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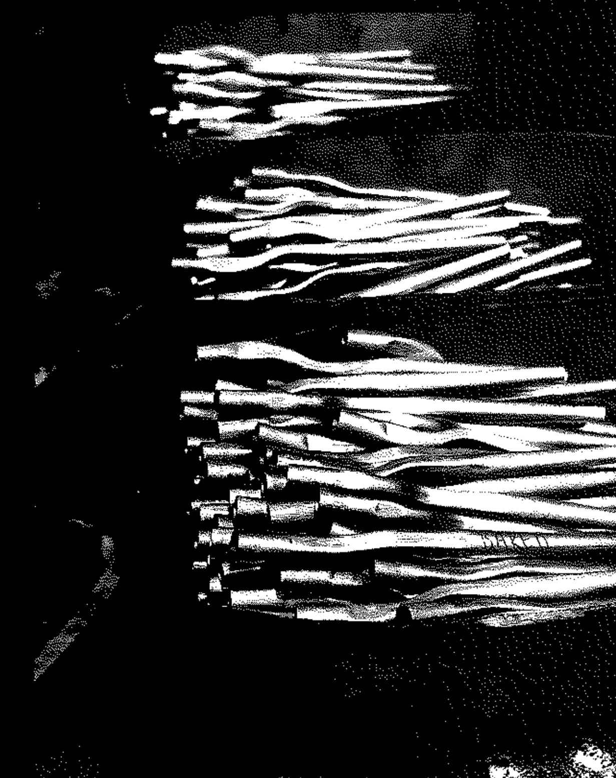

1999
KLEIN BICYCLE TECHNICAL MANUAL

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The Klein Story

Where Klein's are born.

The birthplace of every Klein frame is Chehalis, Washington. This is the home of the research, design, and manufacturing facilities of Klein bicycles. Lewis County in western Washington is a rural area with mountains and Douglas fir forests that provide miles and miles of quiet, meandering roadways for a road cyclist. The Klein factory is also close to Capitol Forest, which is criss-crossed with hundreds of miles of wicked singletrack. It is on these roads and trails that Gary Klein does his best work. It is in this forest and on the surrounding country roads that tomorrow's Klein bicycles are conceived.

The first Klein

During the mid-1970's, Gary Klein was both a successful undergraduate at the prestigious Massachusetts Institute of Technology (MIT) School of Engineering and a fast Category 2 racer on the road, and even did a little cyclocross. Coupling his engineering studies with his considerable hours in the saddle, it wasn't long before Gary set his mind to improving the machine beneath him.

The first Klein bicycle began as a feasibility study in M.I.T.'s appropriately named 'Innovation Center.' Gary's original thesis was quite simple; a large diameter aluminum alloy tube, through the processes of extensive manipulation and heat treatment, would deliver performance gains thought impossible by standard construction methods.

His proof; a prototype aluminum frame. This lightweight frame with oversized tubing radically altered the conventional wisdom of the cycling world.

25 years of Innovation

Since that first prototype, Gary Klein has continually improved cycling performance with 18 patents as proof of his innovation.

As he was back then, Gary Klein is still obsessed equally with riding and engineering, twin passions that are united in his bicycle designs. His mind is filled with a virtual encyclopedia of frame fit, flex characteristics, physics equations, metallurgical testing, and anything else that goes into making great bikes. Spend a moment discussing technical issues with Gary and you'll quickly realize just how deeply involved he is with bicycles. We've included a large volume of information in this technical manual, but its merely a drop in the bucket of Gary's knowledge.

In 1999, twenty-five years later, Gary Klein is still making cutting-edge bikes. And the rest of the cycling world is trying to catch up.

Is Gary a zealot?

To say that Gary is a zealot for detail is no exaggeration. Every element of his framesets, right down to the cable stops, has been isolated and analyzed to the nth degree with high-tech methods like Finite Element Analysis. His bikes are unique because he does not accept conventional thinking at face value. Instead of accepting that "This is how its done", Gary asks "How can it be done better?". If an appropriate solution doesn't exist, Gary creates one. Examples of his ingenuity abound in this manual.

The Klein Factory

Klein is as much a place as it is a person. While Gary's expertise is easy to see in the bikes, it also applies to the way Klein bikes are made. To make these unique bikes, it takes an unique factory and unique machines, both examples of Gary's ingenuity. These Klein designed machines have been created specially to perform the many proprietary processes that go into each Klein bike.

Gary rides bikes

If it sounds like Gary is an Engineering nerd, it's true. But Gary is no lab rat. At Klein, innovation starts on the trail. Each new design is tested personally, by Gary himself, in his Capital Forest backyard. No matter how good an idea looks on paper, if it doesn't ride, it doesn't fly. Gary designs each frame or component to satisfy himself, and his bikes are a reflection of his philosophy. This philosophy is simple: Make bicycles that ride wonderfully and are as light as possible. Test them extensively to make sure they are durable. And finish them to a jewel-like level of quality that is second to none.

Sound obsessive? It is. But then, the object of this obsession is something special. The object is a Klein.

A short interview with Gary Klein

How much does your riding influence the Klein design process?

My riding is the reason I make bikes. I make everything as though it is for myself. It's funny, but the first prototype of a new design seems to always be my size. I have been asked many times to make BMX frames, but because I don't ride BMX, I don't have a clue what is needed there. I am not interested in copying someone else's design.

The riding, and the variety of conditions we have to ride in, are critical to the development of our bikes. You can play around on the computer designing stuff, but the real test is when you get an actual part under you. There is no substitute for saddle time. I feel sorry for engineers who design fighter jets, for example. They don't experience the cockpit time I do. They never really get to see how well their designs work and feel. Nor do they get to test the competition's products. I try to get at least one ride in per day.

What is your most important criteria for designing bikes?

First I think it needs to fit the rider well. Then the geometry needs to be appropriate for the intended use so it handles and performs well. The frame is the backbone of the drive system, so it needs to hold the components in accurate alignment. It is like the engine block, gear case and frame of the car combined.

What is your ultimate goal for the bikes that you design?

I would like my bikes to be the most efficient, best performing bikes available. To do this everything needs to work. The fit and function need to be perfect. The weight needs to be as low as possible. The bike needs to be aerodynamically smooth. The frame and components need to be durable.

In your opinion, what is the most appropriate material for building bicycles?

There is not one "best" material for everything. If there were, we would make everything out of it. Materials have much more complex mechanical properties than most people realize. When they describe a material as "strong", they are often referring to its yield or ultimate tensile strength. This is how well it resists being stretched once. But there are many other types of strength that can be much more important to the product than tensile strength. The way in which the material resists loading in compression or shear, its behavior under repeated loads or in a corrosive environment, how much energy it takes to propagate a crack through it, how far it can stretch before breaking, how strong it is when welded, or how easy it is to fabricate, all of these are very important properties.

I look at each structure we are going to build, and based on the expected loads and operating conditions of that structure, and the process by which we want to make the part, decide what the best combination of materials will be. Based on testing, that may change. Nothing is set in stone.

I think aluminum is a really good material for bike frames, as evidenced by the large and growing number of aluminum frames being produced. Carbon is also an excellent material, but it requires more care in its design, manufacture and testing. For this reason, I treat carbon composite products with more care than aluminum ones. They can be lighter and "stronger", but the glue holding them together is not as strong as the aluminum metal. So they are not generally as resistant to direct impacts, abrasions and compressive forces (like at a fastener). That is why, in most composite products, the places where components attach such as the dropouts, headset or bottom bracket, are often made of aluminum or another metal.

I am not locked into aluminum. I think titanium makes good fasteners. I use carbon and boron composites on some of our products. We have been producing and selling composite bike frames since 1976, but most people don't know that.

Have you pushed aluminum technology to its limit?

I think there is a lot of additional room for improvement in aluminum frames, both in material and the structures we use. I don't think we have reached any limits yet. I intend to keep pushing at them.

Will we see Klein using more carbon fiber designs in the future?

We have used a fair amount of Carbon in products already, from frames and forks to handlebars and seat posts. Anytime there is a high bending or tension load condition over a long length in a single direction, carbon begins to look really advantageous.

Why is a Klein better than any other bike?

Because we have put more energy into design and testing of each of our products than the other manufacturers have. We have spent a lot of time refining the details of our frames and frame building process that other manufacturers have not.

You use a lot of very unique and often hand-built machinery to fabricate your bicycle frames. Can you describe one of these pieces for us?

One machine that we use which is probably unique in the bicycle industry is an antique machine called a Borematic. This is a very heavily constructed, single purpose machine meant to bore straight and true holes very consistently. The thing is quite slow. I purchased the machine for its base castings, and completely rebuilt it with modern controls and hydraulics, and new bearings in the 2 spindles. The moving ways were all rescraped into true. The ways are simple sliding V ways, but they are so well fitted, that when the hydraulics were not yet attached, you could easily push the several hundred pound table back and forth by hand. The machine is probably over 50 years of age, so the castings are completely stable, unlike new machinery that you can purchase. For example, I purchased an expensive, high quality vertical milling machine a few years ago, and had to resurface several parts of the machine because the castings had warped after it was assembled. The reason we use the slow Borematic is because it is rigid and accurate. It holds tolerances a typical CNC machine, which we also use, cannot. We also added heaters and temperature controls to the machine to keep it at constant temperature, and it operates in a temperature controlled room. Dimensions of parts change slightly with temperature.

We need this machine to create the precision bearing surfaces in our headtubes after the frames have been fully heat treated for the proprietary Klein Airheadset™ system. The races need to be much more accurate than those for a typical bicycle headset. The advantage is a much stronger, longer life headset, and a more rigid attachment of the fork to the bike frame. The headset is also more compact vertically than a typical headset, allowing us more flexibility in fitting the rider, and is about half the weight of a typical light weight headset.

There's more to the story......

Its obvious to anyone who has met Gary that he's a brilliant engineer, and a passionate cyclist. But the real Klein story is told when your customer swings a leg over a Klein. And the smiles begin.

Frame Materials

Materials Science

As a bicycle salesperson its important to understand some things about materials. The problem with such a discussion is that when we talk about topics like ultimate tensile strength, fracture toughness, or fatigue resistance, we're referring to materials science. When we give numbers and graphs of a material's properties, we're not talking about the complex structure of a bicycle, but a block of solid material subjected to a specific ASTM defined test in a laboratory. How the material is used in a structure, a tube's wall thickness, its butting, the care in its processing, welding and heat treatment, these all have as much or more effect on the performance properties of the bicycle than the material itself.

And why are all these properties important? Because careful material selection can make the bike ride better and last longer. It is difficult to market, but the best material is not the one that scores highest on a single lab test like yield strength. It is the one that makes the best bike frame by having the best combination of properties.

6061 vs. 7005 alloy

A good case in point is comparing 7005 aluminum to 6061. In bench tests, 7005 has slightly higher properties in fatigue and yield than 6061. Since the density of each material is very close, that makes 7005 look pretty good on paper.

But in a different set of tests, 6061 has greater elongation than 7005. Elongation is the ability to stretch without breaking. Another material with low elongation is aluminum with aluminum oxide reinforcements, like M2. The reason that lab properties and bike frames will behave differently is that the lack of elongation is likely to cause an increase in cracking near the welds due to welding and heat treating stresses. All welded frames have lots of very small cracks in them. They are just small enough so that their growth rate to reach critical size is slower than the frame's lifetime.

From testing actual bike frames, we found that its necessary to use more material in a 7005 frame to prevent breakage under extreme loads. So of two frames of comparable durability, a 7005 frame will be slightly heavier than a 6061 frame.

Aerospace Grade Aluminum

Klein exclusively uses substantially higher quality 'aerospace grade' instead of the more common 'commercial grade' aluminum. Most 'commercial grade' tubes are produced using porthole die or welded seam extrusion techniques. To reduce cost, each batch of these tubes is at most checked for dimensional tolerance, with no regard for purity or strength.

'Aerospace grade' tubing is seamless extruded and then precision drawn with strict alloy purity and strength tests that each batch must pass before it is certified 'aerospace grade.' Low grade aluminums, even though of a good or high strength alloy, will not withstand the extreme butting and manipulation done on Klein Gradient tubing.

OCLV

OCLV stands for Optimum Compaction Low Void. It's a term describing the carbon fiber composite used in the carbon Mantra.

A typical carbon fiber is 0.0002" in diameter. Formed into layers, each layer is 0.005" thick. Quite a few layers can be stacked and still result in a thin laminate. A laminate is what we call a number of layers that have been joined such that in practice they become a solid part.

Without good compaction there are voids, like air bubbles, between the layers which prevent the layers from becoming a single unit. In OCLV, we end up with less than 1% voids. Other carbon lamination processes commonly end up with 5% or greater voids. Although that 4% difference may seem small, it really means about a 30% difference in structural strength. The frame designer working with a low quality laminate will know they can't get sufficient strength, so they add needed strength with internal reinforcements or more material for thicker tube walls.

When you add thickness, or ribs, or anything else, it changes the weight and feel of the frame. Heavy, thick-walled tubes tend to feel dead and heavy. Although some companies market this feel as 'damp' or 'shock absorptive', the thin walls of an OCLV bike make it feel alive under you. An OCLV frame feels like it always wants to accelerate. That fast feel is more than a sensation. Light bikes transmit less shock to their riders, who thereby save energy and go faster.

Honeycomb Carbon Composite

The stiffness of a tube is mostly defined by its outer diameter. So, if you want a tube to be stiffer, you should make it bigger in diameter, not thicker. But flat surfaces are different. When you look at the stiffness of a flat surface, think about its two surfaces like the outer walls of a tube. The further apart, the greater the stiffness.

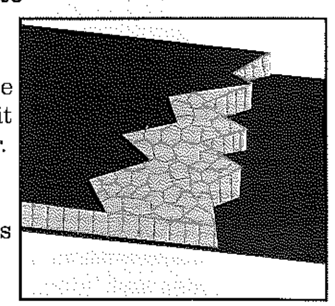
Fig. 1

You can separate the surfaces of a flat section by simply adding material. But even with a low-density material like carbon composite, this adds weight. What we have done is separated the carbon surfaces with a hollow honeycomb in a sandwich construction (Fig. 1). This provides a very stiff laminate that is still very light. Compared to bikes made with conventional carbon laminates, Honeycomb gives Klein bikes a lighter structure that is about 20% stronger and also 20% stiffer.

A bike is more than its frame material

While the material used to make a bike is important, there are many other factors which influence how it rides. The geometry, the tubing wall thickness, diameter and shape at each point along each tube, the joint designs, even the quality of manufacture all have an affect. When all is said and done, the frame material is only one factor in how a bike will ride. You still have to get on it and try it to see how the whole package interacts and how it works for you or your customer.

Geometry and Fit

The 2 functions of bike design

When designing a bike, or looking at geometry charts to find a bike for a customer, there are two things to accomplish. The bike must fit well, and the bike must ride well. Note that its usually required that the bike fit well for it to ride well.

#1 is Fit

First and foremost the bike must fit well. The critical issues are the relationships between the saddle, the pedals, and the handlebars. These are the points of contact between rider and bike. Most geometry charts fail to locate these points, making the charts virtually useless for fit information. We intend to change that.

The old way to fit a bike

You'll notice that this list does not include standover height, a popular but outmoded gauge for fitting bikes. It wasn't many years ago that almost all bikes had horizontal top tubes. If we assume that those bikes had a fairly narrow range of bottom bracket heights, and that all stems were pretty similar in the amount of height adjustment they offered, that meant that the top tube could be used as an indicator of handlebar height, as well as seat height. Even so, standover did not take into account reach, an important part of fit that accounts for the distance from the saddle to the handlebars. So standover sort of worked as a fitting guide.

Today's bikes have lots of bottom bracket height variation, they use sloping top tubes, and many of them use Ahead or Airheadset™ type stems with varying rise, or riser bars. So having a rider straddle a modern bike can no longer tell us if the bike fits. Standover only tells us if there is sufficient room for the rider to dismount safely, a performance issue.

The right way to fit a bike

So how do you fit a bike? The professional shop will start with a persons overall height. Since their height is comprised of their inseam length added to their torso length, with their head height added in, this is a good starting point. Granted, there are more accurate ways to size a bike, but overall height is something most of your customers already know, and it leaves out sophisticated measuring techniques which tend to be inconsistent if done by untrained personnel.

The next parameter for fitting the customer to a bike is riding style. Each bike design has a style of riding in mind, whether its cruising a bike path, charging down a twisty singletrack, or sprinting up a mountain in the Tour de France.

On each Klein we have suggested an overall height range per size and model of bike. The sizing and intended use of the bikes vary, and so do the suggestions. As an example, a 6' tall rider might ride a L mountain bike, a and a 59cm road bike. This is because each type of bike is designed to fit and perform differently, but the rider may want a similar position on each bike. From each of these bikes, you can then make subtle changes to make the bikes fit their best. These changes include moving the seat vertically, moving the seat horizontally, moving the stem vertically (through adjustment or moving spacers), or changing the stem length or angle for horizontal or vertical adjustment.

Since the easiest of these, with the widest possible adjustment, is the seat height, seat tube length should be the least of our worries. And since the hardest of these is changing the stem, the most efficient way to fit a bike should be to choose a bike with a frame design and size that places the handlebars where the customer wants them. Wants is an important word here: don't try to mold your customer to the way you ride your bike. Certainly you can suggest ways to make their riding more enjoyable, but its their bike. Size the bike to their riding style.

Bikes should also be sized based on rider experience levels and how much they anticipate riding. For example, a person buying their first bike who begins to ride seriously will find that he/she becomes more flexible in the hips as they put in the miles. As they gain flexibility, the bike that fit comfortably with a 120 stem will need a 140 to accommodate their physically fit new body.

So what tells you where the handlebars are?

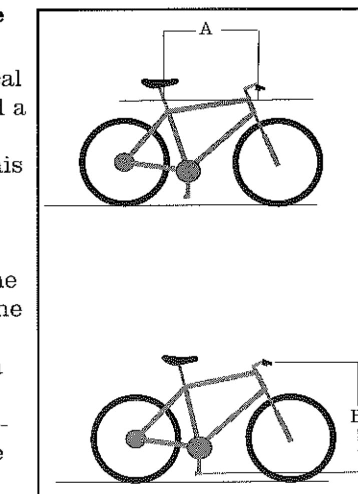

Fig. 2

In this year's technical manual we have included a dimension called handlebar height (B, Fig. 2). This is the vertical distance from the center of the pedal spindle, with the crank at the bottom of the stroke, to the center of the handlebar at the grip. Combined with the reach (A, Fig. 2), or horizontal distance from the handlebar to the seatpost at the top tube/headtube junction, you should be able to identify the right size of bike within each model.

If your first pick of bike size was not satisfactory for the customer, you have three alternatives. You can move to a different size, select a different model which offers the desired size, or customize a bike to achieve the desired size.

Once the size of bike is chosen, some simple fine-tuning can create a professionally adjusted bike. This level of service is what sets you apart from big box stores. Shame on the 'professional' employee who does less!

Geometry and performance

Bike design also effects performance. The geometry charts show some of these parameters, such as bottom bracket height, or head angle. What they don't show is how some of these factors work together. As an example, changing the length of the chainstays can change the way a bike steers. When all is said and done, a geometry chart is only an indication of how a bike will ride. You still have to get on it and try it to see how the whole package interacts.

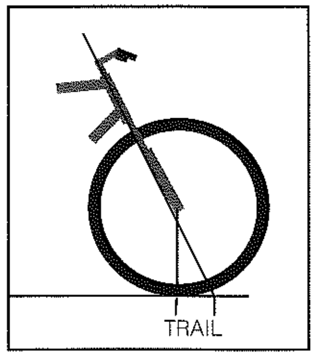

Fig. 3

Trail (Fig. 3) is the measurement on the ground of the distance from the steering axis to the contact patch of the front tire, measured by a vertical line through the front axle. It is the effect of fork rake combined with headtube angle. If by changing the rake, a 90 degree headtube and a 60 degree headtube both have the same trail, the bikes will feel identical in a straight line as long as the front/center is the same.

Trail is more important than head angle in determining the steering feel of a bike. The head angle describes how direct the steering input is (quickness) but trail dictates the feel (heavy or light, stable or twitchy).

