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## Geometry I—Mountain Style

### *The Long And Short Of It*

By Henry Barlow

Road bikes have been with us for so long that frame builders have pretty much reached agreement about what angles and dimensions are best for, say, a criterium bike or a touring bike.

But mountain bikes are so new that what works best still hasn't been entirely sorted out. Head tube and seat tube angles, for example, vary as much as six degrees from one bike to another—an enormous range compared to road bikes.

Obviously, that makes it difficult for you, the buyer, to know exactly what you are buying. Is that new bike on the showroom floor a winner or a sled?

Custom mountain bike frame designers tend to be best able to answer that question, because they design, build and, in most cases, ride mountain bikes every day. But frame designers also tend to be individualistic and able to state convincingly why they do what they do. They're usually strong riders, too, able to hammer

over hill and dale. A cyclist might well return from a ride with any designer convinced that builder's bike is the best, having just witnessed an impressive display of trail riding.

With that in mind, here is an overview of current mountain bike designs—how they differ and why.

Head angles are probably the most controversial aspect of frame design. Any discussion on head angles invariably includes climbing and descending characteristics. That emphasis comes from the genesis of off-road bikes, the Schwinn Excelsior and the Marin County, California downhillers. Mountain bikes, high-speed descents and steep climbs seem to be almost synonymous. Most frames are designed around those not necessarily compatible abilities.

\* Joe Breeze built the first lightweight, chrome-moly mountain bikes in Marin County in 1977. Except for materials, the first 10 varied little from the Excelsior, even to the extent of using the same size

head tube dimensions so spare forks would be readily available. (Typical Breeze; he's renowned for practical ideas such as nickle plating frames for a scratch-free finish.)

When it became obvious that mountain bikes would catch on, Joe modified his design. Seat tube angles evolved from 67 ½ degrees to 69 degrees, then 70 degrees while the chain stays lost ¼ inch. He steepened the head for quicker steering, believing 68 degrees is fine for downhill but 70 degrees is better for all-around riding, and left the chain stays long for high-speed stability. The two degree increase in head angle eliminated what he felt was a tendency for the front end to wash out in turns. He's also recently steepened the seat tube one degree for a more efficient pedaling position.

Tom Ritchey's name is probably associated with mountain bikes more than any other. His bikes have for years been the industry standard and the ones most often

# Framebuilding:

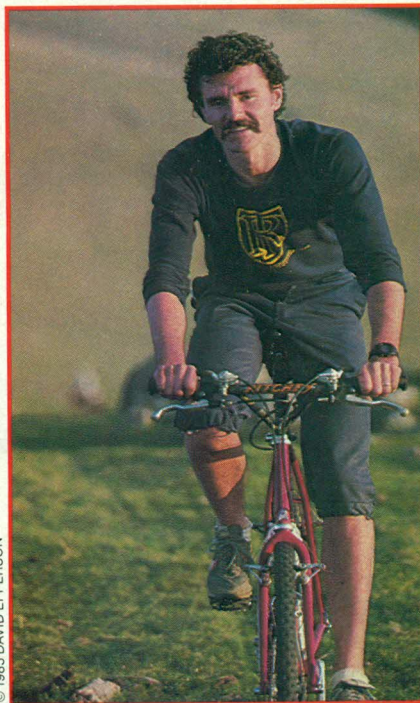
copied by large manufacturers. Tom is the old guard, conservatively protecting tradition. Tom started in 1972 with road bikes, building his first mountain bike in 1978. He's a student of bicycle history and believes trends regularly sweep through designer ranks only to quickly disappear. Steep head angles on mountain bikes he considers such a trend.

He's outspoken in that belief, claiming bike handling comes from the quality of construction and materials and the rider's ability. He says that only so much quickness can be used and that any excess is a handicap. Trail riding continually bounces the front wheel around, deflecting it from your path. A shallow head offsets that skittishness and acts as a shock absorber, enabling riders to maintain control easily in extreme conditions. Tom feels that steeper heads create a front end that reacts too quickly, magnifying the deflections caused by rough terrain. He claims that the inherent stability of shallow head angles enables riders to ride faster, secure in the knowledge that the front end will never react radically. But he also states that with a strong rider up, his bikes are as quick as any, regardless of angles.

