# Tubing must match rider's needs

## dave moulton

*Racing bicycle design*

I was recently asked, "Is a short-wheelbase machine best for climbing hills?" The answer is yes, but not necessarily because of wheelbase dimensions. Climbing will be better because, as I have explained previously, such a bicycle will have shorter tubes and will therefore be more rigid.

It is during hillclimbing that probably the most strain is put on the bicycle frame. A rider climbing out of the saddle will thrust downward on the pedal and bend the lower parts of the frame one way, while pulling upward on the handlebars to bend the head tube area in the opposite direction. This twists the frame first one way and then the other with alternate pedal thrusts.

During hillclimbing lightweight equipment becomes a definite advantage. However, if the bicycle is made of such light tubing that it is flexible, any advantage in weight saved will be lost as the rider's power is absorbed by the frame before it reaches the back wheel.

If you were trying to lever a rock from the ground, you would not use a flexible bamboo pole. Instead you would use a solid iron bar that will not bend. Naturally, a bicycle frame made of solid iron bars would be extremely rigid, but too heavy to ride. What we are looking for, then, is a "strength-to-weight ratio" that will produce a lightweight frame with maximum rigidity. Notice I use the word "rigidity."

Many engineers looking for new materials for bicycle frames think in terms of breaking points rather than flex. For example, I can remember 25 years ago when titanium was being talked about as the wonder material for frames of the future. It promised less weight than steel with equal strength—equal strength in terms of breaking point, that is, but in terms of flexibility the modulus of elasticity for titanium is approximately half that of steel. So when in recent years the titanium frame finally became available, the results were somewhat disappointing.

### Steel Still Superior

Other materials for bicycle frames have been tried in recent years, some with more success than others, and who can say what may be found in the future? But for the moment, I can see no serious rival to the lightweight steel frame. Its advantages are many.

The relatively low price of materials means that most of the cost of a steel frame can go into the construction, which is most important. A steel frame is reliable because the materials have been used and tested for many years by literally millions of riders.

A steel frame will not usually break suddenly. Usually a crack will appear long before actual failure, and the rider will get a prior warning such as a creaking noise or the feeling that the frame is more flexible than it should be. A steel frame is relatively easy to repair, constituting another advantage.

Finally, because there is a reasonably wide variety of steel tubing available in various brands and weights, you will b able to choose a type to suit your needs. To help you do just that, I will go through and discuss the various makes.

### Top Tubings

The main manufacturers of tubing are: TI-Reynolds (England), Columbus (Italy), Vitus and Durifort (France), Ishiwata and Tange (Japan). I have built frames with all these and found them excellent, providing the frame is used for the purpose for which the tubing is designed. I will expand this point later, but first let's look at each brand.

TI-Reynolds produces the widely used 531 tubing and invented the butted tube. This is the tube that is thicker gauge at the ends where the jointing creates most stress, but thinner in the middle to save weight. All other manufacturers now make butted tubes.

Five-three-one is a tubing that can be used for frames of all purposes. Reynolds has a policy whereby they will make 531 tubing to the customer's requirements, but only for a minimum order of 500 sets. Framebuilders who may not find it practical to purchase this much material must go through a separate agent or wholesaler. The design of tubes (chainstays, fork blades, etc.) will vary in both appearance and weight, according to what has been ordered by the wholesaler, and the weight of a 531 tube can vary considerably.

In recent years Reynolds brought out the lighter gauge 531 S.L. in a standard "boxed" set. In my opinion this is a step in the right direction, and I wish Reynolds would standardize all their 531 tubing and list the various weights so that framebuilders can choose the right one for the job. Reynolds also makes a 753 tubing which is heat treated to give it extra strength, allowing the material to be made a lighter gauge.

### Columbus' Range

Columbus of Italy does standardize its tubing and the list is as follows:

P.S.—A heavy gauge for track sprinting.

S.P.—A road set for heavy riders or rough roads.

S.L.—A lighter road set suitable for road racing on good roads.

P.L.—A very light set for pursuiting only.

The S.L. (Strada Leggero) set has an excellent strength-to-weight ratio.

Super Vitus tubing also has a good strength-to-weight ratio. I have used this French-made tubing in England for many years and found it excellent in performance and workability.

As for Japan's Ishiwata and Tange, I have only built using the lighter gauges. Both seem excellent for special purpose ultra light machines.

Which of these various tubings is the right one for you? A lot depends on your own weight or strength, and the type of riding you will be doing. Of course, the ideal situation would be to have a "stable" of bikes so you will have the right one for every occasion, but this should be looked on as a luxury rather than something which is essential.