Another factor is the weight on the handlebars. The more weight placed on the bars, the stronger the effect of the trail. So if you take a quick steering bike and puts lots of weight on the bars, it may become truck-like. On the other hand, if you take a really sluggish bike with heavy steering and put all the rider's weight on the rear wheel (like when climbing a steep hill) the front end may feel too light to control. To accommodate this effect, we adjust headtube angles to adjust the trail, so Klein bikes handle consistently through their size runs.

Bottom bracket height effects the rider's center of gravity. The higher the center of gravity, the less stable the bike is. But the closer to the ground, the harder it can be to move in situations requiring agility and quick handling.

Bottom bracket height also affects the height of the saddle off the ground. The higher the saddle is from the ground, the harder it is to get on the bike. A high bottom bracket can make it hard to get started on a bike for people with balance problems such as older or younger riders, or those with mobility problems.

Another factor when considering bottom bracket height is pedal clearance. For road bikes, this can effect the rider's ability to pedal through corners in a criterium. With full suspension mountain bikes, the suspension allows the rider to sit and pedal through terrain where they would have to stand and coast on a hardtail, such as areas with large rocks sticking up. But if the bottom bracket is so low that the rider hits their pedals on those same rocks, they can't pedal anyway, so they could lose one of the advantages of full suspension.

Handlebar height (headtube length) is critical for comfort. And since most bikes don't have a lot of adjustment (some special headset/suspension systems don't have any!), its critical that the headtube be a length that places the handlebars at the right height.

In the past, Klein mountain bike sizes were listed by the imaginary horizontal top tube. Although this may have confused some, it is an indication of how important headtube length is in fitting a bike. Some bikes use the same headtube length on all sizes, or don't offer the ability to change the stem height without turning the stem over. This missing adjustment drastically reduces the riders ability to get a comfortable ride. Klein direct connect steering systems use size specific stems with 20mm of spacers. By selecting different sizes of Klein bikes, there is lots of adjustment. On the four sizes of Mantras, the handlebar height range goes from 823mm to 912mm, or almost 4" of adjustment with 20 hand height choices. And that's without flipping the stem.

Front/center is the distance from the bottom bracket to the front wheel axle. Since a rider should first be positioned relative to the bottom bracket for optimum pedaling efficiency (fore/aft and height adjustments of the saddle), this dimension tells you how far in front of the rider the front wheel will be. The placement of the front wheel relative to the rider's center of mass effects both weight distribution and stability.

Weight distribution is how the rider's weight is spread over the two wheels. Frame geometry has something to do with this, but so do accessories like riser bars which raise the hands and place more weight on the saddle. As discussed above in Trail, this will effect steering. It also effects rear wheel traction when climbing. The closer the center of mass to the pivot point of a turn (the rear wheel contact patch, as described by chainstay length) the quicker a bike will turn. As an example of this phenomenon, try doing a low speed turn from the front of a tandem.

Tubing diameters, materials, frame flex, and alignment all affect how a bike rides. Geometry charts only refer to lines in a two dimensional drawing. Many more things go into making a bike handle the way it does. The frame material, the tubing wall thickness and diameter, even the quality of manufacture all have an affect.

Its a package

To truly discuss the way a bike performs with a customer, its important that you take the time to test ride the bikes you are selling. Test each model in the manner you will instruct your customers to follow. Perform a series of exacting tests during the ride to highlight strengths and weaknesses in handling and comfort for a typical type of riding. In other words, it doesn't make sense to test the singletrack capability of a city bike. Neither is it required that a road racing bike give a 'heads up' type of comfort. But understanding what each bike does well will help you match your customer to the bikes on your floor. Only when you have this knowledge can you offer more than the guy at the big box store who just talks about rear derailleurs.

A Fit Discussion with Gary Klein

Are you on too large of a bike? Is the saddle position too far to the rear? Is the stem length too long? Do you suffer back pain due to a poor bike fit? This can happen if the sizing was based on traditional recommended fitting guide lines.

Fit Systems Myth -

There are a number of fitting systems I am acquainted with and I have also written a fitting program in Basic. Like most of the fit kits or other systems, mine works well for medium and average proportion riders, but gives inaccurate recommendations for unusual body configurations. Do not count on any of these measurement based systems to fit cyclists unless they are very average. The mechanical trial and error systems have some use also, but unless the rider can test them on the street, they will not see the handling and control benefits of the setup.

The fitting procedures I use are based on experience. I have been cycling for a long time and have had a lot of challenges fitting people for standard and custom frames in the last twenty five years. I have made mistakes which have forced me to think about what was really important in the fitting process. Most of the standard 'rules' out there do not make any sense when analyzed or applied to the non-average person. I have been fighting some of these 'rules' for a long time. Cyclists who are puzzled or frustrated with their riding fit and may have back pain, shoulder pain, or knee pain usually have been reading magazines and following advice that is very general, vague and out of date. The standard type of fitting recommendations such as stand over height have not worked well for them. These recommendations apply to average proportioned male riders of average size and weight attempting to achieve an average riding position.

Most of the current measurements are averages of some kind. The stand-over clearance, saddle fore-aft position, handlebar reach, handlebar height and seat post extension are all averages. That does not make them good fitting techniques and in fact makes them poor techniques for the cyclists who are non-average in some way (most of the population). Why waste people's time and money and discourage them from continued cycling based on these 'average' methods when there are better ways of achieving a good fit.

The common fit systems or programs I have encountered also attempt to work in this same 'average' mode. They will fit the average size, yet people like myself with a very short torso, long arms and long legs will be considerably missed by the fit systems.

Stand-Over Height Myth

Frame sizing has little to do with crotch clearance on the top tube. Although it is nice to have some crotch clearance, I will forgo it in order to achieve the best riding fit. My own road bikes have about 5 inches of crotch clearance. I have very long legs for my height. Someone with short legs relative to their height may have minimal or no clearance. Frame size is best determined by the cyclist's height and riding style. The frame size is really positioning the top of the headtube and thus the handlebar in terms of reach and height. Unlike the saddle, there is not very much useful adjustment range of the handlebar and stem.

The cyclist's riding style can push the recommended frame size up or down one size. For example, a rider wanting a more upright, touring type position, or with limited back flexibility or having non-average body proportions may wish to go up one size. The rider seeking an even lower riding position than a typical racing position or having non-average body proportions might go down one size.

The Inseam Dimension Myth

The inseam measurement method is similar to the stand-over height measurement. Those people with longer legs will get larger frames. But they will not necessarily fit right. The heavy person or the light person will have the wrong size frame just as the person with the long torso or short torso will have the wrong size. In both cases, only the average person will get a good fit. The inseam dimension, which is used by most fitting systems to define the frame size, is only a single measure and does not by itself do a good job of defining the rider's needs regarding frame sizing. It does not allow for other variations in the person's anatomy, riding style or other needs. Using the inseam measurement alone as the determinant of frame size is highly inaccurate and will lead to the wrong frame size in a substantial percentage of cases.

The Knee Over Pedal Myth

What influence does this have and where is the logic for it? Does it mean that all recumbents' and most time trial bikes are 'poor' fits? Does it mean that if I have a long femur that I should adjust posterior and my center of gravity back over the rear wheel? Of if I have a short femur that I should support most of my weight on my hands? I don't think so! This is a case where a medium height, average proportioned rider in a typical riding position may end up with the knee placed directly over the pedal axle in terms of reach and height.

MicroDrops

Consider the conventional rear dropout. A rather thin piece of metal goes from in front of the wheel axle, wraps around the axle, drops down, and then proceeds down to become the rear derailleur hanger. If you follow a rough centerline of the material, total distance from the chain-stay to the derailleur mounting bolt is about 85mm. On a Klein its about 45mm. By shortening the hanger, dramatic increases in hanger strength are accomplished. Not only that, but the dropout itself is much stronger.

Klein teams, and especially the team mechanics, have all complained about wheel changing with the Micro-Drops. For example, we had a difficult time getting the ONCE team to accept them initially. But after a season of use, no team has ever wanted conventional dropouts. Why? Because once you learn how to use MicroDrops, wheel installation is actually faster and more accurate.

As a performance feature, this rear entry style of dropout allows the axle of the rear wheel to rest snugly against the backbone of the drop, making it absolutely impossible for the rear wheel to slip forward when the rider jumps on the pedals.

With MicroDrops it is a straight in shot from the rear, and there is no resulting tire interference with chainstays as in forward entry dropouts. This means Klein bikes can have a lighter, tighter, more rigid chainstay assembly. The Re-Entry ramps really do work to line up the axle and QR for quick engagement.

We overheard one mechanic say he thought MicroDrops were dangerous because the wheel would fall out if the QR was not adequately tightened. On the contrary, chain tension pulls the wheel into the dropout, not out like with conventional dropouts. Even if you bounce the bike on its rear wheel with the QR undone, the rear wheel stays in MicroDrops.

To remove a rear wheel, first shift to the smallest cog. Open the brakes and undo the wheel QR. Pull the rear wheel out of the dropouts about 2 inches (Fig. 4), wrap a single finger around the chain immediately in front of the top of the cog (Fig. 5), and lift the chain off the cog.

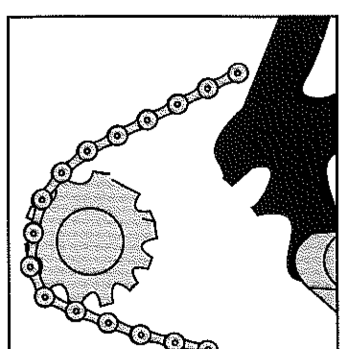
Fig. 4

The chain lift is more positive and reliable than having the derailleur hold the chain. Sometimes the chain comes off of the jockey pulleys in the traditional type, and a snarl is created. With standard dropouts, all procedures must be done simultaneously. With Microdrops, each step is completely isolated, giving the mechanic greater control of the process for increased speed.

To install the wheel, grasp the chain with your finger, and place it on the small cog. Open the brakes further if necessary and guide the rear wheel through the pads. In most cases the Re-Entry ramps of the MicroDrops will allow the chain tension alone to pull the rear wheel into the drops and center it. Tighten the wheel QR, close the brake QR, and you're off.

Once you practice with the MicroDrops you will appreciate Gary Klein's clever approach; stronger, lighter dropouts, a stronger, lighter frame with both increased rigidity and better tire clearance, and faster, easier wheel installation and removal. All in a single design detail.

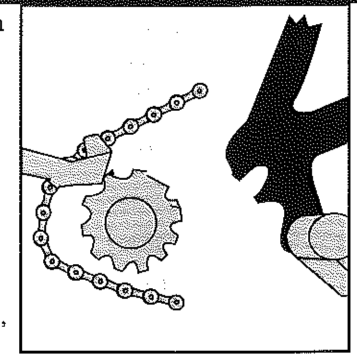
Fig. 5

Internal Cable Routing

The Quantums and Adroits are beautiful looking bikes, helped by the fact that the gear and brake cables are concealed. The key to successful internal cable routing is the patented cable entry holes and dimples. Klein used Finite Element Analysis to produce the cable entry hole to be aerodynamic, evenly distribute headtube stresses down the top and down tubes, and make a measurable structural advantage.

That's a lot of claims for a cable entry hole. Its easy to see how removing the drag of the cables would make a bike more aerodynamic. There is considerable lateral air flow across the top and down tubes in normal operation, and external cables create additional drag. Since the Klein dimples are partially recessed into the tube, the housings also present a slightly lower profile and smoother shape to the air stream.

But how can a hole make a frame stronger? In theory a hole in a tube should be a potential stress riser, or weak point. If the dimple, or hole, were placed on the top and bottom of the tube, in the main load path, it would accentuate the tension and compressive stress in the tube near the hole, and reduce its net strength. However, the overall strength of a structure is not always readily apparent or obvious just from it's appearance.

The toptube and downtube are predominantly loaded by the load provided by the front fork, in plane with the frame tubes (Fig. 6). This force loading places the major stresses on the upper and lower surfaces of both tubes. The forces are the highest at or near the junction with the headtube.

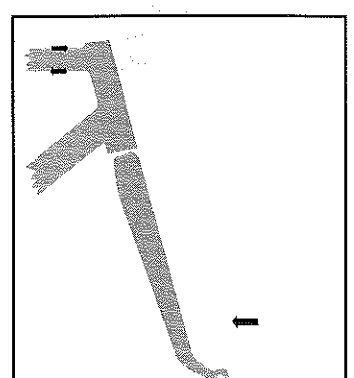
Fig. 6

The sides of both tubes are predominantly loaded in shear (Fig. 7). For example, in order for the top to stretch and the bottom to compress, the side wall material must twist or shear (for lack of a better term). If the side wall material of the down or top tube is very rigid in shear, the welded joint will be more rigid, and the tension and compression load is focused on the very top and very bottom of the tube, as the largest moment is there.

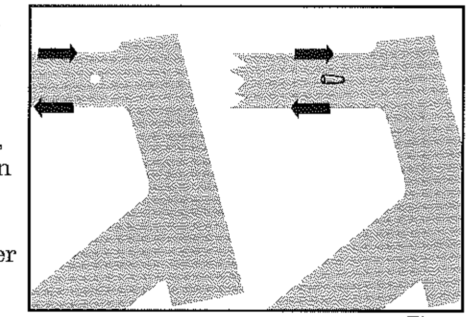
Fig. 7

If there is a hole, or pattern of holes, in the side of the tube, (or some other feature such as a thinner wall) effectively reducing its shear rigidity, then the welded joint is more flexible, and the tube behaves less like a single hunk of material, and more like two independent pieces of material, one taking compression and the other taking tension load. So instead of focusing the high stress on the very top and bottom of the joint, the stress is more uniformly distributed over the whole upper surface and the whole lower surface of each tube. While this improves the durability of the top and bottom of the tubes, a simple hole creates small stress risers of its own.

Our patented dimples act like an accordion to reduce the shear stiffness of the side wall, but do not have the additional stress risers created by a hole. The metal is formed up and around, and the actual hole through the tube wall material is approximately in line with the tube axis. So by changing the direction of the hole, it is not a stress riser for the top and down tube stresses.

Our computer analysis showed a significant improvement in the stress distribution due to the dimples. We did not believe this at first, but subsequent laboratory testing confirmed that the fatigue life was improved in the range of 30 to 50% by the dimples at a given loading.

By making the overall headtube joint less vertically rigid, it is able to absorb more deflection energy without failure. It should also be pointed out that the placement of the dimples on the tube, and in relation to the joint, is critical in order to achieve the structural advantages mentioned.

One further advantage of Klein dimples is that the subtle change in tube flexibility near the headtube may be contributing to the "ride". To explain this we have to talk about a common bicycle design myth, that the length of the stays affects comfort. In most rear triangle designs, the nicely triangulated configuration is basically a space frame, and is thus almost totally rigid vertically. Changing the length of the stays, or adding bends, does little to change this. However, you can make a bike more compliant vertically by allowing it to flex more at the headtube joints. The problem is that without Klein dimples, adding flex to this area of the bike will likely reduce its impact and fatigue strength, possible causing premature failure.

Dimples allow a Klein frame which is very laterally stiff, to flex more vertically and be surprisingly comfortable. Like with the case of Klein MicroDrops, Gary's clever design approach provides a stronger, lighter frame with improved aerodynamics, better looks, and a more comfortable ride. All in a single design detail.

Klein Heat Treating

Before Gary Klein, there was no such thing as an oversized welded aluminum frame. Using the research labs at M.I.T. during the mid 1970's, Gary developed the first use of large diameter tubes to stiffen and strengthen bicycle frames. He did this by refining a heat treating process that actually changes the crystalline structure of aerospace aluminum, helping it regain its high strength properties after welding.

Heat treating is not a secret process, and has been widely employed as a strength enhancement of aluminum alloys for years. Basically, heat treating takes a welded structure through a schedule of precise temperatures for specific amounts of time. If followed correctly, the aluminum molecules form crystals which increase strength and fatigue resistance. However, this requires taking the aluminum almost to its melting point, at which point it becomes very soft and compliant. Then, as it cools, the aluminum tends to bend and warp due to stresses within the metal. Maintaining the alignment of a complicated structure like a bicycle frame during the heat treating process is something that many bike manufacturers are still struggling with today.

Through his research, Gary learned how to heat treat a bicycle frame without losing the alignment. Klein frames today do not pass quality control unless they are within a tolerance of 0.1mm (.004") on all alignment surfaces. These surfaces include the front and rear dropouts, seatpost, top and bottom headset bearings, bottom bracket, and brake mounting surfaces. The alignment has to be dead on or the frame is scrapped. This is very expensive, but we refuse to sell a bike that we know is less than perfect.

After heat treating, some additional machining is done in a temperature controlled room. Our machining tolerances are even tighter, + or - 0.0002". We believe that our quality control standards are the most stringent in the industry, a reality that is reflected in the flawless performance of every Klein bicycle.

Gradient and Power Tubing

In the twenty years since he built the first bike using oversized aluminum tubing at MIT, Gary Klein has learned that what goes into shaping the tubing is more important than the raw material itself. That's why Klein designs its own aluminum frame tubing. All Klein bikes are built using either Gradient or Power Tubing. Both are Klein exclusives which result in lighter, stronger, better riding bikes.

Gradient tubing is the end result of a proprietary process that takes raw aerospace grade aluminum and works it over, using a variety of custom designed and handmade machines, to create a premium material that exists nowhere else.

Gradient tubing is made from a proprietary aluminum alloy, because off-the-shelf alloys do not lend themselves to the extreme metal manipulation of the processes used to create Gradient tubing. Gradient displays our most advanced metal shaping techniques, tapered both internally and externally, maximizing the strength of the structure while minimizing the amount of material needed to achieve that strength. Cut open a

Gradient tube and you'd see that the walls have gradual tapers, with wall thicknesses that vary as much as 260% between sections of high stress and low stress. Other companies use butted tubes that have a short transition areas from one wall thickness to another, essentially just to reinforce the weld zone.

Gradient tubes vary in thickness over the entire length and diameter of the tube. This gradual variation avoids stress risers, points of high force concentration caused by the sharp transition of butts.

Power tubing is a more simply shaped, long taper, butted tube. Formed out of 6000 series aluminum, it delivers many of the strength/weight advantages of Gradient tubing without the additional shaping.

The result of Klein's Power and Gradient tubing? The lightest and strongest production frames available--2.9 lb. ATBs and 2.7 lb. road frames. Custom tubing; another example of the obsessive detail that makes a Klein a Klein.

Large Diameter Frame Tubing

Gary Klein is the pioneer of using large diameter tubing in high performance bicycles. Why are the tubes so big? Let's play math: The stiffness of a round tube of a given material increases as the 4th power of the diameter. The strength increases as the 3rd power. The weight increases only as the square of the diameter.

For a specific thin wall tube length and weight, doubling the diameter will result in half the wall thickness when using the same amount of total material. But the bending and torque strength will increase by 2.2 times due to the larger diameter. And the bending and torque stiffness will increase by 4.5 times due to the larger diameter, even with half the wall thickness! Large diameter tubing frames are stiffer, stronger, and lighter than those of small diameter tubes. This makes them faster, more efficient, and more fun to ride.

Aerospace Grade Aluminum

Klein exclusively uses what is called 'aerospace grade' aluminum. Most other manufacturers use 'commercial grade' aluminum. There is a substantial difference in quality between the two. Most 'commercial grade' tubes are produced using porthole die or welded seam extrusion techniques. At most, each batch of these tubes is checked for dimensional tolerance, with no regard for purity or strength. Using these tubes keeps costs down, but it's a little like ordering the 'mystery meat;' you're never exactly sure what you're going to get.

'Aerospace grade' tubing is seamless extruded and then precision drawn with strict alloy purity and strength tests that each batch must pass before it is certified 'aerospace grade.' This manufacturing process is much more consistent with the strict quality standards of Klein bicycles, and guarantees a solid and durable base material for our frames.

Reinforced Headtube/Downtube Junction

Much like a boxer that leads with his chin, the headtube/downtube junction always takes the first hit, the first impact of everything on the road or trail. This is the point of failure that takes many a lesser bike down to the mat. To address this, Klein starts with a lightweight internally tapered headtube, which is heavily reinforced around the bearing races. This is to prevent bearing shock loads from ovalizing the tube.

Note the distinctive barrel-shaped profile of the ATB headtube, or the even larger diameter headtube of the Airhead headtube. The extra width is designed to conform to the large diameter of the top and down tubes, to maximize the welding surface at this critical juncture. What you don't see is the robust tubing wall thickness in the headtube region, or the uniform crystalline structure created by the full T6 heat treatment performed after welding. This is the most highly stressed area of the bike. Klein goes to great lengths to insure that it doesn't fail.