**R**ichard Cunningham of Mantis Bikes represents the opposite of Tom in frame geometry. According to Richard the necessary modifications to standard road frame dimensions are less than most off-road cyclists have been led to believe. Because road bikes have for years been designed for maximum power transmission and efficient frame/rider relationship, Richard used them as his starting point. He then adjusted dimensions and angles for the more complex requirements of off-road cycling.

Richard's frames have 71-degree seat tubes for ease in changing from sitting to standing and for keeping weight on the rear wheel. The 71-degree angle positions the hips ideally over the pedals for the power stroke.

He arrived at a 71-degree head angle by building and testing bikes with head angles from 67 degrees to 74 degrees. He discovered that lower heads sway during hard, uphill pedaling. Steeper heads eliminated the swaying but if too steep, the ride was too harsh and the steering too quick for trail riding. The 71-degree angle eliminates the swaying, he feels, is quick for maneuverability, yet with 2-1/4-inches of rake, is soft enough for trails.



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The Mantis' chain stays are short, 17-1/2 inches, for rear wheel traction and out-of-the-saddle climbing. Its wheelbase is no less than 43 inches for high-speed stability. Richard's objective is a 40/60 front/rear weight ratio for optimal cornering.

He claims the fastest line through a turn is achieved by lightly balancing between front and rear wheels, subtly adjusting pressure to eliminate skidding. He compares it to skiing where the objective is carving turns.

That is opposite to what many riders advocate. They set up the bike in a slide then wait for their speed to slow down to the point where the bike shoots through the turn, a technique derived from the motorcycle racing history of many of the Marin riders, according to Richard, who shares that background. But where a motorcycle has a motor to accelerate out of the turn, cyclists have to rely on gravity, and Richard feels that excessive speed is lost during the slide.

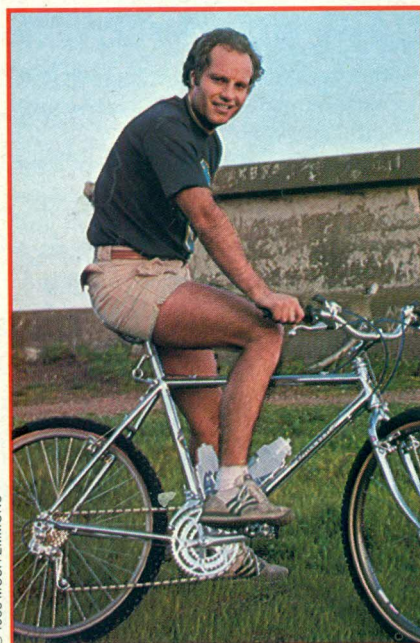
**S**teve Potts, Charlie Cunningham, Scott Nichol and Peter Weigle have evolved geometries between the extremes of the Ritchey and Mantis bikes.

Steve Potts was also a motorcycle racer, but the bikes he and Mark Slate build in Marin County are far from the classic Excelsior sliders. Like Richard Cunningham, they feel the fastest line through a turn is skidless. Parallel 70-degree angles, 17-1/2-inch stays and a 42-inch wheelbase produce what they claim is an

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ideal blend of nimbleness, slow-speed stability, climbing traction, balanced cornering and downhill speed. Steve and Mark are known as crazed downhillers but they're especially notorious for high-speed trail riding where maneuverability is required.

Charlie Cunningham has a penchant for doing things differently even if the end result is similar. A background as an aeronautical engineering student and a reputation as a superb finesse rider and powerful climber lie behind his frame design. He studied off-road racers in 1977 and observed that most bikes lack traction during climbs. He also had an engineer's appreciation for aluminum,

**Most credit Joe Breeze (left) with making the first mountain bikes and Tom Ritchey (top) with setting most of today's standards.**

**Different origins, different coasts, similar bikes:** ex-motorcycle racers Mark Slate (left) and Steve Potts in Marin County build quick-handling bikes, as does Connecticut's Peter Weigle, an ex-road racer. Weigle's wife Betsy (below) gives his bikes their remarkable paint schemes.