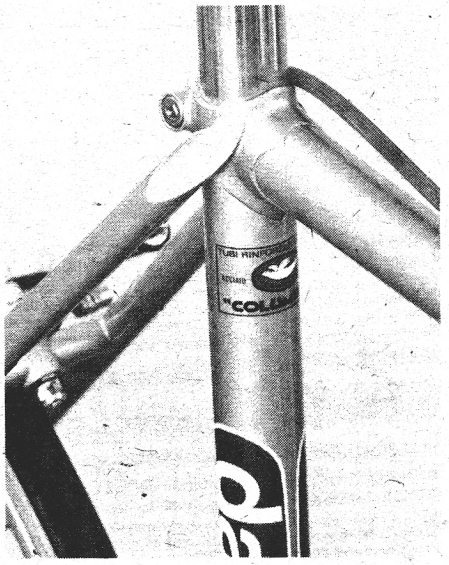
### How to Choose

For any machine, whether it be for road or track and no matter what your weight, you cannot go wrong with Reynolds 531, which is still the most widely used tubing. If you are a heavy and strong rider, 531 or Columbus S.P. is heartily recommended, especially for road racing or criteriums with a lot of fast acceleration, jumping out of corners, etc. You need a machine that will respond to your every effort, and that means a stiff, rigid frame.

If you are of medium build you could use a slightly lighter weight tubing, like Columbus S.L. or Super Vitus 197, and still have a responsive frame. Of course a lot depends on the size of the frame, a large frame is less rigid because the tubes are longer. Often large frames can be made stiffer by putting in a plain gauge down tube or, in the case of a very large frame, a plain gauge seat tube as well.

The very light rider, say 140lbs or less, or a rider using a very small frame could use 531 S.L. or one of the light Japanese tubings. This would be an advantage on the hills, providing it's the type of rider who relies on fast pedaling rather than strength.

Much depends on your style of pedaling and the type of race. For time trial or pursuit, for example, you can use a lighter tubing because these events



*This is the Italian-style seat cluster design which framebuilder DAVE MOULTON prefers. The concave end of the stay is actually the inside of a section of tubing which has been brazed in. (J. M. Mullaney photo)*

call for a smooth exertion rather than the slow/fast efforts of road races or criteriums. Don't be tempted to go too light if you are a big strong pursuit rider, however. The starting effort in a pursuit is very important and a very light frame could absorb this initial effort. Remember also that extra lightness will have little effect once you get the machine rolling on the track.

**Importance of Construction**

Just as much as the type of material used, the way the frame is constructed will have a marked effect on its stiffness and the way it performs. One frame can feel lively and responsive while another seems heavy and dead, even though they are made from identical material. A good framebuilder will miter the tubes perfectly; that is, shape the ends so that one tube fits perfectly against the next inside the lug.

When the lug is brazed, the brass penetrates through to actually join one tube to another inside the lug, making a really solid joint. The builder who does a poor job of mitering, leaving gaps between the tubes inside the lugs, will produce a "soft/mild steel" lug which can flex. Although such a frame may be strong enough that it will not fall apart, it will not be strong in terms of rigidity. Also, if the tubes are over-heated by the framebuilder they will be softened and weakened.

There is always a lot of controversy over whether indents in chainstays weaken them. Today you must either have indented or oval chainstays to give wheel clearance, and the answer is that both styles weaken the tube to a certain extent. But we have no choice; when the standard width for the bottom bracket was set many years ago, it was before the days of short rear triangles and wheel clearance was not such a problem. If the standard width was slightly wider we could probably use round chainstays for maximum strength. Also, sometimes chainstays are manufactured indented and the builder doesn't have a choice. So don't reject an otherwise acceptable frame because it has indents.

Some framebuilders leave out the chainstay bridge, the short piece between the two stays just behind the bottom bracket. This bridge adds a great deal of lateral stiffness to the rear triangle, and should never be omitted.

**Simple is Best**

Finally, another item which causes much discussion is the seat cluster and how best to attach the seat stays.

The best thing here is to keep it simple. The tubing is at its thinnest at this point because the seat tube is not butted at the top; it has to be this way to allow entry of the seat post. Also, the seat lug area has to be heated twice: once to braze the seat lug, and again to braze the stays. A very elaborate seat cluster may look nice, but fancy wrap-arounds mean extra work and consequently extra heating of tubes, which is not good.

I prefer the method shown in the photograph because it is simple and the stays are brazed to the lug and not to the thin seat tube. Incidentally, the concave top of the stays is made by brazing in a piece of tube and is not the solid machined top that some builders use. This saves weight and allows less heat to be used to braze the stay to the lug.

Some people argue that stays shot into the rear of the seat lug make the frame stronger. But it should be remembered that the frame is suspended between the head tube and the rear hub, the seat cluster being midway between the two. So a super-strong seat cluster will not be much use if it is stronger than the rest of the frame. Just as you don't want weak points in the frame, there is no sense in making one part much stronger than the rest. Frame rigidity is an overall thing.