Airheadset™

Its not that we don't like the AheadSet system, we do, and use it on many models. Its lightweight, strong and rigid, and can be adjusted with just a couple of allen keys. What could be simpler?

The Klein Airheadset™is stronger, lighter, and more rigid than any other frame/fork/stem connection on the market today. Its 50% lighter and seven times more durable than a comparable cup and ball set up.

Since the Airheadset™ uses special bearings which are totally sealed, dirt and moisture penetration are eliminated giving extremely long bearing life. The Airheadset's aerospace torque tube bearings are designed to handle both radial and lateral loads, so they will outlast a conventional headset. No maintenance is required, nor is any adjustment (the top cap and 'adjusting bolt' on the carbon Mantra are used for installation, not truly for adjustment). Its that simple. And if after a few years it is necessary to replace some Airhead bearings, they won't cost you an arm and a leg.

For 1999 Klein mountain bikes, the Airheadset™ will be matched to Manitou forks fabricated specially for Klein, and topped off with Klein's superlight MC3 front load stem. The end result is unparalleled weight savings, with a notable improvement in steering precision and control. New for 1999, the Airheadset™ on Klein mountain bikes can be fitted with adapters allowing the use of any standard, 1 1/8" steerer, in the Klein bearing system. While not as light or rigid as a Klein Airhead steerer, the adapter makes the Klein Airheadset™ totally interchangeable with any fork on the market.

Void-Free Welds

While you are inspecting the headtube/downtube junction, take a moment to admire the fine welds of the Klein frame. Inside of the headtube you will see evidence of burn through--a sign that the welds are full fusion thickness, penetrating to the root of the fillet without any strength-robbing gaps. This is accomplished through a proprietary deep-penetration TIG welding technique. Note also how smooth the welds are all the way around the joint, with no shrinkage cracks or pits in them. Feel how evenly they flow into each tube surface. These welds are not sanded, ground, or puttied. Their clean, fluid appearance is a testament to the skill of our frame builders, and the exacting attention to detail that they dedicate to their work.

As a compliment to Gary Klein's development of this process, you'll notice that other builders are starting to copy this technique. How did they figure it out? By hiring former Klein employees!

Gradient Seat Tube

A Klein Gradient seat tube is heavily reinforced at the seat clamp to stand up to the clamping and riding stresses inflicted by the seatpost. The seat tube diameter is huge, and we use the largest post available to achieve maximum post strength with minimum weight. Remember the frame tube diameter lesson. Below the reinforced seatpost zone, the tube tapers into a lightweight section before it is reinforced again at the bottom bracket. After all welding and final heat treatment, this tube is precision bored for an exact and consistent seatpost fit. Most manufacturers settle for a less expensive reaming process, but Klein quality demands total precision for exact concentric wall thicknesses.

Gradient Chainstays

Turn a Klein frame over and look at the sculpted chainstays. This is perhaps the most complex and perfectly designed component of the Klein frameset. They are, without question, works of art.

Starting in a large D-section for a rigid and secure attachment to the bottom bracket, the stays smoothly change into a compact and heavily reinforced rectangular section to accomplish the tight bends around the chainrings and the tire. From there the stays transition into a large round diameter, the largest in the industry, for incredible rear end stiffness and power transfer. The thin walled center of the chainstays reduce weight, and then the stays change shape into an oval to effectively attach to the cold forged MicroDrops. These chainstays are the heart of a Klein, and the single greatest determinant in that sweet Klein ride.

Manipulating one aerospace grade, seamless drawn, aluminum tube into four different shapes, three tight-radius bends, and continuously varying the wall thickness in a short 16 centimeter span is very difficult. Klein had to custom design and hand build the machines to make these stays a reality. And it's also quite expensive. In fact, our chainstay assembly alone costs more than many complete off-the-shelf aluminum frames. But without this costly and time-consuming manipulation, the bike wouldn't ride like a Klein.

These remarkable chainstays allow for an ultra short chainstay length, keeping the rear wheel under the rider for superior climbing traction and control. And the tight, precisely placed bends make for gobs of mud clearance, even when using 2.35 tires. Klein bicycles consistently receive rave reviews for their climbing capabilities. The rigidity achieved with these chainstays is one of the reasons.

Earlier we spoke of obsession. Gary confirmed through extensive lab tests that the right chainstay is under considerably more stress than the left due to chain compression. So Klein chainstays are different, right to left. Again, through innovative design and tireless effort, Gary has tweaked his design to make a frame that is lighter, stronger, and rides better than anything else.

Klein Seatstays

Linear pull brakes, or V brakes, are the new industry standard, superseding cantilevers with their increased leverage and their ability to apply much greater stopping power to the rims. In order for linear pull brakes to work to their fullest potential, delivering the greatest possible modulation and control, they need to be mounted to a frame that will not deflect under load. Klein Gradient seatstays have their internal taper tuned for maximum lateral stiffness at the area of the brake boss. These are the stiffest seatstays in the business, insuring the least amount of deflection and the best braking performance on the trail.

High-power brakes are wasted if the frame that they are attached to cannot withstand the forces that they apply. The best parts in the world bolted onto an inferior frame is money thrown away.

The Finest Paint Jobs

Highlighting these fantastic technological advances are the most artful and distinctive paint jobs on the scene. All paint work is done in Chehalis using a color coating process almost as remarkable as any Klein manufacturing procedure. The normal Klein paint scheme includes a powder base coat for its durability and adhesion to the metal. Over the base coat, a 'liquid' paint is applied for its high gloss and deep color.

Graphics are 'debossed' instead of decals. Rub your fingers over the Klein name on the downtube and you'll notice that instead of raised, applied decals the letters actually sit slightly lower. Debossing means careful masking of the base coats before the top coats are applied. Then by removing the masking, the base coat paint shows through. The graphics are paint, so there are no cheap decals to tear, wrinkle, or shift.

The bikes are finished with custom formulated top coats that cost up to $1800 per gallon. Again this is very expensive, but we demand a finish that is worthy of the best frames in the world. Klein covers their bikes with automotive paints exclusively, laid down in a ten step process to achieve the gorgeous multi-dimensional fades that enthusiasts have come to expect from Klein.

The Lightest Frames That Money Can Buy

Klein has gone far beyond any other frame manufacturer to increase strength and minimize weight, right down to the dropouts and cable stops. Klein bicycles offer the best design, the most advanced technology, and the finest execution of welding and paint. Because of all this, Klein bikes cost more. But to demanding bicycle enthusiasts, riding the lightest, most refined aluminum frame available is worth the price.

We present this information because there are many Airheadset™ bikes with either the first system with a one-piece bar and stem, or the Airheadset™ MC2. For 1999, the Airheadset™ has been combined with a pinch-bolt type stem called MC3 shown on the next pages.

The earliest Airheadset™

The first Airheadsets™ used a 1.25 inch diameter quill type stem, and 2 bearings with 2.0 inch OD and 1.5625 inch ID. This early system has its own installation tool set and removal procedures (not covered here). The bearings are mounted into the frame from the top and bottom like a conventional headset. They use Loctite to retain them, and have separate seals protecting them from the elements in addition to the custom made full contact bearing seals. This system uses a steerer which is specific to frame size. The stem was only produced as a welded bar / stem combination.

MC2 Airheadset™ design

Between 1993 and 1998 the Airheadset™ MC2 was used. The MC2 uses a smaller upper bearing, and both bearings are aircraft torque-tube type bearings. They are both installed from the bottom of the frame and are retained with Loctite.

The MC2 stem uses a collet (Fig. 8) to grip the steerer tube. This lighter design allowed Klein to produce a long steerer which could be cut to the needed size for a variety of frame sizes. The MC2 The stem was only produced as a welded bar/stem combination. There is a separate tool set to service the MC2 system.

If the collet is to be replaced with a pinch-bolt type stem, only use a Klein approved stem. Stems with poorly designed clamps may cause the steerer to fail.

With the MC2 Airheadset™, the stem does not apply any preload to the bearings. The collet is only to hold the stem in place.

Bearing OD	Upper 1.75".	Lower 2"
Crown race seat	39.7mm	

MC2 handlebars and bar ends

Some Klein Airheadset™ bikes used a one-piece aluminum stem and handlebar assembly called MC2.

MC2 handlebars have reinforcements in the bar tips to support bar-ends. Bars should grip MC2 handlebars for at least 0.7 inches (18 mm). Do not cut MC2 handlebars if they are to be used with bar-ends.

The original Mission Control handlebars did not incorporate reinforcements for bar-ends. These bars should only be used with reinforcement plugs (BERTS) if bar ends are to be used.

Stem removal

1. Remove the Airhead cap by prying up the edge. Be careful not to cut the plastic.

2. Use the MC2 wrench to unthread and remove the collet nut. The nut uses regular threading.

If the nut becomes overly tight when unscrewing, put a protective plate (piece of wood for example) across the top of the nut and tap it with a hammer to jar the collet loose. The nut is permanently attached to the stem.

3. When the nut is completely loose, lift the stem off the steerer. The collet may or may not come with it.

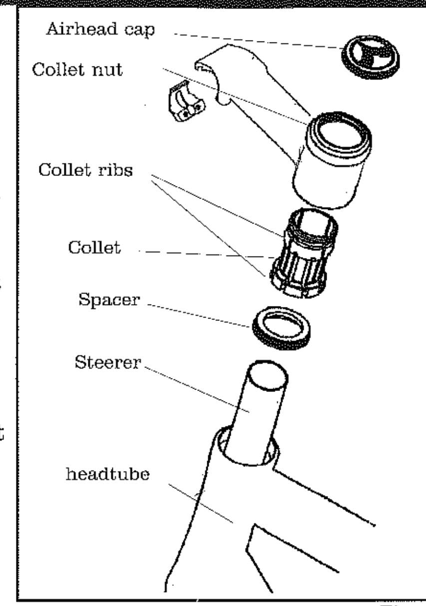

Fig. 8

4. The black spacers slide off. They are mostly decorative, and can be used with any number desired. When installing the spacers, do not force the spacers together such that they are dragging on the top of the frame. This will cause extra friction when turning the fork

Stem height adjustment

The collet position determines the stem position. The top of the collet should be flush with the top of the steerer. If the collet threads extend beyond the steerer, they may bend inward when load is applied to the threads and strip. Thus to change the stem height, you must cut the steerer.

1. Follow regular procedures to cut the steerer to the desired length. Deburr the end of the steerer.

2. Lightly grease the steerer, and remove any excess grease with a rag. Also lightly grease the collet threads and the collet ribs, where the collet contacts the inside of the stem (Fig. 8).

3. Install any desired spacers. To determine the number of spacers, the collet should just be touching the spacers and the spacers should not be dragging on the headtube.

4. Place the collet onto the steerer, threaded end up, until the top edge of the collet is even with the steerer.

5. Place the stem on the collet and carefully engage the threads of the collet with the collet nut.

6. Tighten the MC2 nut (collet nut) with the Airheadset™ set wrench to 300-360 lb•in (33.9-40.7 NM).

7. Replace the plastic cap.

Bearing installation

Follow the instructions on pages 13-15 for MC3 bearing installation in aluminum headtubes.

MC3- the newest Airheadset™

For 1999, the Klein Airheadset™ has been revised to provide full Airheadset™ advantages with easier service using a pinch-bolt type stem clamp. The steerer clamp diameters of these stems are not conventional 25.4 or 28.6mm, but oversize to maximize the benefits to the steering system. **Only use a Klein approved stem. Stems with mis-sized, or poorly designed clamps may cause the steerer to fail.**

Adroit Pro ATB Airheadset™

The Adroit Pro Airheadset™(Fig. 9), is similar to earlier Airheadsets where both the upper and lower bearings are installed from the bottom of the headtube. The upper bearing is pressed into the headtube, while the lower is pressed onto the fork crown. Then the fork is inserted from below the headtube and both bearings, the headtube and the steerer are pressed together at the same time.

Once the fork is installed, spacers are used in a cosmetic application below the MC3 stem, which uses external pinch-bolts to clamp to the steerer. Finally, a rubber ATB Airhead cap should be installed into the top of the steerer. Starfangled nuts, or any other method of preloading the bearing should never be used, as they may press the upper bearing out of the headtube.

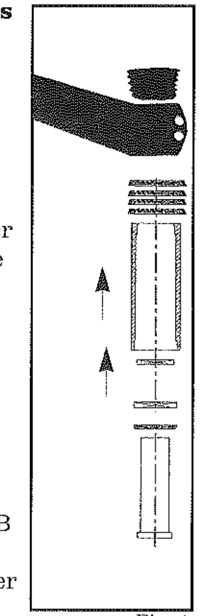
Fig. 9

Bearing OD	Upper 1.75".	Lower 2"
Crown race seat	39.7mm	

Quantum Pro road Airheadset™

The Quantum Pro Airheadset™ is identical to the Adroit Pro (Fig. 9), except for the dimensions.

Bearing OD	Upper 1.5".
	Lower 1.75"
Crown race seat	33.4mm

Carbon Mantra Airheadset™

With the carbon Mantra (Fig. 10), the upper bearing is pressed in from top of the headtube, while the lower bearing is pressed in from the bottom. The bearings are the same as the Adroit, but they are retained mechanically, so require no Loctite. This new Airheadset™ uses a starfangled nut to slightly preload the bearings, much like an Aheadset.

The Airhead top cap is a different size than standard, although the starfangled nut is a standard dimension for 1 1/4" headsets, and the headset adjusting bolt is the same for all steering sizes.

Bearing OD	Upper 1.75".
Lower	2"
Crown race seat	39.7mm

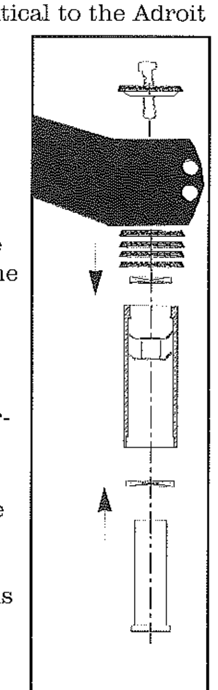
Fig. 10

Airheadset™ Tools

When working with Road or ATB Airheadsets™ you must use the correct size of tools.

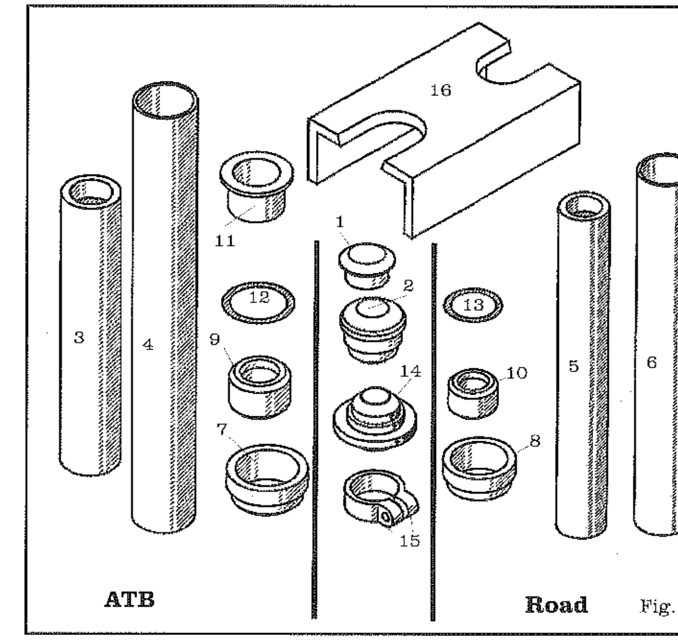

Fig. 11

1. Steel anvil	2. Aluminum anvil
3. ATB bearing remover	4. ATB bearing installer
5. Road bearing remover	6. Road bearing installer
7. Large knurled bushing	8. Small knurled bushing
9. ATB lower bearing guide	10. Rd lower bearing guide
11. Flanged bushing	12. Large rubber O-ring
13. Small rubber O-ring	14 Alignment spud
15. Tube clamp	16. Steel channel

Other materials needed:

Fork cutting tools (as needed)

2 people (for some operations)

New bearings (never reuse bearings)

Loctite RC-680

Loctite sets up quickly. Time is critical is performing these tasks. Read all of these instructions, and make sure you have all materials close at hand, before proceeding.

Loctite Kleen 'n Prime, acetone, or other fast drying solvent

Do not use petroleum based solvents like kerosene or gasoline which leave an oily residue because the Loctite will not set a proper bond.

Steel or brass headed hammer

C-clamp, or vise — Sharp knife

Small file — Safety glasses

Junk front hub (may possibly be hammered on)

Caution: During these procedures, always keep tools aligned so that lateral forces which could gouge or in other ways deform the frame or fork are avoided. Avoid striking or dropping frame parts. Avoid dropping tools or tool assemblies.

Never use heat to dislodge the bearings. Excessive heat could damage the paint or frame.

Aluminum headtube ATB Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the headtube vertical.

2. Remove the front wheel, stem, front brake, and any other attachments on the fork (computer sensors, etc.).

3. If possible, disassemble the suspension fork and remove the sliders (lower legs).

Remove the fork

1. Install the **large rubber O-ring** onto the **flanged bushing** (Fig. 12).

2. Slide the **flanged bushing** onto the steerer, flange up.

3. Slide the **tube clamp** onto the steerer.

4. Fully insert the **steel anvil** into the steerer.

5. Position the **tube clamp** just below the **steel anvil** and tighten to 70 lb•in (8 Nm).

6. Support the fork with one hand, the headtube with another. Hammer the **steel anvil** to drive the steerer from the headtube.

Hit straight. It may take repeated blows to disbond the Loctite and loosen the steerer. Once the fork is loose, the fork clamp will come to rest on the flanged bushing.

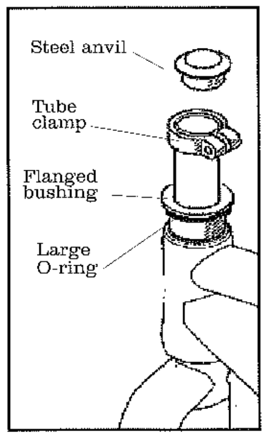

Fig. 12

7. Continue hammering until the upper bearing drops into the headtube.

8. While supporting the fork, remove the **tube clamp** and all the tools.

If the top bearing is still seated on the fork and the lower bearing is still in the headtube, the fork will not come out; go to Step 9.
If the fork comes all the way out, the lower bearing may still be in the frame; go to "Remove the Headtube Bearings".
If both bearings are on the fork, go to "Remove the Fork Bearings".

9.With the fork resting in the headtube, slide the thin-walled end of the **ATB bearing remover** over the steerer (Fig. 13).

10. Insert the **steel anvil** into the **ATB bearing remover**.

If the steel anvil fits loosely, the ATB bearing remover is upside down and must be installed correctly.

11. Hammer the **steel anvil** until the lower bearing unseats.

Keep the steerer straight in the frame to avoid damaging the headtube. Support both the fork and the headtube.

12. Remove the fork from the frame and go to "Remove the Fork Bearings".

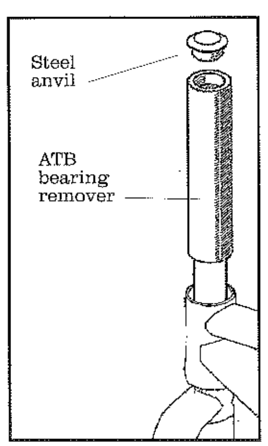

Fig. 13

Remove the Headtube Bearings

1. Insert the **steel anvil** into the thick-walled end of the **ATB bearing remover**.

If the steel anvil fits loosely, it is in the wrong end of the ATB Bearing Remover. Set this tool nearby.

2. Insert the large end of the **alignment spud** into the lower bearing (Fig. 14).

3. Position the upper bearing onto the **alignment spud**.

The bearing is in the headtube. A long blade screwdriver helps. Keep upward pressure on the alignment spud as you go through the next steps.

4. From the top of the headtube insert the **ATB bearing remover** with the **steel anvil** in place until it engages the **alignment spud** with the upper and lower bearings caught between the **alignment spud** and the **ATB bearing remover**.

