Although the front end of a bicycle is quite simple compared to many other types of vehicles, there are certain subtle angles that can affect the way a bike or trike steers. A few extra degrees of head tube angle can make a ride feel "twitchy", or too much rake can create something called "wheel flop". When building a bike from scratch, you may have to mess around with these angles in order to get your ride tuned exactly the way you like it, and you will quickly find out that there is no magic rule to getting it right without a little experimentation.

Figure 1 shows your typical hardware store mountain bike, which has what I consider "typical" front end geometry that often works well for many home built projects. Although a more relaxed head tube angle is better for a longer cycle, you can’t go wrong using typical upright bicycle front end geometry as a starting point when creating your own frame from scratch. Your first test ride will give you more useful data than any technical frame building guide or chart ever will.
There are three angles of concern when working with bicycle steering, and they are shown in Figure 2. Head tube angle is shown (A), and is usually measured from a line taken parallel to the ground. A 90 degree head tube angle would be straight up and down, and a 45 degree head tube angle would be very relaxed, pointing your forks way out front like a chopper. Typical head tube angle on most upright bicycles is between 60 and 70 degrees.

Trail is shown (B). It is the distance between two lines drawn to the ground - one line extends through the head tube (the longest line), and the other is taken from the front wheel axle to the ground at 90 degrees. This measurement is called trail because the point from the front wheel axle to the ground is usually behind the point extending through the head tube to the ground.

Excessive trail can cause a condition called "wheel flop" where the wheel seems to fall to one side while steering, causing your frame to lift off of the ground. Too little trail could create a "twitchy" feeling in your steering, as if every small movement created a large amount of steer in one direction or the other. A typical amount of trail on upright bicycles would be somewhere between 2 and 3 inches.
Rake is shown (C). It is the distance between the front wheel axle and the line extending through the head tube. In other words, rake is the distance your front axle is ahead of the forks. Less rake results in more trail as the point extending 90 degrees to the ground is pushed further behind the point extending through the head tube.

Rake helps your steering system "self center", which is why some cycles can be easily ridden with no hands, while others with less rake need to be moving at higher speeds before going hands off. Rake can be introduced anywhere on the front forks, and in Figure 2, it is done by placing the dropout on the front side of the fork legs. On many speed bikes, the forks are simply bent forwards at the ends to create rake.

Figure 3 - SWB recumbent front end geometry

Short wheelbase recumbents, like our HighRoller recumbent pictured in Figure 3 have a wheelbase often close to that of a typical upright bicycle, so head tube angle, rake and trail are often close to the same typical measurements. When I built the HighRoller, I used the exact same head tube angle, rake, and trail measurements that I took from the donor cycle, and the ride is very smooth, even with no hands! The shorter the wheelbase, the more that head tube angle and rake seem to affect the ride, so be careful when making adjustments as sometimes only a few degrees in either direction will achieve the result you are looking for.

Figure 4 - SWB recumbent front end geometry
Rake and trail

A very long wheelbase recumbent bike such as the Marauder Recumbent Lowracer pictured in Figure 4 will handle a little better with a more relaxed head tube angle. This relaxed angle creates a more stable steering system for higher speeds, which are often well within grasp on such a low and aerodynamic racing bike.

This very relaxed head tube angle, also increases the trail, and adds some "wheel flop" into the design, but I have found this is only noticeable when navigating tight spaces at very slow speeds. The Marauder is another recumbent that I can ride with no hands, although it has to be moving at a speed of at least 15 miles per hour before I feel safe riding hands free.

![Figure 5 - Tadpole Trike front end geometry](image)

No matter what kind of cycle you are making, head tube angle, rake and trail will always come into play, even on a tadpole style trike like our Warrior Racing Trike pictured in Figure 5. The Warrior uses standard bicycle fork components in the steering system, so the exact same measurements can be taken as a two wheeler.

A tadpole trike is typically close to the same wheelbase as an upright cycle, so the head tube angle, rake and trail are very close to the same "generic" measurement. Trikes with under seat steering such as the Warrior also introduce other dynamics such as mechanical disadvantage in the linkage, so there are a few new ways to fine tune the ride. But head tube angle, rake and trail all influence the steering and handling the same way as any cycle.
Figure 6 - Rake, trail and center point

Because the head tubes on a tadpole style trike are usually placed to one side of the front wheels, another angle called "center point" becomes important, as illustrated on the right side of Figure 6, next to the rake and trail illustration. Center point steering takes an imaginary line through the center of the head tube directly to the point on the road where the bottom center of the tire will hit, allowing the steering system to operate without any wheel scrub. Without center point angles in the steering geometry, the front wheels would shift from side to side when steering, causing your frame to sway from side to side which is a problem that can create havoc at higher speeds.

When creating a new bike or trike from scratch, it is always a safe bet to just copy the head tube angle, rake and trail from a typical upright bicycle and then make adjustments after your initial test run. For longer wheelbase bikes, add a few extra degrees of head tube angle, but experimentation is the key. Now you have a better understanding of rake and trail. Need more help? Log onto the Atomic Zombie builders forum. It’s a great family friendly community of bike builders from around the world.

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