider's ability to constantly correct his line of direction." In one of the papers Gentes consulted (it's listed on the back of the brochure), David Jones establishes that the bicycle itself plays the major role in stability, the steering being almost perfectly self-centering.

In another fluff, the brochure claims stability is enhanced by increasing fork rake, or offset. Not so, say Drew Banton and Crispin Miller in an article published in the July 1980 *Bicycling*. Less fork rake increases trail, according to Banton and Miller. And that increases stability, particularly at speed.

Quibbles aside, the tests and conclusions of Blackburn and Gentes are a genuine and highly useful contribution to basic knowledge about bicycling.○

Our Experiences

During preparation of this article, Jim Blackburn Design lent us two front racks — one, a low-rider, and the other the more usual type — and the same pair of small front panniers that Jim Gentes used for his test ride. My wife Lynne and I mounted the racks on our bikes and experimented with carrying modest loads on local errands. While our experiences could not compare to Jim Gentes' extensive tests, our impressions tended to confirm them.

When we tried these racks, we had just returned from an extensive tour in Europe. For the tour our bikes were equipped with the standard American handlebar bag and rear pannier setup. We were not entirely happy with the handlebar bags. If any substantial weight was placed in a handlebar bag — a 35 mm camera and lenses, for instance — steering was adversely affected, especially at low speeds. By mid-journey Lynne so thoroughly despaired of her handlebar bag that she mailed it home. I persevered with mine, mostly because it was handy for maps.

Placing weight in front panniers has an opposite effect. Where a loaded handlebar bag destabilizes steering, loaded front panniers seem to enhance stability. It is as if a steering damper has been added, and the bike's geometry modified to increase the tendency to run in a straight line. This is as reported by Blackburn and Gentes. Heavily loading rear panniers only, on our bikes, affected the steering to a minor degree, making it somewhat skittish at low speeds. Blackburn and Gentes concluded after their experiment that equalizing loads between front and rear panniers is perhaps the best disposition of weight for touring. We agree.

What about the difference between weight carried on the standard front racks and the low-rider? The standard rack gave decidedly "heavier" steering. While the stabilizing effect was still noticeable with the low-rider, the steering more closely resembled that of an unencumbered bike.

Darryl Skrabak