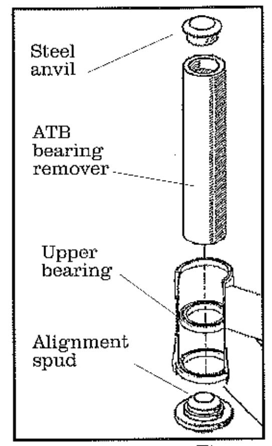

Fig. 14

5. Support the headtube while using the hammer to drive both bearings from the headtube.

Remove the Fork Bearings

1. Clamp or bolt the **steel channel** to a bench with the flanges facing up and the large opening overhanging the edge of the table (Fig. 15).

Its possible to put the steel channel in a vise, but will not work as well.

2. Cut the lower bearing seal with snips and remove it from the fork.

3. Slide the **tube clamp** onto the steerer and tighten to 70 lb•in (8 Nm).

4. Insert the **steel anvil** into the steerer.

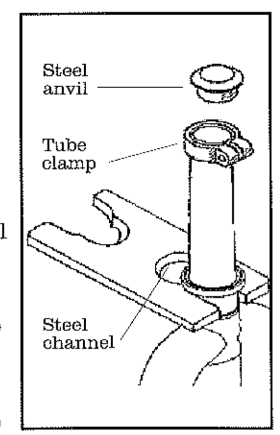

Fig. 15

5. Position the steerer in the notch of the **steel channel** with the fork crown below the channel and the lower bearing inside the channel.

6. Hammer on the **steel anvil** to drive the steerer down through the lower bearing until the bearing is free.

If the upper bearing is still on the fork, continue driving the steerer down until the tube clamp contacts the upper bearing.

7. Remove the **tube clamp** and **steel anvil**.

You should be able to remove the bearings by hand. If the bearings hang up on the end of the steerer, deburr the steerer with a small file.

Install the Bearings

1. Turn the frame upside down in the workstand.

2. Use a sharp knife to scrape off any residual adhesive from the bearing seat surfaces (Fig. 16).

Be careful not to scrape off any aluminum or mar the surfaces in any way.

3. Use a fast drying solvent to clean the inside of the headtube, the outside of the steerer, and the metal surfaces of the inside and outside of the new bearings.

Avoid touching any of these surfaces, as the oil from your fingers will prevent proper bonding.

4. Identify the upper bearing by its smaller diameter.

Note the seal on one side is notched. After installation this seal will face the notched seal on the other, lower bearing.

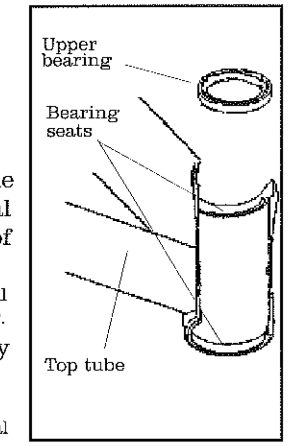

Fig. 16

5. Apply a thin layer of Loctite RC-680 on the upper bearing seat of the headtube.

For clarity, the upper bearing is on top when the bike is standing upright. You turned the bike upside down in Step 1.

6. Apply a thin layer of Loctite RC-680 on the outer surface of the upper bearing.

Do not use excessive Loctite. Loctite on the bearing seal will cause the bearing to stick or fail prematurely.

7. Slide the upper bearing down into the headtube so that the notched seal will face the other bearing when installed.

8. Insert the **large knurled bushing** into the headtube (Fig. 17).

9. Insert the **ATB bearing installer** into the **large knurled bushing**.

10. Install the **aluminum anvil** into the end of the **ATB bearing installer**.

11. Tap the bearing into place by hitting the **aluminum anvil** carefully with the hammer.

Keep the ATB bearing installer aligned so that the bearing stays aligned. Continue until the bearing is fully seated.

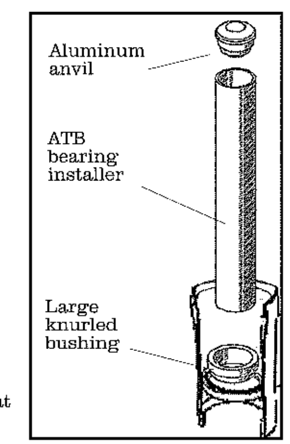

Fig. 17

12. Remove all tools from the headtube and wipe off any excess Loctite, being careful not to contaminate any clean surfaces.

13. Apply a thin layer of grease to the inner diameter of the lower seal.

14. Install the lower seal onto the steerer, flat side down.

Do not get any grease on the bearing seat of the fork crown. If you do, clean the steerer as before and re-install the seal.

15. Apply a thin layer of Loctite RC-680 to the crown race seat of the steerer and to the inside diameter of the lower bearing.

Again, avoid excess Loctite.

16. Slide the lower bearing onto the steerer with the notched seal facing up.

The notched seals should end up facing each other when done. If they do not, the bearing will wear prematurely.

17. Place the **ATB lower bearing guide** over the end of the steerer.(Fig. 18)

18. Slide the **ATB bearing installer** over the **ATB lower bearing guide** and steerer.

19. Insert the **aluminum anvil** into the **ATB bearing installer**.

20. Tap the **aluminum anvil** until the bearing seats squarely.

21. Remove the tools from the steerer.

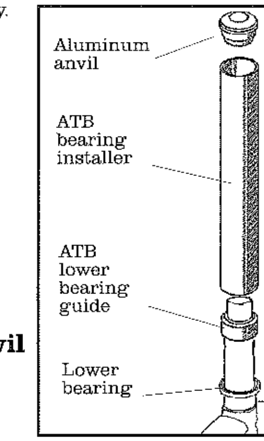

Fig. 18

22. Apply a thin layer of Loctite RC-680 to the inside diameter of the upper bearing, and to the steerer where is will enter the upper bearing.

23. Insert the steerer into the headtube and upper bearing (Fig. 19).

By supporting the headtube, the fork can usually be inserted through the bearing by hand. If not, put a fork block (like a junk hub) into the dropouts and tap on the hub with the hammer.

24. Check that the fork spins freely.

If it does not, you may have installed the bearings crooked, and will have to reassemble. Immediately disassemble and clean the parts to re-install.

25. Push the lower seal up into the headtube with a blunt screwdriver or putty knife.

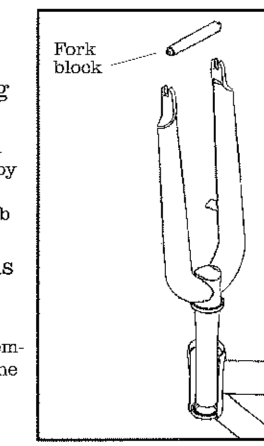

Fig. 19

26. Allow the Airheadset™ to cure in a warm place for 24 hours before the bicycle is ridden.

Road Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the headtube vertical.

2. Remove the front wheel, stem, front brake, and any other attachments on the fork (computer sensors, etc.).

Remove the fork

1. Install the **small rubber O-ring** onto the **steel anvil** (Fig. 20).

2. Place the **steel anvil** over top of the steerer.

3. Support the fork with one hand, the headtube with another. Hammer the **steel anvil** to drive the steerer from the headtube.

Hit straight. It may take repeated blows to disbond the Loctite and loosen the steerer.

4. Continue hammering until the upper bearing drops into the headtube.

5. While supporting the fork, remove all the tools.

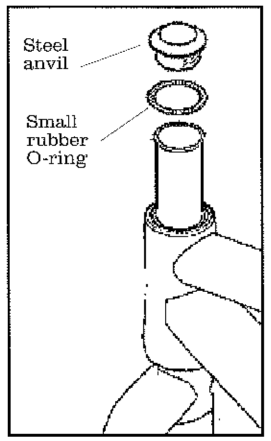

Fig. 20

If the top bearing is still seated on the fork and the lower bearing is still in the headtube, the fork will not come out; go to Step 6.

If the fork comes all the way out, the lower bearing may still be in the frame; go to "Remove the Headtube Bearings".

If both bearings are on the fork, go to "Remove the Fork Bearings".

6. With the fork resting in the headtube, slide the thick-walled end of the **road bearing remover** over the steerer (Fig. 21).

7. Insert the **steel anvil** into the **road bearing remover**.

If the steel anvil does not fit, the road bearing remover is upside down and must be installed correctly.

8. Hammer the **steel anvil** until the lower bearing unseats.

Keep the steerer straight in the frame to avoid damaging the headtube. Support both the fork and the headtube.

9. Remove the fork from the frame and go to "Remove the Fork Bearings".

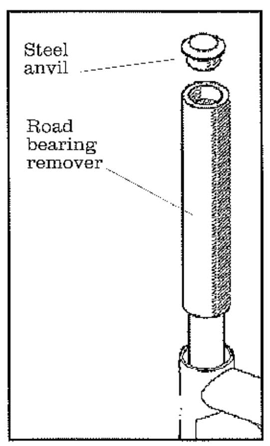

Fig. 21

Remove the Headtube Bearings

1. Insert the **steel anvil** into the thin-walled end of the **road bearing remover** (Fig. 22).

If the steel anvil fits loosely, it is in the wrong end of the road bearing remover. Set this tool nearby.

2. Insert the small end of the **alignment spud** into the lower bearing.

3. Position the upper bearing onto the **alignment spud**.

The bearing is in the headtube. A long blade screwdriver helps. Keep upward pressure on the alignment spud as you go through the next steps.

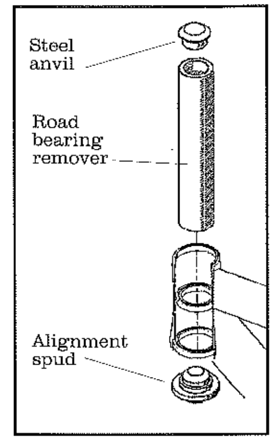

Fig. 22

4. From the top of the headtube insert the **road bearing remover** with the **steel anvil** in place until it engages the **alignment spud** with the upper bearing and lower bearing caught between the alignment spud and the **road bearing remover**.

5. Support the headtube while hammering both bearings from the headtube.

Remove the Fork Bearings

1. Clamp or bolt the **steel channel** (Fig. 23) to a bench with the flanges facing up and the small opening overhanging the edge of the table.

Its possible to put the steel channel in a vise, but will not work as well.

2. Cut the lower bearing seal with snips and remove it from the fork.

3. Place the **steel anvil** over the top of the steerer.

5. Position the steerer in the notch of the **steel channel** with the fork crown below the channel and the lower bearing inside the channel.

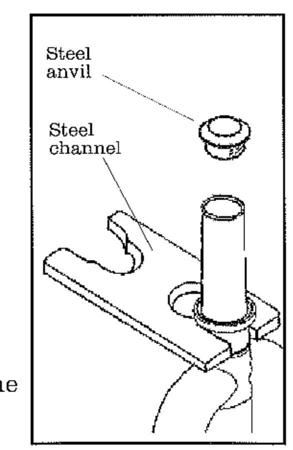

Fig. 23

6. Hammer the **steel anvil** to drive the steerer down through the lower bearing until the bearing is free.

If the upper bearing is still on the fork, continue driving the steerer down until the lower bearing contacts the upper bearing.

7. Remove the **steel anvil**.

You should be able to remove the bearings by hand. If the bearings hang up on the end of the steerer, deburr it with a small file.

Install the Bearings

1. Turn the frame upside down in the workstand.

2. Use a sharp knife to scrape off any residual adhesive from the bearing seat surfaces (Fig. 24).

Be careful not to scrape off any aluminum or mar the surfaces in any way.

3. Use a fast drying solvent to clean the inside of the headtube, the outside of the steerer, and the inside and outside of the new bearings.

Avoid touching any of these surfaces, as the oil from your fingers will prevent proper bonding.

4. Identify the upper bearing by its smaller diameter.

Note the seal on one side is notched. After installation this seal will face the notched seal on the other, lower bearing.

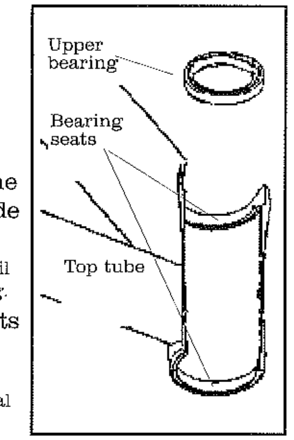

Fig. 24

5. Apply a thin layer of Loctite RC-680 on the upper bearing seat of the headtube.

For clarity, the upper bearing is on top when the bike is standing upright. You turned the bike upside down in Step 1.

6. Apply a thin layer of Loctite RC-680 on the outer surface of the upper bearing.

Do not use excessive Loctite. Loctite on the bearing seal will cause the bearing to stick or fail prematurely.

7. Slide the upper bearing down into the headtube so that the notched seal will face the other bearing when installed.

8. Insert the **small knurled bushing** into the headtube (Fig. 25).

9. Insert the **road bearing installer** into the **small knurled bushing**.

10. Install the **aluminum anvil** into the end of the **road bearing installer**.

11. Tap the bearing into place by hitting the **aluminum anvil** carefully with the hammer.

Keep the road bearing installer aligned so that the bearing stays aligned. Continue until the bearing is fully seated.

12. Remove all tools from the headtube and wipe off any excess Loctite, being careful not to contaminate any clean surfaces.

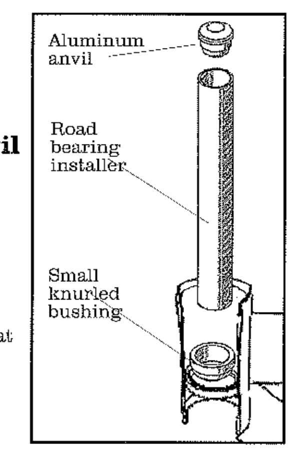

Fig. 25

13. Apply a thin layer of grease to the inner diameter of the lower seal.

14. Install the lower seal onto the steerer, flat side down.

Do not get any grease on the bearing seat of the fork crown. If you do, clean the steerer as before and re-install the seal.

15. Apply a thin layer of Loctite RC-680 to the crown race seat of the steerer and to the inside diameter of the lower bearing.

Again, avoid excess Loctite.

16. Slide the lower bearing onto the steerer with the notched seal facing up.

The notched seals should end up facing each other when done. If they do not, the bearing will wear prematurely.

17. Place the **road lower bearing guide** over the end of the steerer tube (Fig. 26).

18. Slide the **road bearing installer** over the **road lower bearing guide** and steerer.

19. Insert the **aluminum anvil** into the **road bearing installer**.

20. Tap the **aluminum anvil** until the bearing seats squarely.

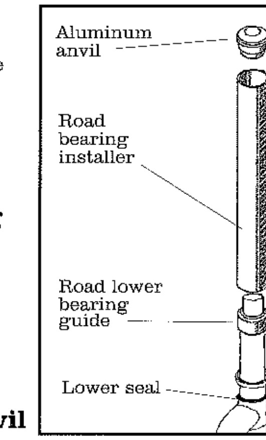

Fig. 26

21. Remove the tools from the steerer.

22. Apply a thin layer of Loctite RC-680 to the inside diameter of the upper bearing, and to the steerer where is will enter the upper bearing.

23. Insert the steerer into the headtube and upper bearing (Fig. 27).

By supporting the headtube, the fork can usually be inserted through the bearing by hand. If not, put a fork black (like a junk hub) into the dropouts and tap on the hub with the hammer.

24. Check that the fork spins freely.

If it does not, you may have installed the bearings crooked, and will have to reassemble. Immediately disassemble and clean the parts to re-install.

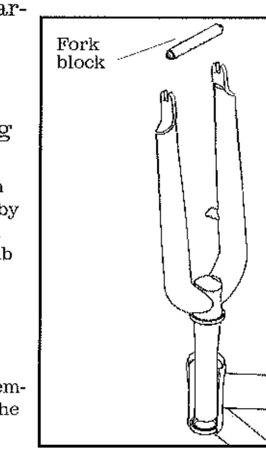

Fig. 27

25. Push the lower seal up into the headtube with a blunt screwdriver.

26. Allow the Airheadset™ to cure in a warm place for 24 hours before the bicycle is ridden.

Carbon headtube ATB Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the headtube vertical.

2. Remove the front wheel, stem, front brake, and any other attachments on the fork (computer sensors, etc.).

3. If possible, disassemble the suspension fork and remove the sliders (lower legs).

Remove the fork

1. Install the **large rubber O-ring** onto the **flanged bushing** (Fig. 28).

2. Slide the **flanged bushing** onto the steerer, flange up.

3. Slide the **tube clamp** onto the steerer.

4. Fully insert the **steel anvil** into the steerer.

5. Position the **tube clamp** just below the **steel anvil** and tighten to 70 lb•in (8 Nm).

6. Support the fork with one hand, the headtube with another. Hammer the **steel anvil** driving the steerer from the headtube.

Hit straight. It may take repeated blows to loosen the steerer. Once the fork is loose, the fork clamp will come to rest on the flanged bushing.

7. While supporting the fork, remove the **tube clamp** and all the tools.

If the lower bearing is still in the frame; go to "Remove the Headtube Bearings".
If the lower bearing is on the fork, go to "Remove the Fork Bearings".

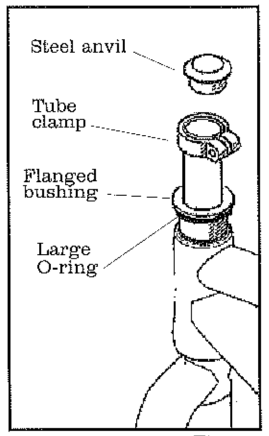

Fig. 28

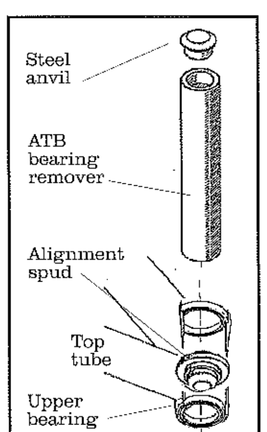

Fig. 29

Remove the Headtube Bearings

1. Turn the frame upside down in the workstand.

2. Insert the **steel anvil** into the thick-walled end of the **ATB bearing remover**.

If the steel anvil fits loosely, it is in the wrong end of the ATB Bearing Remover. Set this tool nearby.

2. Insert the large end of the **alignment spud** into the upper bearing (Fig. 29).

Remember, the frame is upside down so the upper bearing is on the bottom.

3. Slide the **ATB bearing remover** with the **steel anvil** in place through the lower bearing.

4. Engage the **alignment spud** with the upper bearing caught between the **alignment spud** and the **ATB bearing remover**.

5. Support the headtube while using the hammer to drive the upper bearing from the headtube.

6. Turn the frame back to its upright position.

7. Insert the large end of the **alignment spud** into the lower bearing (Fig. 30).

8. From the top of the headtube insert the **ATB bearing remover** with the **steel anvil** in place until it engages the **alignment spud** with the lower bearing caught between the **alignment spud** and the **ATB bearing remover**.

5. Support the headtube while using the hammer to drive the lower bearing from the headtube.

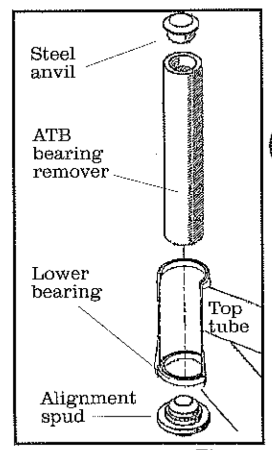

Fig. 30

Remove the Fork Bearings

1. Clamp or bolt the **steel channel** to a bench with the flanges facing up and the large opening overhanging the edge of the table (Fig. 31).

Its possible to put the steel channel in a vise, but will not work as well.

2. Slide the **tube clamp** onto the steerer and tighten to 70 lb•in (8 Nm).

3. Insert the **steel anvil** into the steerer.

4. Position the steerer in the notch of the **steel channel** with the fork crown below the channel and the lower bearing inside the channel.

5. Hammer on the **steel anvil** to drive the steerer down through the lower bearing until the bearing is free.

If the upper bearing is still on the fork, continue driving the steerer down until the tube clamp contacts the upper bearing.

6. Remove the **tube clamp** and **steel anvil**.

You should be able to remove the bearings by hand. If the bearings hang up on the end of the steerer, deburr the steerer with a small file.