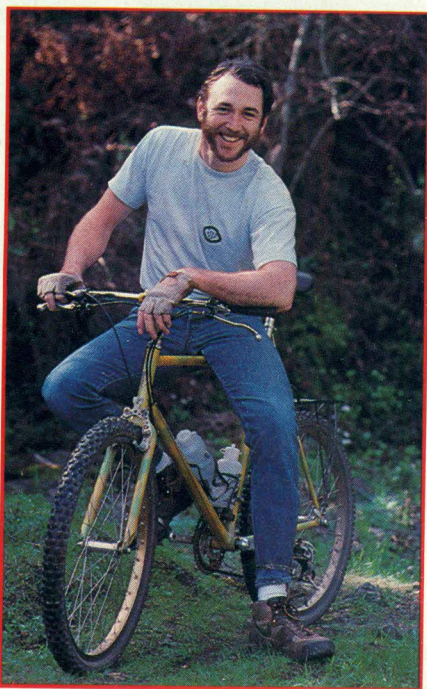
Scott Nicol of Ibis Bikes is another frame designer who tries everything, combining engineering principles with empirical data. The result is a bike with steep angles, short stays, and short wheelbase, differing little from the Potts and Cunningham. He's tested steeper and shallower head angles but has settled on 70 degrees as the optimum for all-around performance for the same reasons as the others. His bikes, like Potts' and Cunningham's, demand a higher-than-average rider ability—but then, that's what high performance is all about.

Scott is also an exceptional bike handler, relying on finesse rather than power, and designs accordingly. But he doesn't have a single frame geometry. Instead he modifies his basic guidelines according to the rider's strength, size, and riding technique, but always with his belief in the superiority of quick handling.

Peter Weigle arrived at pretty much the same geometry but from a different direction. Relatively isolated on the east coast, he relied on his Category 1 road racing experience and his eight years building road bikes to design his mountain frame. Most of the offroad riding near his Connecticut home is on wooded trails requiring maneuverability. Consequently his design is almost identical to what Steve, Mark, Charlie, and Scott build.

Still another approach to mountain bike design is advocated by Jeff Lindsay of Mountain Goat Cycles. He uses steeper angles, too, but on a long wheelbase, though he has since designed a shorter competition model. The standard model's number-one consideration is bullet-proofness. He wants the bike to always come back from any ride in one piece with the rider having had a comfortable, smooth experience over the roughest of terrains. In the interest of all-around ridability, he places the cyclist in a fairly neutral position relative to the wheelbase.

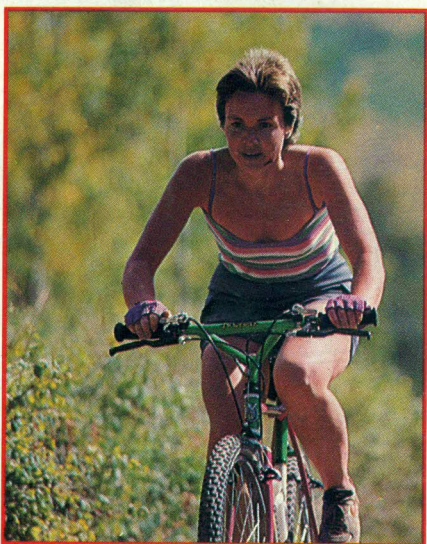
Though these are not the only mountain frame designers around, they are representative. Their designs vary from one extreme to the other, but all have one thing in common: a cadre of riders who



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and in 1978 produced the first mountain bike made of oversized aluminum tubing. His objective was minimal weight and maximum strength. A 70-degree head, 71-degree seat, 17-inch stays and a 41  $\frac{3}{4}$ -inch wheelbase resulted in a radical departure from the status quo.

Charlie almost always comes out of the saddle for climbs, that being universally accepted as the fastest climbing technique. He designed accordingly. The short stays keep weight on the rear wheel when standing, the short wheelbase creates enough forward pressure to keep the front wheel on the ground during climbs, and the 70-degree head provides quick, precise steering.



