

Arcane Knowledge Lost & Found

UNTIL THE APPEARANCE of Suzuki's air-cooled 1983 XN85 Turbo, introduced in 1982, street motorcycles would typically use the same tire diameters front and rear, as in a 4.00" x 18" rear and a 3.50" x 19" front. This design principle had persisted for decades.

The XN85 Suzuki used the still common 18" rear, but was the first sportbike to use a much smaller 16" front to reduce gyro resistance to steering effort. Honda's remarkable 1983 VF750F was further proof of the concept. And Kawasaki's benchmark 1984 GPz900, the first "Ninja," was another, and also the first of the now-ubiquitous DOHC, four-valve, liquid-cooled in-line fours. The Ninja was hailed as the first production bike capable of exceeding 150 mph (if you could forget the indelible image of Rollie Free in his bathing cap, lying prone on the Vincent HRD at Bonneville in 1948 doing 150.313 mph). The Ninja raced at the Isle of Man just three months after its 1983 unveiling and finished first, second and fourth.

Old paradigms were shattered. Staggered tire sizes also gave the bikes' styling a fresh "big/little" aspect that seemed to suggest hot rod cars, dragsters, or other vehicles with an excessive need for rear traction—visual legitimacy.

Phil Vincent was a man who could clearly see the first principles of physics at work in a motorcycle. A popular journalist as well as an engineer, his designs were so innovative they were enlightening. Vincent's Series B Rapide used a 3.00" x 20" front tire and 3.50" x 19" rear.

So why had this long-held principle been abandoned so easily? Were there no drawbacks to the new paradigm?

Many of us ride or have owned motorcycles that followed the old tire size logic. As I rode more motorcycles, some only briefly as pre-sale test rides, I began to accumulate body memories of how various motorcycles handled. The BSA B50MX was one early lust object. It originally came fitted with an unusual 20" front, 18" rear wheel combo that gave very neutral balanced handling. The dearth of 20" tires later caused a production switch to common 21" fronts, but then the handling wasn't as neutral, *hmm?*

Understanding the why behind the various sensations different bikes produce has never been easy to decipher. Was it weight, center of gravity (of the machine, the rider, or both together), rake, trail, misalignment, chassis stiffness, suspension compliance, tire compounds, constructions or pressure variations? Could it possibly be sorted out? It obviously fascinated



me to try, and I'd file every impression away for later analysis and comparison, hoping to grasp an underlying truth.

Wheel sizes have been a favorite study, because I sensed a correlation between front/rear sizes and handling I'd rate as neutral and confidence-inspiring—or not. Which is not the same thing as saying that bikes without neutral handling can't be ridden quickly. The Ninja proved that point. But subjectively, there was always the sense that undersized front tires would understeer at corner entry, giving me a queasy moment or two as I eased past the feeling that the front end was trying to push off line, even when everything else worked so well I could then get a knee down. The early CBR900RR was my first experience with this type, and it gave me the willies, it understeered so strongly.

However, I noticed that bikes that used 19"/17" front/rear wheel sizes (closely matched in tire diameter, like the various sized BMW GS models), were some of my special favorites—very neutral. And the more neutral the handling, the more natural it felt to add corner entry speed for a more rapid overall pace.

A couple of months ago, we tested Suzuki's TU250X, which uses narrow 18" wheels and skinny tires on both ends. It was a handling revelation. Despite its low power, it could carry amazing average speeds on twisty roads and encouraged such high corner entry speeds that we found ourselves easily chasing down traffic, including serious sportbikes.

Inspired to find the reason, I recalled that Francisco "Paco" Bulto, Mr. Bultaco, another successful engineer from earlier

days, was once quoted as saying a motorcycle's front and rear axles should be the same height from the ground (or something to that effect). Was this a clue?

Was it about gyroscopic force? A gyro creates mind-bending acts of physics, able, for instance, to somehow create an axis of force so powerful it can be supported at just one end, with its axle horizontal to the ground, without falling.

I asked Tony Foale, our former Technical Editor (before he was hired by Segway—makers of a device that relies heavily on gyroscopes) if the gyroscopic force of the differing tire sizes was causing the understeer feeling with smaller front tires. He scoffed, "It doesn't make any difference." Trying to wrap my head around that idea, I thought, if gyro forces were a dead end, what could it be?

Here's my observation in a nutshell: Because the wider the rear tire in relation to the front and the larger the diameter variation at the rear, the stronger the understeer sensation. And the opposite arrangement, like a dirt bike's taller front tire, gives an oversteer sensation. So it must be a problem of geometry.

When a bike is straight up, there's no noticeable steering effect from unequal wheel diameters. But imagine it leaned at 45°. If you draw a line through the centers of both wheel axles, it will be a descending line, tipping down in the direction of travel. The wider the rear tire in relation to the front, the greater the additional lateral displacement of the rear axle center toward the inside of the turn in a lean, and the greater this downward tilt.

Here's the insight: Because this line is not parallel to the tangent described by the tire's contact patches on the circumference of the cornering arc, but points to the outside at the front, you get an understeer effect. Identical tire and wheel sizes would keep the axles parallel to the contact patches and thus create neutral handling. To achieve a parallel axle centerline to the contact patches when using much wider rear tires, you'd need to increase the front axle height to compensate for the rear's greater lateral displacement in a lean.

Modern lightweight wheels and discs have effectively reduced the original impetus behind smaller diameter front tires, but is there another even more important reason to reconsider the idea?

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