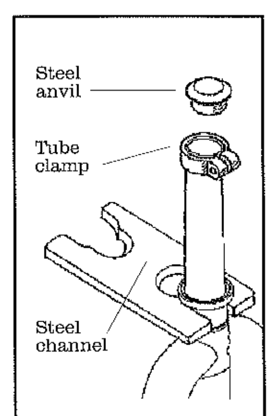

Fig. 31

Install the Bearings

1. Use a sharp knife to scrape off any residual adhesive from the bearing seat surfaces (Fig. 32).

Be careful not to scrape off any aluminum or mar the surfaces in any way.

2. Use a fast drying solvent to clean the inside of the headtube, the outside of the steerer, and the metal surfaces of the inside and outside of the new bearings.

3. Identify the upper bearing by its smaller diameter.

Note the seal on one side is notched. After installation this seal will face the notched seal on the other, lower bearing.

4. Apply a thin layer of grease on the upper bearing seat of the headtube and the outer surface of the upper bearing.

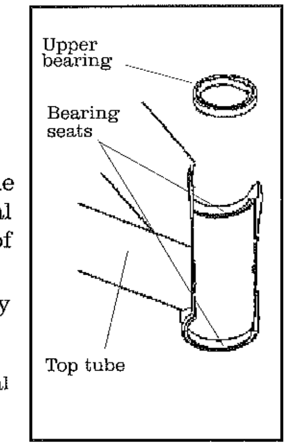

Fig. 32

5. Slide the upper bearing down into the headtube so that the notched seal will face the other bearing when installed.

7. Insert the **large knurled bushing** into the upper bearing (Fig. 33).

8. Insert the **ATB bearing installer** into the **large knurled bushing**.

9. Install the **aluminum anvil** into the end of the **ATB bearing installer**.

10. Tap the bearing into place by hitting the **aluminum anvil** carefully with the hammer.

Keep the ATB bearing installer aligned so that the bearing stays aligned. Continue until the bearing is fully seated.

11. Remove all tools from the headtube and wipe off any excess grease.

12. Install a starfangled nut into the steerer.

13.Apply a thin layer of grease to the crown race seat of the steerer and to the inside diameter of the lower bearing.

14. Slide the lower bearing onto the steerer with the notched seal facing up.

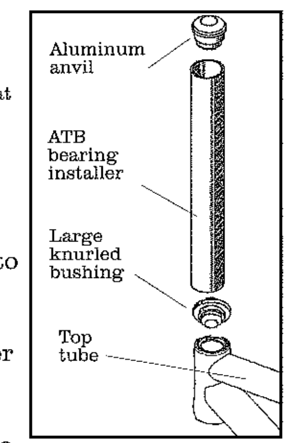

Fig. 33

The notched seals should end up facing each other when done. If they do not, the bearing will wear prematurely.

15. Place the **ATB lower bearing guide** over the end of the steerer.(Fig. 18)

16. Slide the **ATB bearing installer** over the **ATB lower bearing guide** and steerer.

17. Insert the **aluminum anvil** into the **ATB bearing installer**.

18. Tap the **aluminum anvil** until the bearing seats squarely.

19. Remove the tools from the steerer.

20. Apply a thin layer of grease to the inside diameter of the upper bearing, and to the steerer where is will enter the upper bearing.

21. Insert the steerer into the headtube and upper bearing (Fig. 34).

By supporting the headtube, the fork can usually be inserted through the bearing by hand. If not, put a fork block (like a junk hub) into the dropouts and tap on the hub with the hammer.

22. Check that the fork spins freely.

If it does not, you may have installed the bearings crooked, and will have to reassemble. Disassemble and re-install.

23. Install the stem.

24. Lightly grease the threads of the Airhead adjustment bolt. Place the bolt through the Airhead cap and thread into the starfangled nut. Adjust the Airheadset™ just until all the parts are snug. Do not preload the bearings.

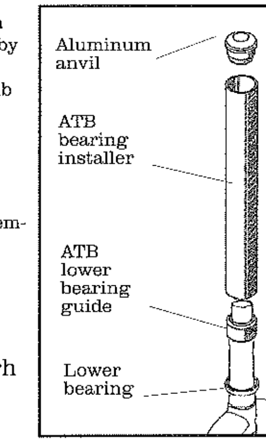

Fig. 34

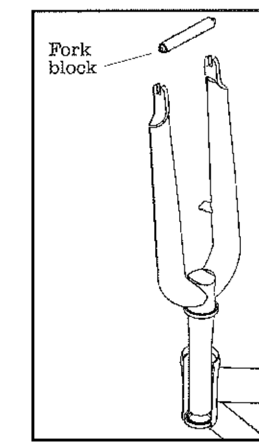

Fig. 35

Bontrager Components

Saddles

When Keith Bontrager designed his first saddles, he was actually able to get a patent for his ideas. With careful analysis of how a saddle was used, his concept was to pare away the parts of the saddle which are not weight bearing. That is, some parts of the conventional saddles in use were just hanging in space, yet managed to get in the way when the rider attempted technical maneuvers. And why have material on the bike which isn't doing anything? It just adds weight.

His first designs are still being made today (and heavily copied), but Keith has brought fresh inspiration to a new model line called the FS. The saddle shape has a slight bucket to allow a rider to 'settle in' to their favorite spot. They also feature a widened saddle nose. The wider FS+10 has just a bit more padding for those so inclined which also makes it about 10mm wider overall.

Prior to Keith's design, conventional wisdom was that a wide saddle nose would interfere with pedaling. Keith noticed that the front of the saddle is in front of the rider's legs, not between them. By widening the nose, the FS saddle offers support for the rider who has slid forward on the saddle in a climbing position. To get the most from this feature, the saddle nose has just a touch of suspension from an elastomer pad between the rails and the shell.

RE-1 Clipless Pedals

Clipless pedals have become a mainstay for off road riders because they position the riders foot on the pedal for increased pedaling power on the climbs and flats, and then keep the feet in position on technical or rough descents.

However, other facets of off road riding can change clipless pedals from an asset to a problem. Mud and grit can render clipless pedals almost worthless by preventing entry with contaminated cleats, or worse by trapping the cleat in the pedal and preventing release.

While most clipless pedal mechanisms are pretty good in clean, dry conditions, they make no allowance for crud in the interface between the cleat and pedal body. By cleverly removing material, Keith was able to design a cleat that allows room for crud without sacrificing retention (Fig. 36). This new cleat will work perfectly with Shimano SPD 535s and 747s, offering a slight amount of rotation.

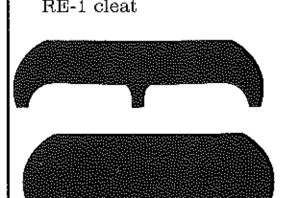

Fig. 36

To get the full benefit of the mud evacuation properties of these cleats requires the use of the RE-1 pedal. This pedal has been 'ported' to make room for excess crud to move away from the mechanism. They also have excellent seals, bearings, and fastener hardware to make these pedals work as well and long as anything on the market.

Rims

Bontrager rims came about one day when Keith realized that a 36° 700c rim could have 4 spoke holes cut out and be the exact diameter needed for a 32° mountain bike rim. By rolling these cut-down rims to a 26" diameter, Keith made the first prototype of modern mountain bike rims; light, narrow and super strong.

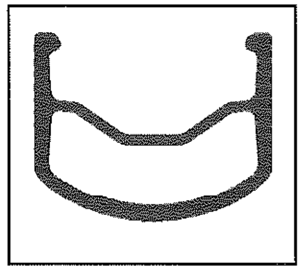
Fig. 37

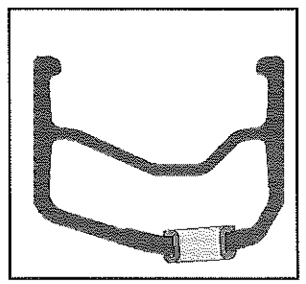
Fig. 38

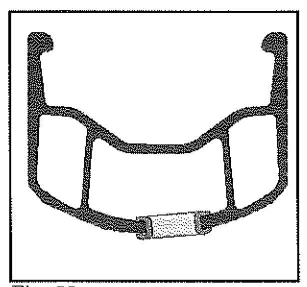
Fig. 39

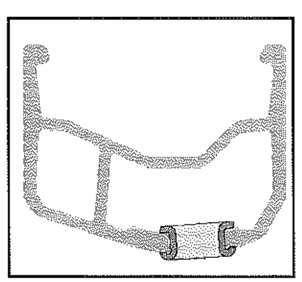
Fig. 40

Since then, Keith has designed his own extrusions, adding features like tall sidewalls for increased braking surface area. This helps prevent pad dive, or tire sidewalls from being eaten by the brake pads. All Bontrager rims (except the Disc specific versions) have these tall sidewalls, but Keith goes to great lengths to make sure those taller sidewalls still have the strength to resist impacts in the case of a flat tire, a detail overlooked by many attempts to copy his ideas.

The Corvair and Maverick rims (Fig. 37) feature double cavity construction, where the internal bracing adds stiffness and strength to the rim while reducing weight. The Mustang and Valiant rims (Fig. 39) use a triple cavity design, where even more weight has been removed.

All Bontrager rims are a welded construction, avoiding the twisting that can happen at the joint of a pinned-construction rim in an accident, or when building it up. The Bontrager rims on Klein bikes are all eyeletted, where reinforcements are added to the spoke holes of the rim. This distributes the spoke stress over a wider area, and also provides a lower friction bed for the spoke nipples. Finally, the rims are machined for a flawless braking surface. This machining also removes any anodization which could reduce brake pad friction.

A final detail developed last year was the Bontrager ASYM rims (Figs. 38 and 40). These rims have an assymetric shape which offsets the spoke bed further from the freewheel (or disc brake in front). This offset moves the spoke bed such that the angle difference between the drive spokes and non-drive is lessened, reducing the wheel dish. by reducing the dish, more even spoke tension is achieved, resulting in a stronger wheel.

Keith Bontrager on Wheels

Durability comes in a few flavors. This discussion is all for MTB applications. Many of the issues are similar on road bikes, but there are enough differences in the way those bikes are typically used that the info below isn't very sharp when applied to pavement use.

Brake wall wear:

If you want a rim that has sidewalls that last longer, you have two choices. The first is to use a ceramic coated rim. The coating keeps the brake pads from wearing away the rim. The second is to use a heavier rim. It's thicker and lasts longer, even though it wears. The former is a good choice if you are a smooth rider and don't kill rims on rocks (and you have a good income). The latter is good for everybody else.

Lateral strength:

Even the light rims are pretty good these days, but the heavier rims are stronger from either (any) brand. Mavericks are stronger than mustangs, and the Valiants are about the same as the Mustang (though they are lighter - a better cross section). The ASYM design pushes lateral strength for the back wheel up about 10%. If you are real big and taco rims when you crash, buy heavier rims. They will be stronger.

Spoke bed fatigue strength:

Some light rims die because the spokes pull through the spoke bed. This is a fatigue failure. All light rims are close on that. We had some rims ground down a little to far at the weld (they are ground so they look smooth - cosmetic only) and the spokes next to the joint pulled through quickly. It was only a few tenths of a millimeter of material removed.

Light, elastic spokes help. We use those on the Race lite wheels. This type of failure is going to be more of an issue on a ceramic rim where it can have a long service life (because of the extended brake wall life). M217s had some big problems with this.

Rock dings:

Not much you can do except pump up your tires, use fatter ones, and miss the rocks. I laughed when someone dissed the Mustangs because he dented them. There is no difference in "dentability" between the best light rims. You can buy very heavy rims and get a little more strength, but very little.

Anything I missed? A well built wheel is important of course. Matching rim, spoke and hub properties (in that order of priority)to the rider and application is important. That's about all there is to it.

Bontrager Comp AHS stem

Bontrager stem, forged. Removable face plate

28.6 steerer, 41.0mm steerer clamp height

5° rise, 60, 75, 90, 105, 120, 135mm extensions,

Bontrager Race AHS stem

6061 T6 forged aluminum, side mounted steerer bolts, dual bolt bar clamp. Removable face plate

28.6 steerer, 44.5mm steerer clamp height

7° rise, 60, 75, 90, 105, 120, 135, 150mm extensions

150 gms,

Bontrager Crowbar Comp handlebar

4130 Cro-Moly, 40 mm rise, welded crossbar for increased strength

630mm width, 400 gms

22.2mm center requires shims

Bontrager Crowbar Race Modified handlebar

2014 Al, 40 mm rise, no crossbar

630mm width, 280 gms

22.2mm center requires shims

Bontrager Comp II handlebar

2014 Al,reinforced for bar ends

25.4 mm center, 580 mm, 5 degree bend

150 gms

Bontrager Race Lite handlebar

EA 70, BERTs required

25.4 mm center, 580mm, 5° bend,

140 gms

Bontrager Comp seatpost

2014 quill, dual rocker bolt clamp,

285 gms

Bontrager Race Lite seatpost

7075 T6 quill, dual rocker bolt clamp

230 gms

Bontrager Race Lite wheelset

Bontrager design, manufactured by Chris King. Alloy freehub body. King precision sealed cartridge bearings with contact and labyrinth seals. Large drive side flange diameter. Lightweight.

Bontrager Valiant Race Lite . 24°

Bontrager Valiant ASYM Race Lite . 28°

DT Revolution 2.0/1.5 front & rear non-drive, radial lacing. DT Competition 2.0/1.8 rear drive laced 3X.

DT alloy nipples

Bontrager design quick release. CNC machined lever and nut, titanium rod.

612g F/822g R

Bontrager Race wheelset

Bontrager design, forged MTB shell. FCM angular contact semi-cartridge caged ball bearings. Labyrinth and contact sealed mechanism. One side cone adjustment for ease of adjusting. Alloy oversize axle end nuts.

Bontrager design, forged MTB hi-lo shell. FCM angular contact semi-cartridge bearings. Labyrinth and contact sealed mechanism. Alloy axle end nuts.

Bontrager Mustang Race. 24°

Bontrager Mustang ASYM Race. 28°

DT Competition 2.0/1.8. Radial lacing, front wheel. 3X lacing drive side/radial non-drive, rear wheel., DT alloy nipples

Bontrager design quick release. Extruded lever, steel rod. Front uses oversize rod for stiffness.

705g F/992g R

Bontrager Race Lite crankset

2014 T6 arms, CNC rings & assembly, 22/32/44 rings (all 7075 with hard anodize), 170, 175mm arms. Bead blasted, black, laser etched logo, alloy outer bolts, 640 gms

Comp II front hub

The Comp II hubs use a conventional cup and cone design, with contact seal, on a Cro-Moly axle. The bearing surfaces have ground and polished bearing surfaces

Comp II hubs also use a rubber external seal, which will exhibit quite a bit of drag when new. We considered a looser seal, but after its break in period a looser seal would not be as effective in protecting the bearings from contamination.

An important feature of the Comp II hubs is its compatibility with oversized, 6mm quick release rods. Combined with the oversized 23mm axle end caps, this increases the stiffness of the hub-to-fork connection. This stiffness improves steering control when used with a suspension fork.

Spoke hole PCD	38.0mm
Flange width	71.4mm

Comp II rear hub

The Comp II rear hub uses both internal and external rubber seals for bearing protection. A Cro-Moly axle with 19mm end caps uses a 5mm quick release rod. The comp II rear hub also uses ground and polished bearing surfaces for easy maintenance and long bearing life.

Spoke hole PCD	45.0mm
Flange width	57.3mm

Bontrager Jones 49/53 front tires

A fast rolling cross country racing tire with good technical riding characteristics. Long center knobs for good trolling characteristics. Wide dew claws on the leading edge increase braking shear edge length. Stiff, well proportioned edge and transition knobs make the tie a singletrack cornering ace and also last longer in hard conditions. the knob pattern is open laterally to provide a route for mud evacuation.

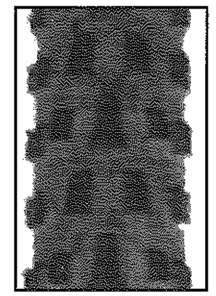

Fig. 41

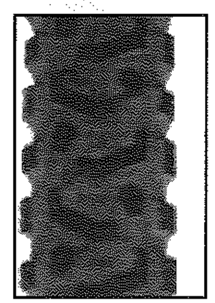

Fig. 42

Bontrager Jones 46/50 rear tires

A wider, middle with rear tire for technical cross country riding. Especially good for larger riders in sand and mud. Design emphasis is on traction in all conditions. The central paddle knobs are widely spaced and well supported. The transition and edge knobs are stiff and arranged to grip in wet or off camber conditions. This is a fast tire in very rough or wet technical conditions and on loose terrain.

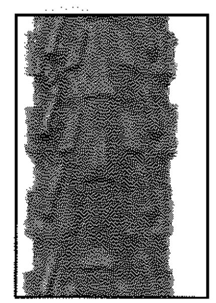

Fig. 43

Bontrager Revolt ST-2 49/53 front, 46/50 rear tires

3mm tread block height for better traction the the Revolt SS in a variety of conditions. Center file pattern adds puncture resistance. Tread design is laid out to minimize rolling resistance. These tires are fast.

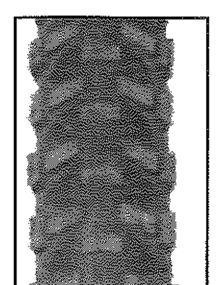

Fig. 44

Bontrager Revolt Super-X tires

There's nothing wrong with the other Bontrager tires, which are specific to certain types of riding. And when used in their predestined conditions, they may be the best tire out there.

But some folks- racers, mainly- want a tire that's fast and handles a wider variety of conditions. They also want more traction. The key to this is, of course, a bigger tire. But traditional big tires weigh more.

Keith worked through a few design exercises, rode some prototypes, and concluded that a bigger casing without big knobs was the way to go. By trimming back the edge knobs, but leaving plenty of sharp edges in the center of the tread, the Super-X was born.

Big casing for shock absorption and large 'footprint' for traction. Small, but plentiful, knobs for traction. A double benefit of the larger footprint is that one tire can work well for either front or rear applications. And since the knobs are not too tall, with an overall low tire weight, these are also very fast tires.

ICON Components

ICON is a complete line of premium bicycle components. Driven by advanced technology, ICON components are specifically engineered from the ground up to fulfill the requirements of the serious cyclist.

Every detail of an ICON component's design is carefully scrutinized by a team of engineers to maximize strength and function, while minimizing weight. As an example, the inner walls of the bar ends, stems and handlebars are butted to shave weight. At the same time careful concentration of material adds durability in key stress areas.

Premier ICON components are formed from a proprietary one-piece, cold forging that leaves no welds to break or bonds to fail. This forging leaves grain alignment that is always placed in the direction that will yield the most support. This makes ICON parts over 40% stronger than conventional forgings.

With conventional forging, extensive machining may be required to attain the part's final shape. Like with a CNC'd part, as the machining chisels away material it leaves thousands of tiny stress risers. The ICON forging process gives a very clean final shape with little or no additional machining necessary, further enhancing strength and fatigue resistance.

Fatigue life is increased on the surface as well, using a proprietary finishing process developed by the aerospace industry. A final touch of elegance is added with laser-etched logos which augment the sleek look and are less susceptible to wear than decals or paint.

Because the ICON forging process eliminates extra material, ICON parts are very light with the highest strength-to-weight ratio possible. Still, all ICON products are fully tested for fatigue, energy absorption and impact, so we know they will withstand the stresses of hard riding. As insurance of this quality, all products have a visible date code so that each can be traced to exactly when and where it was produced.

Swoop Ergo Road Bars

Instead of the traditional curved shape, the Swoop Ergo has a flat, ergo drop for a natural, more comfortable feel. The special bend also makes dual control levers easier to reach and operate. Stiffer for big riders or sprinters. 6061 alloy, bulged center..

Widths: 38, 40, 42, 44, 46cm, center to center

284 grams in 42cm width

26.0mm bar clamp diameter

Stash Ergo Road Bars

Like the Swoop Ergo, this is a very comfortable ergonomic bend that better fits the hands. The Stash is made from premium 7075 alloy to reduce weight without sacrificing strength.

Widths: 38, 40, 42, 44, 46cm, center to center

254 grams in 42cm width

26.0mm bar clamp diameter

Bordeaux Road Stem

The quill-style Bordeaux brings to the road stem the engineering and user-friendly features that ICON is known for. A completely redesigned handlebar clamp utilizes a removable front face plate for easy handlebar switching. Add this to the laser etched logo, proprietary surface treatment and super-light hardware, and you get a road stem that is strong, stiff and elegantly simple.