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# Framebuilding:

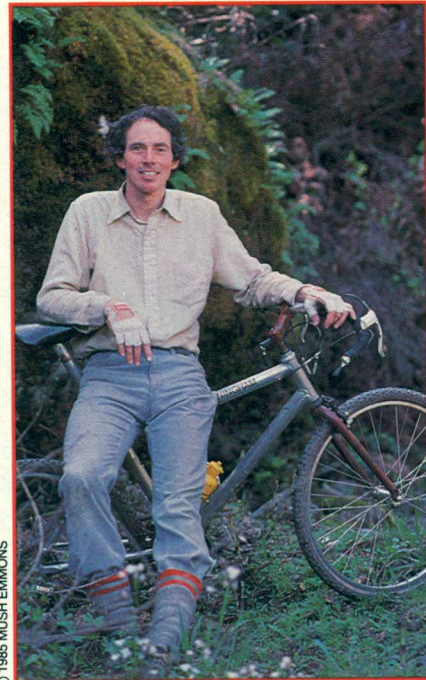


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will swear that that particular builder's product is best. And those riders are quite capable of proving it.

So what should you look for? A design that reflects your riding style. If handling is the name of your game, short wheel-

bases and steeper angles will probably satisfy you. If downhills are where you get your thrills, you might want shallower angles and a slightly longer wheelbase. Those who want every climbing advantage might look for bikes with



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**Richard Cunningham (left) favors steep angles and a long wheelbase. Charlie Cunningham (above)—no relation—and Steve Potts (below) build bikes of similar dimensions but different materials, Charlie's bikes being aluminum.**

short rears and long fronts. The bottom line is that what feels right to you is. Everybody can, and no doubt will, pass out advice, but only you will have to live with your purchase. When you ride a bike that feels "right" to you, buy it. Just because someone builds frames, races, works in a bike shop or writes about bikes doesn't mean he has the answer. He just has another opinion. ■

## How To Fix A Donkey By Henry Barlow

• I knew, or was pretty sure, I liked the frame of my Ross Redcay Signature mountain bike, but the truth was the bike was a bit of a clunker. Though at times I felt hints of greatness, as soon as I got on my Steve Potts bike I knew the Ross was a clunker indeed. Could changing the bike's components help?

Good question. To find out, I switched wheels, fork, brakes, stem, handlebars and seatpost.

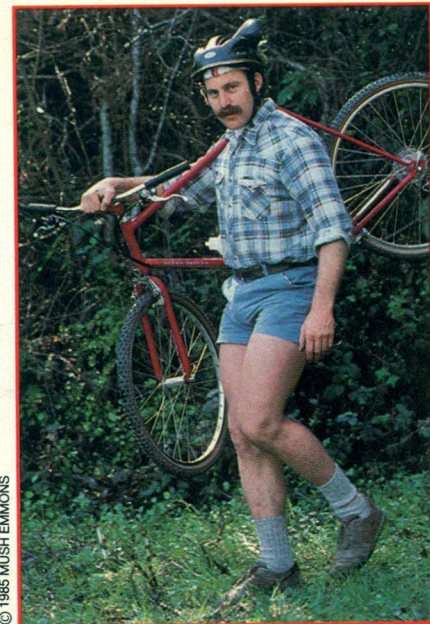
All the new parts are built by Steve Potts and Mark Slate under the "Wilderness Trail Bikes" logo. They installed a Type 2 competition fork, a newly developed aluminum stem with their exquisitely bent handlebars, roller cam brakes, Bonfraeger cut down Super Champion rims on their own sealed hubs, 1.75 knobbies, and a fixed-angle seatpost.

That slashed 4-½ pounds off the weight. The bike now weighs just over 27 pounds. And what a joy it is to ride. I like a short, quick bike and that's exactly what the Redcay now is.

It's faster than a nervous cat, never ceasing to amaze me how easily it maneuvers down a rock-strewn trail. But even more important, the bike fits me.

Before, I felt stretched out over the frame with the standard bull moose bars. The new stem is shorter and combined with the handlebar bend, my hands are now closer. I feel compact and poised to spring forward. The fixed angle seatpost enabled me to move the seat forward over an inch more than previously, placing me in a more powerful pedaling position. And the brakes are amazing. Not that the Shimano cantilevers were bad. But now I have far more braking power with a much lighter grip. In short, I now have the performance I thought the Redcay would have but never delivered.

So don't be afraid to change your bike. The one you're currently thinking is a donkey might in fact be a raging racehorse with a few appropriate modifications. ■



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