0°, -17° rises, 60, 70, 80, 90, 100, 110, 120, 130, 140mm lengths

22.2mm insertion, 26.0mm bar clamp diameter

190 grams in 60mm length

Havanna Road Stem

The direct-connect Havanna shares the same new road-specific handlebar clamp as the Bordeaux. The steerer clamp and extension are a continuous piece of 6061 T6 aluminum forged hollow to give longitudinal grain alignment, minimal wall thickness, and no need for a rear weld. The result is an incredibly light and strong road stem with all of the standard ICON touches like proprietary surface finish and laser etched logos.

0° rise, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140mm lengths

25.4mm steerer clamp, 39.5mm steerer clamp height, 26.0mm bar clamp diameter

146 grams in 80mm length

Klein MC3 Road Stem

The Airhead MC3 road stem shares the same new design as the Havanna, but with a powdercoat finish and a steerer clamp for the Klein Airheadset™.

6° rise, 70, 80, 90mm lengths

0° rise, 100, 110, 120, 130mm lengths

27.0mm steerer clamp diameter

39.5mm steerer clamp height

26.0mm bar clamp diameter

170 grams in 100mm length

Klein MC3 ATB Stem

This is a mountain version Airhead stem.

6° rise, 75, 90, 105, 120, 135mm lengths.

33.3mm steerer clamp diameter

45.0mm steerer clamp height

25.4mm bar clamp diameter

182 grams in 105mm length

Oz Seatpost

One-piece forged post of 2014. Differential wall thickness (the sides are thinner than the front and rear) for increased strength and lower weight. Single bolt saddle clamp for easy adjustment. Full ICON treatment of surface treatments. Laser etched logo.

250, 300, 350, and 400mm lengths, 27.2 and 31.6mm diameter.

189 grams in 250mm, 27.2 diameter

De La Sole Clipless Pedal

This new single-sided road pedal shows many of the ICON hallmarks. Minimalist design for ultra light rotating weight and great cornering clearance. SPD-style cleat attachment makes it compatible with virtually every shoe on the market. Plus, the ICON cleats have 6 degrees of float to make them knee friendly.

9/16" pedal spindle

270 grams per pair

Air Rail Fork

OCLV carbon composite fork with forged aluminum crown and fork tips, Cro-Moly steerer. The Air Rail is stiffer to resist lateral flex and splay (forward/rearward flex). Although stiffer than the Carbon Classic, the Air Rail's OCLV construction is still more comfortable than most steel or aluminum forks. Excellent fork for heavier riders, or riders wanting crisper handling and rock-solid feel when out of the saddle on hard sprints or climbs.

Wheel size 700c

1" headset, threaded or unthreaded

Size specific offsets of 43 and 47mm.

540 grams

Frame re-alignment is not recommended

Aluminum and the aluminum parts of bicycles (like dropouts) are not as ductile as steel. Attempting to make adjustments to a part by bending or twisting it poses a risk of breaking it. Readjustment of frame alignment is not recommended. If the frame has been damaged, send it to the Klein factory for repair.

Parts fits and torques

Tolerances for press fits and thread fits are critical. Pressing a part which is too large, or misaligned, may break the frame or part.

Lubricate threads

Be sure the rear derailleur and bottom bracket threads are clean and well greased before insertion. Start threads by hand, not with a wrench. For more information on grease applications, see Torque Specs and Fastener Prep, page 71

Torque specs

Over-torquing a threaded fastener may ruin the threads or break the part. The torque specification for rear derailleur threads is 70-85 lb•in (6.8-9.6 NM). For water bottle mounting screws, CCD screws, or rear rack and fender mounting screws, the correct torque is 20-25 lb•in (2.3-2.8 NM). Do not tighten the front derailleur clamp bolt more than 20 lb•in (2.3 NM) to avoid damaging the derailleur or frame.

For more information on torque specifications, see Torque Specs and Fastener Prep, page 71

Seatposts

The seat lug of a Klein is designed to accept seat posts with an outer diameter between 31.45 mm and 31.60 mm. The seatpost should be measured for conformity to this tolerance prior to installation because installation of a seatpost of incorrect size may damage the frame. Use of adequate lubrication to prevent seizing of the aluminum seatpost to the aluminum seat lug or tube is very important.

With carbon Mantras DO NOT grease the seatpost. A fiberglass sleeve bonded into the carbon seattube prevents galvanic corrosion of the seatpost and carbon, so no grease is needed, nor recommended. If grease is applied, it may be very difficult to get adequate clamping force to hold the seatpost. If you have accidentally greased a carbon Mantra frame, use a cloth with some degreaser to remove the grease, using normal caution to protect bearings and paint.

Minimum seatpost insertion

A minimum of 4 inches (100 mm) of seatpost must be inserted in the frame. On some seatposts, the minimum insertion mark is determined by using a calculation of 2.5 x seatpost diameter. This does not result in sufficient seatpost insertion for Klein frames. If you are uncertain, measure the mark on the seatpost.

Do not clamp frame tubes

Avoid clamping Klein bicycle frames in repair stands or racks used to carry bikes on cars. Mechanical clamping devices have a great deal of leverage which can easily crush, dent, or in other ways damage a Klein bicycle's lightweight Power or Gradient tubing. With repair stands, clamp the seatpost. With bike racks, clamp the fork tips.

Care of paint

When cleaning frame parts, do not use solvents, harsh chemicals, or abrasive cleaners (including some waxes). Remove road film with a soft rag and a mild detergent and water solution. Use of industrial solvents for cleaning or paint removal may damage the paint. Also, some energy enhancing drinks may harm the paint.

Avoid excessive heat exposure to the frame or fork

Excessive heat, such as that used in powder coating, or any open flame, may damage the frame or its parts. Do not exceed 160° F. (71° C.) exposure to a Klein frame.

Paint removal

Removing paint from any frameset requires special techniques and great care. Harsh abrasives will remove frame material, possibly weakening the bicycle.

Frame modification

Never modify a Klein frameset in any way, including sanding, drilling, filing, or by any other technique. Modifying the frameset in any way will void the manufacturers warranty, and may be unsafe.

Shimano

ATB 9 Speed in '99

Although road bikes have had 9 speed shift systems from both Shimano and Campagnolo for several years, mountain bikers have been stuck in an 8 speed world. But in 99, Shimano is opening the flood gates on mountain bike 9 speed, going all the way down to the LX level.

By reducing the spacing and width of the cogs, Shimano has squeezed 9 cogs onto a standard 8 speed cassette hub with 135mm OLD. The other good news is that the gear range has extended. The standard low has gone from a 30T to a 32T, and there is even a 'Megarange' cassette with a 34T cog.

Since the cassette spacing is narrower, a 9 speed chain with slimmer proportions is in order. The 9 speed width is the same on road and mountain bikes, so you'll notice that on some ATB models we've spec'd the super high quality Dura-Ace chain.

To maximize shifting performance with the 9 speed chain, new chainrings were designed. The spacing between the chainrings is slightly narrower than 8 speed, plus the tooth profiles and tooth width is different. Shimano also boosted the size of the big chainring from a 42T to a racier 44T on all 9 speed cranks. The small and middle rings remain 22T and 32T as they were on the 8 speed cranks.

To get the full enchilada of Shimano shifting performance, the front derailleur cage has to be the right shape, width, and the shifting ramps have to be lined up correctly. 9 speed chains are narrower, and LX/XT 9 speed cranks have a 44T big ring. So a 9 speed front derailleur is needed to get the best shifting possible. Although the new XTR crank has the same number of chainring teeth as the old one, the new XTR front derailleur has improved link and differential plates for better shifting.

The 9 speed rear derailleur uses 11T pulleys to better shift the wide range 9 speed cassettes. It has the same cable pull as an 8 speed model, so this item can be subbed by the old 8 speed derailleur. But the newer version has a sweet new shape, extra booties for better cable sealing, and redesigned pivots for stronger shifts and longer life.

To get 9 gears in back, you have to have 9 speed shifters. The LX, XT, and XTR units all got a redesign for 9 clicks, but also with new lever shapes and lengths which are very hand friendly, repositioned barrel adjusters that are easier to reach, and more.

As an option, there is a new full-cartridge XTR bottom bracket. This design is slightly heavier, but the better seals and reduced maintenance are well worth it. Klein will use this new bottom bracket exclusively.

Other ATB improvements

Shimano has enjoyed several years of incredible success with their V brakes. The XT and XTR versions of these brakes use a linkage system which instead of following an arc to the rim, provides a linear path for the brake pads. Shimano says this provides increased stopping power. It also decreases pad dive, so the brakes have less tendency to go under the rim or up into the tire as the pads wear. Since the cartridge type pads on XT and XTR brakes are very thin, the parallel push wears the pads evenly to increase pad life.

Shimano has redesigned the XTR and XT models for '99. By lengthening the bearings of the linkage, and placing them further apart, the linkage has been made much stronger. This will decrease brake noise, while increasing the life of the linkage bearing surfaces. The redesign also allows the brakes to open up a bit further so tires fit through more easily, making wheel installation a breeze.

More 8 and 9 speed road

In addition to all the ATB improvements, Shimano revised the RSX and105 groups for '99 as well. 105 joins the upper end Ultegra and Dura-Ace groups in the 9 speed world, and RSX is now 8 speed. Both these groups are available as doubles or triples, and RSX is only offered in full-sized chainring sets.

Shimano has also introduced a new road pedal system at the Dura-Ace level. This system uses a new, wider cleat which requires a new hole pattern not available on '98 model or older shoes. What does a person do who wants to ride these new pedals? They buy new Shimano shoes, of course!

Manitou

New Features

After talking with a lot of shops and riders in the field, Manitou has identified one of the biggest losses of suspension fork performance as a need for lubrication. Stiction is a major problem since most riders rarely, if ever, lube their forks.

The Microlube system is found on all '99 Manitou forks, allowing easy lubrication of the forks. Each fork leg has a small grease port on the back, near the top of the slider. A maximum capacity of 15 grams of grease gets the job done without the excess weight of a full oil bath. And the job can be done in mere minutes with special grease and applicators supplied by Manitou.

The frequency of Microlube application varies with the severity of conditions. In most cases a few squirts per side every third or fourth ride will keep the fork well lubricated and performing like new. A periodic disassembly to clean out debris and excess grease is a good idea for frequent users.

To further enhance a stiction free fork, Manitou is using a Sub 7 surface finish on the stanchions, which is 50% smoother than other fork legs. Combined with their NorGlide bushings, this also makes for 50% increase in durability.

TPC

In '98, Manitou introduced TPC (Twin Piston Chamber) damping. This system has several key features.

• Separate compression and rebound damping, and true individual damping adjustability

• Large oil volume resists heat and cavitation (air mixed in the oil).

• Low speed compression flow

The SX used on the Mantra Race (in Airheadset™ dimensions) and Mantra Comp offers 80mm of travel, and on the Attitude Race offers 70mm. Both versions are using a combination of MCUs for a progressive spring rate and a short coil spring for plushness. Preload adjustment is external at the top of the right leg. Rebound damping can be adjusted externally at the bottom of the left leg. Beefy 28.6mm alloy stanchions coupled to a one piece die-cast magnesium slider assembly with leading axle design give lots of steering rigidity.

Since the standard SX compression damping is not externally adjustable, Klein has chosen to replace the compression adjuster with Manitou's new Lok-Out feature for 1999. The the Lok-Out retains the internally adjustable compression damping, so this is only a benefit for the customer.

Why Lok-Out? When a rider gets out of the saddle on any bike, the force path of their CG is almost directly in line with the axle path of the front wheel. As they move up and down on the pedals, their CG excites the suspension and this makes the bike bob. On a full suspension bike, the motion of the front of the bike excites the rear suspension. And pedaling efficiency drops.

By locking out the fork, the bike can be more efficient under pedaling forces that would normally make it bob. And since the Mantra's true full suspension design still provides suspension with a rigid fork (see Spot-On™ Geometry, pages 41-43), the customer again wins with increased performance and no down side.

SX-E

While some manufacturers stick their springs in a pool of oil and call it damping, the TPC Sport system in the SX-E uses the same sophisticated valving as the TPC system. The difference is that the TPC Sport rider is riding factory settings while the more costly TPC system allows the rider to tune to their own preference. The Mantra uses an 80mm travel version, while the Attitude Comp's SX-E offers 70mm.

SX-R

The SX-R uses a full length coil spring for added plushness. With the additional plushness, Manitou decided that adjustable compression damping would be a smart feature. This extra tuning feature means the same fork can be enjoyed by anyone from a cruising recreational rider to Pro racer. The Attitude Race uses this fork with 70mm of travel.

SX Ti

This is essentially a tricked-out version of the SX-R. Light weight parts, and even a titanium spring, make this an incredible ride. You'll find this fork on the Mantra Pro in Airheadset™ size, with 80mm of travel.

SX Carbon

This new 'Project' fork offers Manitou's full bag of tricks for unparalleled suspension performance at an incredibly low weight. Combined with the Adroit Pro's Airheadset™ and Manitou's new Lok-Out feature, this becomes the hottest suspension fork ever!

While other manufacturer's have given up a plush ride to reduce weight, Manitou managed to keep coil spring plushness, dual external adjustable TPC damping, and still make a fork that weighs just 2.8 pounds. The key is high quality aluminum and magnesium alloys combined with carbon fiber composite arch. Not only is this combination very light, but its also quite stiff laterally for the steering precision that racers demand.

MRD Lok-Out

The MRD (Manitou Racing Development) Lok-Out is an unique feature which allows a rider to eliminate fork bob which might otherwise rob pedal power. The MRD Lok-Out has a safety blow off to protect the seals should you hit a large bump or other obstacle while the fork is locked out.

Klein has added this feature to up-spec the forks on the Mantra Pro, Race, and Comp, the Adroit Pro and Race, and the Attitude Race and Comp. The upgrade kit is also available for 1998 SX, SX-R and SX Ti, 1999 SX-E, SX, SX-R, SX-Ti and SX Carbon model forks with TPC Damping.

Once installed in the fork, the Lok-Out can be turned from the open to closed position by simply turning the knob on top of the left fork leg. The color left exposed once the knob is turned allows the rider to easily tell what function their fork is providing; green for regular TPC suspension and red means that the fork is locked out enough to resist bobbing under pedaling loads.

Putting the Lok-Out lever in the halfway position does not increase compression damping. The MRD Lok-Out is simply an on-off switch for your fork, changing the fork from the Lok-Out position to the open position. However, compression damping through the full range is still adjustable internally. See Step 5 of **Lok-Out Installation** for details.

Troubleshooting with Lok-Out on Klein Bikes

Although we had been testing the Lok-Out for some time prior to production, there were some start-up problems at the factory. If a Manitou has a non-functioning Lok-Out, this may result from incorrect oil depth. Go to the section **Lok-Out Installation.**

Some early Manitou forks were shipped without the special high-pressure seal required for the Lok-Out. If a customer's fork has a leaky seal, follow these instructions starting with **Installing the MRD Lok-Out.**

Installing the MRD Lok-Out

Before you install the Lok-Out in your SX fork, you must first replace the lower shaft assembly in your suspension fork by following the instructions below. Do not remove the fork from the bicycle, just remove the front wheel, the front brake, any other attachments to the fork (like a computer sensor), and turn the bike upside down.

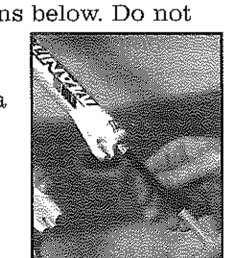

Fig. 45

Lower Shaft Assembly Installation

1. Remove both bolts on the bottom side of the fork with an 8mm allen wrench (Fig. 45) and a 4mm Allen wrench.

2. Once the bolts have been removed, pull the lowers up off from the upper assembly. Leave the boots on the uppers.

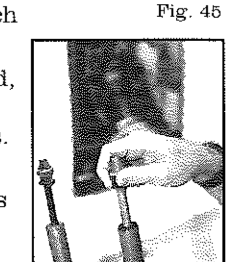

Fig. 46

3. With the bike upside down, grab the shaft on the left side (the left side as seen from a position on the bicycle) and stroke it about ten times until you feel the oil in the TPC damper drain to the other side of the chamber (Fig. 46).

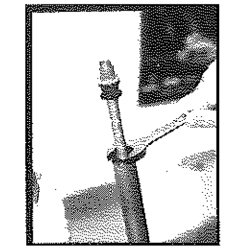

Fig. 47

4. Use an adjustable wrench to loosen the end cap of the lower shaft assembly (Fig. 47). Use caution doing this as the end cap is plastic and can be easily damaged. Completely remove the lower shaft assembly.

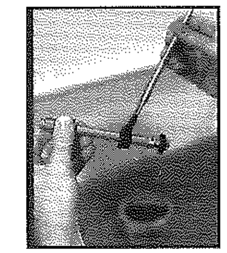

Fig. 48

5. Take the lower shaft assembly provided with the MRD Lok-Out (with high pressure seal) and grease the end cap's O-ring (Fig. 48) with Wrench Force synthetic grease of similar lube.

6. Install the new lower shaft assembly into the leg (Fig. 49) and thread it into the end of the stanchion. Tighten the end cap to 30 lb•in max. Do not over tighten as this may cause damage.

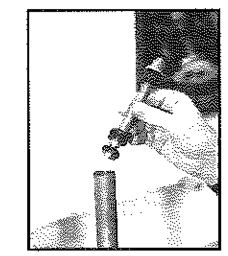

Fig. 49

7. Clean the lower legs carefully to remove any built-up grease or grime and relube them (with the Microlube system, you can lubricate the fork externally after you have assembled the fork), gently ease the fork lowers back on to the uppers. Thread in the 4mm and 8mm bolts and tighten to 10-30 lb•in.

Lok-Out Installation

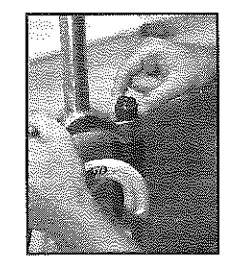

Fig. 50

1. Turn the bike into the upright position, install the front tire and place the bike on the floor. Push the handlebars up and down about 20 times to cycle the oil back down into the bottom of the fork. Slide the fork boots back into place.

2. Remove the compression damping assembly from the top left side of the fork by unthreading it counter-clockwise (Fig. 50).

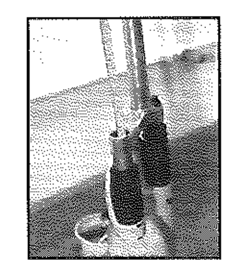

Fig. 51

3. The MRD Lok-Out shaft locates the compression piston higher in the chamber than a normal TPC compression rod, so oil must be added for proper function of the Lok-Out. Proper oil height can be measured with a simple dip stick which you can put down into the fork leg (Fig. 51). The proper oil height, measured from the top of the left leg and extending down into the leg, is between 3.75-4.25 inches (95-105mm). Use Maxima SAE 5-weight oil only.

WARNING: Do not overfill the fork with oil. Overfilling the fork could cause damage to the fork and possibly injure the rider.

(continued next page)

4. Although the Lok-Out lever replaces external adjustment of the compression damping, it is still possible to make this adjustment. On the lower piston of the Lok-Out assembly is a small set screw which can be dialed in or out to increase or decrease compression damping respectively. Just don't over do it: a half turn makes a lot of difference, so make small and incremental changes to the set screw.

5. Lightly grease the O-rings and threads on the MRD Lok-Out (Fig. 52). With the Lok-Out open (green sticker exposed), install the Lok-Out into the left side leg with a turning motion. Be careful to avoid damaging the rubber O-rings as you turn them past the threaded portion of the leg. The fit is tight, so SLOWLY twist the Lok-Out as you SLOWLY twist it into the leg.

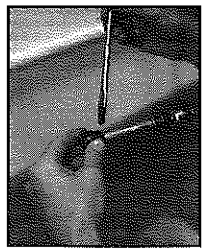
Fig. 52

NOTE: Do not use the Lok-Out knob to create a turning force when tightening.This can damage the Lok-Out lever stop.

Thread the top of the Lok-Out assembly into the fork and tighten firmly.

5. If you have the Microlube system and did not lubricate the fork before reassembly, do it now with Prep M grease.

6. Stand the assembled bike on the floor. With the lockout assembly in place, turn the lever to expose the red sticker indicating the Lok-Out is on. Apply the front brake and compress the fork. It should only move a very small amount and then should feel firm. Remember that the MRD fork lockout has a safety blow off which allows the fork to move under extreme bump forces (when locked out), so if you push it very hard or with constant pressure, you will see more than a few millimeters of movement. The Lok-Out is designed to eliminate bobbing, not make a rigid fork.

Troubleshooting

If after installation the Lok-Out does not function properly, remove the Lok-Out and check the O-ring for tearing on its outer surface.

If you think you've done everything right and the lockout is still not functioning properly, remove the compression assembly and recheck the oil height.

Fox

Air Vanilla Float

The ultralight Air Vanilla rear shock was introduced by Fox in 1998, and improved it still further for 1999. This shock uses the stiction-free damping from the Vanilla, but with an air cartridge replacing the steel coil. Since the air and oil are completely separated, the heavy seals and floating piston used to keep them separate in other air shocks is gone. This makes for a very stiction-free air shock which is even lighter than old air shocks.

The '98 Air Vanilla used a coil negative spring to smooth the spring curve during the first few millimeters of travel. For '99, the improved Air Vanilla Float uses an air negative spring instead of a steel coil. Air is lighter and more importantly, the air negative spring is automatically tuned to the main spring for a plusher ride.

After pressurizing the main spring and the shock is compressed several times by riding over a few bumps, the air in the main chamber will pass through a valve to the negative spring. In this way, whatever pressure you select will equalize with the negative spring. This means there is a progressive negative spring, and one that is perfectly matched to the main spring. The result is a very smooth transition off the negative spring, for incredible performance over bumps of all sizes.

Since we use the Air Vanilla Float RC with lockout, the Mantra Pro and Race rider has the ability to further tune their shock for rebound damping, and to completely turn off the shock by closing the compression damping.

Time pedals

There are a lot of pedal systems in the mountain bike world. And many of them work quite well. Why did we use Time pedals on the top Klein models?

Time pedals are very easy to enter. There is no wiggle or special entry required. Just step in. And unless the cleat is totally obscured you can always do just that. The only pedal that works better in gunky conditions is Gary's favorite; toe clips.

Time pedals are one of the most knee-friendly pedals on the market. A smooth, slightly progressive exit allows the rider to feel their way to the point where they are no longer connected to the pedal. And Time pedals will always let you disconnection, something other pedals occasionally neglect.

Sometime even the best of us go spaz and miss a pedal, sliding off accidentally. With most pedals, this means drawing blood on sharp edges. Times have none. Everything is rounded.

Time pedals have an unfounded reputation for being heavy. While they are not the lightest pedal on the market, they are within a few grams of the 'standard'. And we feel the advantages listed above more than make up for a few grams. Those ultra-light pedals won't seem nearly as glamorous when you're lying on your backside in the mud because you couldn't get out when you needed to.

Rolf wheels set a new standard in wheel performance with patented Paired Spoke Design technology. Paired Spoke Design means Rolf Wheels are light, fast, and rock solid. Rolf Wheels solve all of the problems associated with conventional low spoke count wheels:

- Inherent radial and lateral rim deviations
- Truing difficulties
- Short fatigue life of rim and spokes
- Performance robbing weight increases

The key is the patented Rolf Paired Spoke Design. Lateral force at the rim, generated by the spokes, is perfectly balanced with Rolf wheels. This has many beneficial effects for bicycle wheels.

Rolf wheels have reduced spoke fatigue

As the wheel turns with a rider on the bike, the rider's weight presses down on the rim, and in turn, the ground presses the rim up toward the hub. As this happens with a conventional low spoke count wheel, the spoke at the ground is detensioned (Fig. 53). As the wheel rotates further, it is tensioned again. This cycle of stress and release may create spoke fatigue which can eventually lead to spoke or even rim failure. With Rolf wheels, the spokes are much more highly tensioned, and they're in pairs. Since the spokes are more highly tensioned, they lose less tension as they are released. They also share the load, effectively cutting it in half, so the tension change is less. With less tension change, the fatigue inducing cycle of loose-tight-loose-tight is greatly reduced. The result is less fatigue on both the spokes and the rim.

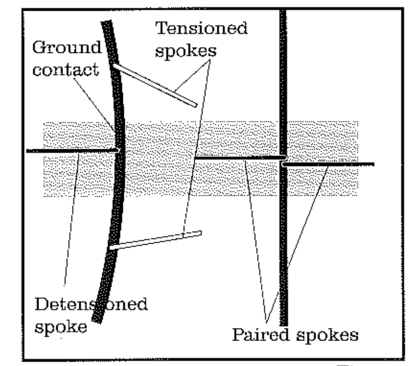

Fig. 53

Rolf wheels have no rim wobble

Another effect of conventional low spoke count wheels is that as each spoke has its tension released at the bottom of the wheel, it allows the rim to move slightly out of true, so the wheel does not track straight (Fig. 45). With Paired Spoke Design, the rim runs straight because the pairs of spokes do not exert unbalanced force on the rim.

When the rim runs straight on the ground, the wheel is more efficient. With less lateral wheel flex, the whole bike feels more solid. Don't confuse the solid efficiency of Rolf wheels with loss of comfort. The sensations of a laterally flexing wheel may fool you into thinking they are adding comfort, but that's not reality. The fact is that the rim has very little vertical displacement in a well built wheel. Wheel comfort comes primarily from the tire.

Rolf wheels stay true longer

Still another effect of the cycling of spoke loads is that as a spoke is detensioned, the nipple loosens. The cycling of spoke loads is a major contributor to wheels coming out of true. It may take a few miles before longer fatigue resistance seems important, but low maintenance is something a rider will appreciate every day.

Rolf wheels attack this problem in three ways. First, Paired Spoke Design allows higher spoke tension. With conventional low spoke count wheels, over tensioning can cause rim failure. With the higher tension possible in a Rolf wheel, the nipple has less change to get loose. Second, Paired Spoke Design means that spokes share the load at the bottom of the wheel so each spoke sees less tension change as its loaded. This keeps the spokes from being loosened as much as conventional spokes. Third, the lowest spoke count Rolf wheels, Vector Pros, use a custom alloy spoke nipple with a nylon insert to prevent loosening.

Left hand torque transmission

The reason Rolf rear hubs have their unique shape is to allow torque transmission to the non-drive side spokes. With a conventional hub, all torque is transmitted solely through the right hand, drive side flange. This is why many low spoke count wheels use radially laced spokes on the left side. But let's do a spoke count. If only the drive side spokes transmit torque, and only half those spokes are pulling, then only 1/4 of the spokes in a conventional rear wheel carry all the torque loads for the wheel. For a 32 spoke wheel, that's just 8 spokes. You can do the math on those other low spoke count wheels.

But on Rolf wheels, torque is transmitted through both the left and right flanges, so 1/2 the spokes carry the torque. In other words, a 16 spoke Rolf rear wheel has as many spokes transmitting torque as a 32 spoke conventional wheel. And each of those Rolf wheel spokes is paired so there is no lateral rim deflection and the Rolf wheels are more efficient!

There are three things required to accomplish this feat. First, the hub must be stiff enough. Rolf hubs use a large diameter barrel with increased wall thickness. This creates a very stiff structure. Second, the spokes must be laced tangentially. A spoke laced radially cannot transmit torque, but instead allows the hub to 'wind up' relative to the rim when torque is applied. And last, the left flange must be larger than the right. In this way, the left spoke is moving in a larger circle and therefore leads the right side spoke. This may all sound a bit strange, but we have instrumented Rolf wheels with strain gauges, and the data supports the theory.

The details of Rolf wheels actually go deeper than this. As an example, Rolf looked at other factors leading to premature parts failures in wheels and addressed them. All Rolf hub flanges have been specially designed with extra thick flanges to better support the spoke bend, reducing fatigue. Spokes in Rolf wheels have specially designed heads to eliminate the most common area of fatigue, the transition from the spoke shaft to the head. Prior to Rolf's analysis of this issue, a spoke went from a cylindrical shape to a cone in one sharp angle (Fig. 54). Rolf had spokes specially made with a smooth flare, removing the large stress riser created by the abrupt transition found on other spokes.

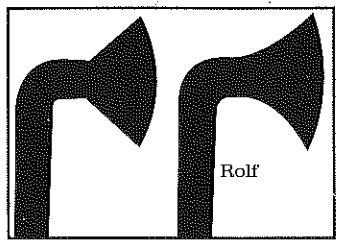

Fig. 54

After looking at Rolf's design, DT is in the process of changing all their spokes to this low-fatigue design. Some theorized that a straight pull spoke would remove the need for a spoke head altogether, but Rolf looked at the way a wheel 'winds up' from drive torque (or disc brake torque) and saw that the wind up would create a stress riser where the spoke exits the hub. A spoke fixed with its head axially (perpendicular to the spoke pull) would allow a slight rotation which does not incur stress to the spoke.

Technical information:

Paired Spoke Design allows a higher spoke tension because the rim does not see the unbalanced lateral forces found with alternating spoking patterns. With Rolf Vector Pro wheels with a 14/16 spoke design, this tension is greater than most tensionometers can accurately measure. The next best way to determine correct tension is to listen to the tone of the spoke when you pluck it, and compare it to that of a factory tensioned wheel.

Rolf spokes in Vector Pros are bladed 13 gauge so are much stronger than conventional spokes. Vector Pro wheels also use special self-locking alloy nipples for low weight and resistance to unthreading. Rolf nipples require a 3/16" nut driver or socket-type spoke wrench (stocked by Wrench Force tools) which will fit through the access holes in the rim.

Truing Rolf wheels

In many respects, truing Rolf wheels is just like truing a conventionally spoked wheel. Each spoke has both a vertical and lateral component to its pulling force. As you tighten a spoke, it pulls radially in towards the hub, and laterally out towards the hub flange.

The difference is that on a Rolf, the lateral force is directly opposed by its 'partner', the spoke adjacent to it. As the partner reacts to your tightening of a spoke, there is no further lateral force applied to the rim.

Contrast that to a conventionally spoked wheel where each spoke has two 'partners'. As you tighten one spoke, it is like trying to bend the rim between the two partners. A wave of distortion is passed by each partner, and affects the third spokes out on the rim as well. This is why over tightening a conventionally spoked wheel will eventually lead to rim failure, commonly known as the potato chip.

When truing Rolf wheels, the paired spoke design gives you more control over both vertical and lateral rim deviations. If the rim is slightly out of true but very round, you can loosen one partner and tighten the other. The rim moves laterally, but not up or down. And since no other spokes are directly affected, you're done. With a conventionally spoked wheel with a lateral deviation and no hop, you tighten one spoke, loosen two, and tighten both of the third spokes slightly to balance the tensions. 5 spokes are needed for the control of one spoke in a Rolf wheel.

When a spoke breaks in a conventional wheel, its two opposing spokes pull the rim in their direction. The third spokes from the broken one are now under greater tension, resisting the second pair. If nothing else was done to the rim, and the remaining spokes were carefully detensioned and removed, you'd likely find that the rim was actually bent in a gentle (or not so gentle) sine curve. Usually this can be trued out once the broken spoke is replaced, but you'll have to work on hop, and the tensions will be difficult to balance.

When a spoke breaks in a Rolf wheel, only half of the vertical force is found at the rim because the partner is still working to control vertical deviation. The rim will come very out of true due to the distance between pairs. But the next spokes adjacent to the missing spoke are still laterally balanced, so the rim is not bent. To repair the Rolf wheel with a broken spoke, simply replace the spoke and bring it back to tension. Normally you will not need to retension any other spokes to have a true wheel.

There is an unusual side effect of Paired Spoke Design that occurs when a spoke breaks. If a spoke is missing, the lateral deviation may barely pass through the brakes with the quick release open because the unopposed remainder of the pair is a long way from the next spokes. When the section of rim where the spoke is broken reaches the ground, its unopposed partner loses tension. Without a tensioned spoke pulling the rim sideways, there is no lateral deviation, and the rim runs true on the ground.

Vertical deviations

With wheels built in our factory, the tolerance allowed for vertical deviation is 0.5mm. A 23c tire with 120 PSI will exhibit more out-of-roundness than this.

Our wheel builders use a vellum, a highly sensitive truing stand that uses dial indicators driven by wheels pressing on the rim. When 0.5mm passes by the indicators on the vellum, the needles move about an inch. What looks like a mountain on the vellum will be totally missed by the rider, even at high tire pressures on smooth pavement.

With an egg-shaped wheel where 0.5mm height change occurs over 1/2 of the wheel rotation, the out-of-roundness may be invisible with a normal truing stand. If that same 0.5mm deviation occurs in a short rim section, its very visible to the naked eye.

With Rolf wheels, the same 0.5mm vertical tolerance is allowed, but instead of an egg shaped wheel it can show up over a very short section of the rim. In either case, the rider will not feel it, nor will it effect the ride of the bike. Consider the much greater magnitudes in the out-of-roundness of a wheel. The tire will be out of round by 1-2mm on a 23c tire, more as the casing gets bigger. A rider sitting on the bike with that same 23c tire at 110PSI will compress the tire by another 2-3mm. And unless your roads are a lot better than here in Wisconsin, the road surfaces often have 5, 10, and even 20mm variation.

Rolf ATB

Instead of aerodynamics, Rolf ATB wheels focus on the other salient Rolf features: stiffness, strength, high fatigue resistance, and low maintenance.

Rolf ATB wheels are designed to be very user serviceable. They use standard spokes with standard external nipples. Of course, when we say 'standard', we mean the best quality from DT. Rolf ATB wheels also use Rolf specific box section rims with reinforced spoke beds. These extrusions allow low weight, yet enough stiffness and support to get the benefits of Rolf technology with the spokes slightly spread apart. The slight distance between spokes in Rolf ATB wheels is there so you can use a spoke wrench on them. This way, if a rider crashes in the backcountry, with a little luck and skill they can rework the wheel and ride home. The box section rim also allows the use of standard valve stem lengths.

Vector Pro

765 g front, 995 g rear   14° front/16° rear

Vector Pro wheels are among the fastest available- only 132 grams total aerodynamic drag at 30MPH.

The spokes are bladed 13 gauge so are much stronger than conventional spokes. Vector Pros use special self-locking alloy nipples for low weight and resistance to unthreading. Rolf nipples require a 3/16" nut driver or socket-type spoke wrench which will fit through the access holes in the rim.

Vector Pro tension:

Front-   80-95 kgf, 15kgf maximum range

Rear, Drive side-   155-190 kgf, 30kgf maximum range

Non-drive side- sufficient to center or dish the rim

Vector Comp

18° front/20° rear   790 g front, 1077 g rear

Vector Comp tension:

Front-   80-125 kgf, 40kgf maximum range

Rear, Drive side-   115-145 kgf, 30kgf maximum range

Non-drive side- sufficient to center or dish the rim

Vector

20° front/24° rear   786 g front, 1070 g rear

Vector tension:

Front-   65-125 kgf, 30kgf maximum range

Rear, Drive side-   80-135 kgf, 30kgf maximum range

Non-drive side- sufficient to center or dish the rim

Propel XC

20° front/24° rear   642 g front, 894g rear

Propel XC tension:

Front-   91-135 kgf, 25kgf maximum range

Rear, Drive side-   68-135 kgf, 40kgf maximum range

Non-drive side- sufficient to center or dish the rim

Suspension Primer

What is the best suspension?

Which car has the best suspension; Cadillac, Porsche, or Jeep?

The correct answer is: It depends on how and where you drive, and the 'feel' you like.

Bike suspension is no different. Some riders want the comfort of a Cadillac to keep bumps at bay at relatively low speeds. Others scream on singletrack like it was the autobahn, and they need the crisp control of a Porsche. And for huge rocks and ruts, the sure-footed traction and high ground clearance of a Jeep may be what's required to keep the rubber side down.

Many riders assume that a bike with lots of comfort and suspension movement is doing a good job. Using our car examples, that would make the Cadillac the suspension of choice. But take that marshmallow through some tight, high speed turns and you'd appreciate the shorter travel Porsche suspension and the way its stiff springs keeps all the wheels gripping. Now take the Porsche off road and see what happens. Sure, the Jeep may have a high center of gravity, but it comes in handy when rolling over big drops. At different speeds and through different terrain with different sized riders, suspension has to do different things. And not all riders sit on their bike the same, or like the same bike 'feel'.

A technical note: We realize that there are more differences between these three cars than just suspension. Their weight and overall design (geometry?) also play a role in how they perform. So our analogy stands.

Probably the biggest problem with understanding suspension is that riding a bike is dynamic. Things are in motion and changing, and changing fast, all the time. Not only does the terrain change, but the position of the rider on the bike changes. So does attitude of the bike. If the rider's weight is on the pedals, the bike will do different things than if the rider is seated. The rider needs to substantially shift weight forward and aft to clear obstacles, corner, climb and descend. Pedaling hard creates different forces than coasting. The suspension reacts differently if its somewhat compressed already. These situations can make it hard to tell what the bike is doing, even when you're the one riding it. Its even harder to understand if you only look at a picture or read a magazine article.

Why are bicycle and motor vehicle suspensions different?

Its apparent that on average, a car or motorcycle travels at much faster speeds than a bike. But the bigger difference is the relationship of vehicle weight to motor weight. The motor is a small part of the overall weight of a car, it runs at very high RPMs, and its bolted securely to the frame through stiff, high frequency dampers. On a bike the motor is the rider, so the motor is most of the weight and is moving up and down a lot. The rider's motion provides large, low frequency pulses of torque at RPMs that easily activate the suspension.

The challenge of bicycle suspension design

On a car, the suspension can be tuned to eliminate motor vibration, yet still be reactive to the frequencies produced by the wheels rolling over irregularities. But on a bicycle, the motor vibration and the terrain produce the same frequency. Tuning the bicycle suspension to eliminate pedal induced motion will also cause the suspension to ignore terrain induced motion, the very reason we need bicycle suspension.

The biggest challenge in making good bike suspension is reducing the unwanted suspension motions caused by rider pedaling while allowing the suspension to be as reactive as possible to terrain. If the suspension does not react well to terrain, it isn't doing its job. If the rider is creating a lot of suspension movement with each stroke, this is not efficient. The suspension is wasting his or her pedaling energy.

Bob or dive cause lost energy

When the bike raises with each pedal stroke, it is called bob. When it lowers with each pedal stroke, it is called dive. Either of these unwanted pedaling motions can rob the rider's power through energy transfer to the shocks, or by interrupting the rider's pedaling rhythm. If a bike is bouncing up and down, its not only hard to put power to the pedals smoothly, its just plain annoying. In extreme cases bobbing can even work to lessen traction on a climb, and spinning the wheels really eats up power.

How shocks can eat up energy

Shocks are comprised of two parts; the damper and the spring. Since the damper is designed to dissipate energy, any activation of the shock by the rider's pedaling motion is wasting energy. This energy loss is easy to measure (see Engineering Sidebar).

The suspension spring also drains the riders energy, converting it to heat. To illustrate this, some exercise machines employ springs instead of weights. From this example its easy to see that it takes work to deflect a spring and then relax it. This work is being done by the cyclist. Like the exercise machines, the bike does not convert energy and get hot. But the person pushing on the springs does.

Engineering Sidebar

Damper: the damper, which resists motion by friction or viscous action will dissipate the rider's pedaling energy as heat. The amount of energy lost per stroke through the damper is a function of how much resistance the damper provides times how far it moves. This is the simple integral F x d where F is the resistance force the damper provides as a function of the deflection, and d is the distance it moves. If the damping force is really high, then the damper will barely move during the rider stroke (not much suspension), and the total energy lost will be small. If the damping force is almost zero, then the motion may be large (very bouncy), but the energy lost will be small again. The most energy will be dissipated per pedal stroke with a medium amount of resistance with a medium amount of travel.

Spring: when the cyclist exerts force on the bike, he or she deflects the structure and any suspension spring. The bike structure and suspension spring in most cases store the energy as mechanical work and do not dissipate it as heat, although some types of springs such as elastomer and air springs have significant hysteresis and as a result do dissipate a small amount of heat.

The formula for the amount of energy stored in the structure or spring is the same as for damping, the integral F x d. F is the spring force developed as the spring is deflected, and d is the amount of deflection. As we do not want to reduce the pedaling force of the cyclist, the only way to minimize the energy lost in this equation is to make the bicycle frame structure very stiff, and reduce pedal induced suspension action (bobbing) in order to minimize the total deflection.

Suspension saves the rider's energy

When a bike hits a bump without suspension, the rider must absorb the energy of impact. That's done with muscles. When those muscles work, they build up heat and they fatigue, just like when pushing springs. Sometimes they can't adequately handle the forces incurred and the rider loses control.

To compensate for the abuse of off road riding, suspension allows the wheels to deflect upwards. This diminishes the force felt by the rider, saving their energy and keeping them in control.

Good suspension allows a bike to roll over bumps without losing as much speed as a non-suspended bike, so the rider saves energy because they do not have to pedal as much to maintain momentum.

Engineering sidebar:

When a bike hits a bump, the bump converts some of the bike's forward kinetic energy into vertical kinetic energy, by accelerating the bike upwards. As forward kinetic energy is reduced, so is forward speed. How much energy, and speed, is determined by the height and shape of the bump, the bikes speed, and the mass and compliance of the different parts of the bike and rider.

Suspension does not eliminate forces felt by the rider, it only deflects them or changes their energy. The amount of "shock absorption" provided by the bicycle is called the attenuation, expressed as a percentage.

Equal and opposite forces

Good suspension reacts to even the smallest bump, allowing the wheels to move up and over without disturbing the rider. But if a given force can move the wheels up, an equal and opposite force will move the frame down.

If a rider shifts his weight up and down on a bike without the brakes applied, and the suspension is supple and high quality, it will respond significantly to the riders movements. This is what it is designed to respond to, as in landing a jump or hitting an obstacle. If the rider keeps his/her body level and pedals with a smooth stroke, the bobbing or diving action of the suspension can be controlled and almost eliminated with a carefully designed suspension system.

But if the rider shifts his/her weight up and down while pedaling, movement of the suspension cannot be eliminated as this is what the suspension is designed to react to. The only way around this is to turn off the suspension to some degree, or find a counter-balancing force to the rider's up and down motion.

Reducing pedal bob and dive

There are several ways to reduce pedal dive and bob. The degree to which these designs are effective, or noticeable to the rider, depends on the particular design. Its even possible to combine more than one of these techniques in a single bike. The key to bicycle suspension performance is to balance the dynamic pedaling forces so that they do not induce undesired suspension movement, yet leave the suspension as supple and as effective as possible. Since different riders pedal differently, and feel different things, there will always be varying opinions on which suspension design offers the best performance.

Types of Suspension

Unified Rear Triangle-

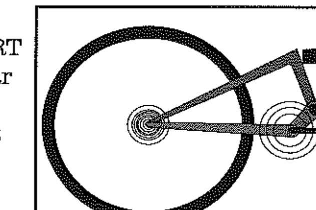

Fig. 55

The basic design of a URT puts a pivot between the rear triangle and the front triangle, with the bottom bracket being part of the rear. Some variations of the URT don't include an entire triangle, but the bottom bracket and rear axle are still fixed with no pivots between them.

Whether a Floating Drivetrain or URT, the rigid connection of the drivetrain prevents chain tension from causing the suspension to react or slow down. By separating the chain forces from the suspension system, the chain tension does not pull or push on the suspension in any way. In addition, the high chain loads are not being put through any of the suspension bearings, lessening wear and flex.

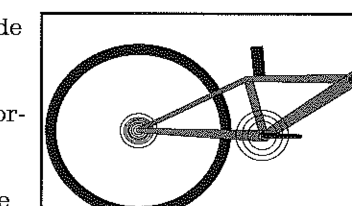

Fig. 58

While all URTs provide these benefits, the pivot placement makes a great deal of difference in performance. Some variants place the pivot so far forward (Fig. 56) as to cause the rider to be almost unsprung when they apply pedal pressure, whether its by pedaling hard or standing. The rider is literally standing on the swingarm and holding the rear wheel down. The rider is only effectively suspended when sitting on the saddle. Other designs, with the pivot further to the rear, have a more conventional suspension action and feel.

Pros: Chain tension does not compress or extend the shock in any gear

Wide variety of axle paths available, according to pivot placement

Lightweight

Single pivot for low maintenance and lateral rigidity

Pivots are not subjected to high chain stresses.

Pivot can be placed away from crowded BB area.

Bearings can be spaced further apart, for better stiffness and performance.

Suspension action for cranks and saddle can be individually and specifically tuned for desired performance via pivot placement.

Cons: Depending on pivot placement, rider weight is placed on the swingarm, reducing suspension function when standing

Depending on pivot placement, bottom bracket moves relative to the saddle.

Simple swingarm-

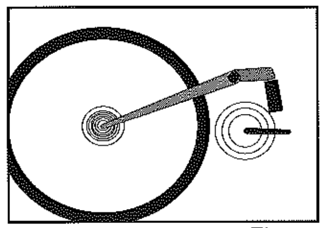

Fig. 57

With this design, the bottom bracket is located on a different frame member than the rear axle, but there is only one pivot between them.

With a simple swingarm chain tension comes into play pulling the swingarm either up or down depending on the pivot location and the gear combination If the pivot lies above the upper chain run, pedaling will resist shock compression and accelerate rebound (pedal bob). If the pivot lies below the chain run, pedaling will compress the shock and resist rebound (pedal dive). Only when the pivot is in line with the chain is the suspension approximately balanced with respect to the chain forces. This does not mean it is necessarily balanced to the remainder of the pedaling forces, like from the rider jumping hard on the pedals, or from the bike accelerating from a strong pedal stroke. Some riders feel that as chain tension pulls the rear tire downward, as when the pivot is slightly above the chain line, it enhances traction to provide an advantage when climbing.

Pros: Wide variety of axle paths available, according to pivot placement

Lightweight

Single pivot for low maintenance and lateral rigidity

Cons: Depending on pivot placement and gear selection, chain tension extends or compresses suspension

Pivots experience high chain loads

Performance changes with the gearing used.

Low/Forward BB Linkage-

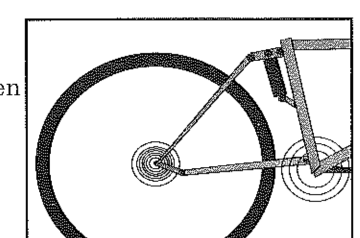

Fig. 58

Linkage systems have a link, or rigid member, between the main pivot and an additional pivot, with both pivots between the bottom bracket and rear axle (Fig. 58). With the low/forward pivot placement, the main pivot is directly behind the bottom bracket, and the second pivot is on the chainstay just in front of the dropout.

The extra articulation of the linkage means that virtually every gear is affected by chain tension. This does two things; in low gears it slows suspension movement and helps prevent bobbing. In high gears chain tension compresses the rear shock, making the suspension feel livelier. The linkage also changes axle path, although only by a small fraction. More importantly, with this low pivot placement, the axle path is slightly forward.

Pros: Very reactive suspension

Cons: Multiple small pivots wear easily, cause noise, flex

Chain tension either compresses or extends suspension depending on gear selection

Pivot location is limited.

Pivot is in tight area between tire and chainrings so must be narrow. Also in bad mud area.

Difficult to manufacture because there are many frame parts which require alignment, which adds cost if done right, or makes pivots noisy and wear prematurely if done wrong.

All pivot points are stress risers, so frame requires much reinforcement, making it heavy

Variations and Hybrids

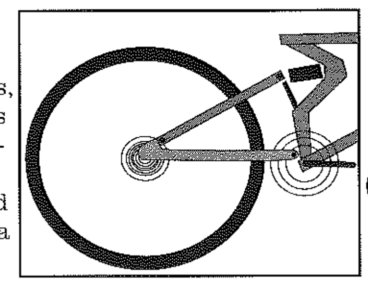

Fig. 59

There are many variations of these three designs, and there are a few designs which don't fit these definitions, but most do. As an example, if a pivot is placed above the rear dropout on a simple swingarm, it may look deceptively like an entirely new linkage system. It may allow the design some additional benefits, but the rear wheel action will be that of a simple swingarm. Likewise, the shape of the swingarm, whether a beam or a triangle, does not change the way the rear wheel moves or the relationship of chain tension to suspension action.

In addition to these basic suspension designs, additional features can be added. With each of these three categories, additional linkages can be added to allow modification of shock compression ratios. Different shocks with different spring curves and damping rates will change how the suspension reacts. Pivots can be moved around, forward or rearward, up or down, all with slightly different results.

Some variant designs even forego pivots, allowing the frame itself to flex. Their marketing may make this seem like a solution to pivot bearing maintenance, but a well designed pivot system can control torsional force and chain compression quite nicely, where the simple leaf spring created by a pair of flexing chainstays does not. If you want a small amount of high quality, light weight suspension, a high performance suspension seatpost is a much more affordable and effective approach.

Some new designs have appeared which attempt to blend the advantages of different systems. From what we've seen so far, these hybrids usually take on unwanted complexity while losing the primary advantages of both the systems they are attempting to merge. As an example, one new system claims its major feature is eliminating the seat-to-pedal height change of a URT. But all those pivots and complexity adds several pounds to the Mantra weight. At the same time it allows the distance from the bottom bracket to rear axle to change, losing the drive train benefits of an URT.

Suspension bike design issues

There are a few things that every designer has to keep in mind. The more pieces, the greater the weight, flex, & play. The more complexity, the more need for maintenance. Given similar technology, the smaller the bearing surfaces, the faster the wear. Adding lots of parts to the frame increases its cost, complexity, and replacement part problems. The narrower the separation of the bearing surfaces, the less lateral rigidity. And the more of these problems your design exhibits, the tighter quality control must be. With higher quality demands, higher costs are inevitable, or the greater the problems which will plague the rider.

A bicycle is both very simple, yet highly complex. Adding suspension into the limited space of a bike creates many challenges. With some designs, the suspension precludes building reasonable size ranges. Several current designs allow the front derailleur to move relative to the crankset (closer and further away), a real problem with sensitive 9 speed shift systems.

Performance trade-offs

Each of these designs has its benefits, depending on what the rider considers the best trade-off in performance. Do they want the lightest bike possible? Or do they want the most travel? Or the plushest feel over small bumps? The lowest maintenance? Each of these features have their importance. But regardless of other design features, if a suspension bike is to be ridden up hill, it should be light and has to avoid bobbing.

The easiest and most effective method of preventing bobbing is to completely lock out the suspension with a shock lockout, where flipping a lever keeps the shock from moving. This is true lockout, where the suspension is turned off. There is no suspension.

Some URT designs create a lockout effect, not a true lockout but a slight interference of the suspension action. This is done by moving a portion of the rider's mass from sprung to unsprung weight as they stand. The rider's weight or pedaling movement doesn't effect the suspension as much because they are no longer suspended to the same degree.

Another way to avoid bobbing is with very stiff suspension from either springs or damping, or by limiting the travel. This results in less suspension travel in all conditions, and reduced suspension effectiveness. A bike maker may claim a model has 12 inches of suspension travel, but if the spring is from a 1 ton truck, you may only see 1/8 inch of travel in actual use. Alternatively, the damping may be set up relatively stiff at low speeds, so that suspension movement under pedaling is greatly reduced. Suspension response to small bumps will also be greatly reduced, and the suspension rebound may be too slow for the wheel to follow terrain and maintain traction.

A better strategy to avoid bobbing while still supplying some suspension is to use chain tension to counteract wheel movement. If the distance from the rear axle to the bottom bracket increases, chain tension can provide resistance to this movement. This technique is used on linkage systems and simple swingarm bikes where the pivot is above the upper chain run. Bobbing is most noticeable when the RPMs are low and the rider moves their upper body a lot, such as climbing in a low gear. In first gear the bike is moving slow and bump forces are low, so the slowing of the suspension compression is mostly over the small amount of travel generated by hitting a bump at 4 MPH. However, if the pivot is below the upper chain run, chain tension from the rider's pedaling will compress the suspension and slow the suspension rebound. This is more likely to occur in higher gears at higher speeds.

A third method used to avoid bobbing is balancing torque. The harder a rider pedals, the more force goes downward which would normally create bobbing. But the harder they pedal, the more torque they generate at the rear wheel, and with careful pivot placement the equal and opposite force is lifting the frame. If these two forces can be balanced, bobbing will be minimized. This requires very careful pivot location and since riders sit on their bikes differently, and they rarely sit still, this method is much harder to execute successfully.

Most methods of preventing bobbing rely on chain tension to interfere with the suspension movement. The interference is applied by your muscles as a form of damping. Rather than view this as a negative, think about the work done by your legs when you stand on a hardtail. Not only do your legs do the work of a spring, they also do all the damping. Plus they're working harder, because they have to hold you up as you stand. And since its difficult to pedal over rough terrain, your legs then have to do extra work to get you back up to speed after coasting a section that a fully-suspended rider could pedal over

Active vs. Inactive Suspension

An ongoing argument is that of Active vs. Inactive suspension. These terms are thrown around a great deal, but without any definition of exactly what they mean.

For our purposes here, lets just say that if a suspension is working without interference, its active. Since most systems rely on some interference to prevent bobbing, the term doesn't mean much.

Since it doesn't mean much, be more specific when describing suspension movement. Some suspension is more lively, or lightly damped. Others move slowly being heavily damped. But in either case it may be the result of suspension interference or could also be incorrect tuning.

Pivot location and axle path

A very important, but seldom discussed, area of suspension performance is that of axle path. The axle path is the actual movement of the wheel axle as the tire contacts a bump (Fig. 52). Since most systems really only have a single pivot, axle path is tied very closely to pivot location. Even on systems with a "virtual pivot" there is typically a main pivot from which a simple arc will very closely describe the axle path.

The axle path of telescoping suspension forks is very easy to see, described by the legs. This seems very simple, but is efficient because it allows the wheel to move backward slightly as it moves up. By the wheel moving backwards, the rider's mass can continue moving forwards as the wheel moves over the bump. The rider does not slow down as much, and the force at the handlebars is reduced. But if the axle path is anything other than vertical, the wheelbase will change when the suspension is compressed and that can affect handling.

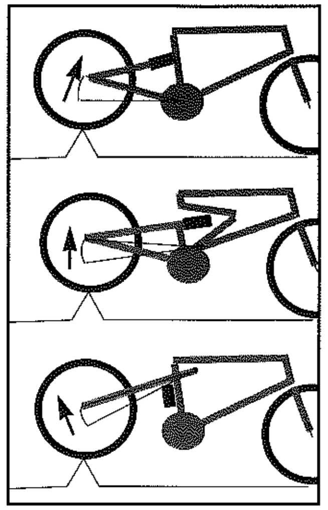
Fig. 60

Since the axle path of the front wheel is in line with the force path of the rider's mass, forks can feel very plush. However, this also means that any up-and-down motion from the rider will activate the fork. This limits the useful travel and plushness of forks on a bike which has to be pedaled uphill.

When the rear wheel encounters a bump, its natural motion to get out of the way is up and back. Most of the current suspension designs move the wheel in the up and back direction, where it is more likely to be supple.

If the direction of travel is approximately perpendicular to the direction from the rear contact patch to the CG of the bike and rider, then the pedaling induced forces will be neutralized and will not activate the suspension. In this case, the rear suspension can be made very supple with long travel and provide excellent suspension function. Yet not rob energy when the rider is pedaling.

If you trace the axle path of an URT or simple swingarm, the axle path is easy to see as a simple arc. The same analysis applies with a more complex linkage. A single pivot will typically be able to provide a similar path with a lighter, stronger and more rigid structure.

Another component of axle path is angle of attack. The direction of force applied by a bump to the wheel depends on the size of the bump, or the height at which it contacts the wheel. A suspension system is at its most efficient, or sensitive, when the force is in line with the axle path (Fig. 61). However, other suspension characteristics can easily override this factor. A suspension system with reduced mass and reduced static friction moving not directly in the direction of impact may be more sensitive than a heavier or stickier suspension moving directly away from the point of impact. Moreover, it is difficult to optimize the direction of travel for all conditions as different size bumps will contact the wheel in different locations. And some suspension action is completely vertical, like when landing a jump.

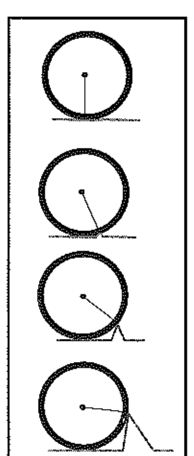
Fig. 61

So what's the best pivot location? There are several considerations. If you oversimplify and only want to consider shock absorption, pick a pivot point that gives the best axle path for the size of bump you want to absorb most often. But since there are many forces applied to the bike and suspension, pivot point selection is not as simple as it may seem. Every location will be some sort of compromise as suspension function, component interface (like how it affects derailleur placement and adjustment), and overall geometry (like how small the bike can be made).

All about Springs

A spring is a mechanical energy storing device. As the suspension is compressed when the wheel rolls over a bump, the energy from the bump is momentarily stored in the spring. Then the spring pushes the wheel back down, returning most of the energy (but not all, see Damping).

The stiffness of a spring is called its Spring Rate. Usually this is expressed in pounds per inch of deflection.

If each increment of compression requires the same amount of increase of force, the spring is said to have a Linear spring rate (Fig. 54). With a progressive spring, compression varies with each increment of force applied. So the first 50 pounds compresses the spring a different amount than the next 50 pounds. The progressive type of spring allows the designer to make a suspension that is relatively supple and responsive to small bumps, but when a large bump or landing is encountered, the spring becomes much stiffer as it travels further into the stroke, still preventing bottom out.

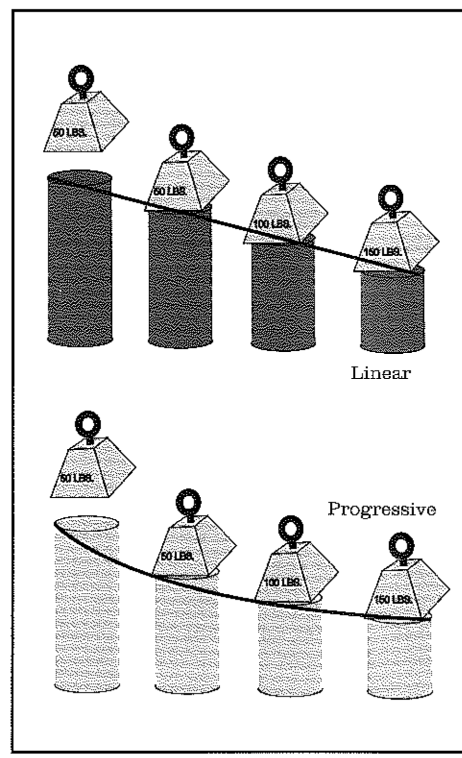

Fig. 62

Metal springs are generally linear. Coil springs can be made to be progressive, but its quite expensive. Elastomer and air springs are progressive by nature.

Since metal springs require lots of material, usually steel, they are quite heavy. In some cases the coil alone weighs more than an entire air shock. The best gas and elastomer springs are also more efficient springs than the metal springs. That is, they can store more energy per mass than a metal spring can.

An elastomer is a type of plastic from a broad chemical family, so there are actually lots of types of elastomers with somewhat varying characteristics. They can also be made to different durometers (hardness, which also relates to stiffness). Some have tiny air bubbles (micro-cells) that further alter their performance. High performance elastomers are fairly low in weight. They offer a reasonably wide adjustment range, but different durometers are required to cover all the ranges required in a bike. After time, some elastomers can become semi-permanently compressed so that for best performance they need to be replaced, although others may last 10 years. The spring curve of an elastomer spring is determined by the ratio of elastomer length to percentage of compression and specific elastomer.

Air or other gas makes the lightest spring and never wears out. But the container it is in may make up for the light weight of the air, requiring a stout container and highly engineered seals to prevent the air from escaping, and the tight seals can induce stiction and wear. Air springs are easy to adjust to virtually any stiffness by simply pumping up the air pressure.

Air or gas springs trap an amount of gas molecules in a chamber. The springs works by compressing the gas in the chamber. As the chamber becomes smaller and smaller, the force needed to compress the gas goes up exponentially. The ratio of air chamber size to percentage of compression will determine what the spring curve looks like.

It is also possible to incorporate a combination of different types of springs such as metal and elastomer, or air and metal, or air and elastomer into a single unit.

Preload

For optimum performance with most systems, it is desirable to have a slight amount of suspension compression when the rider is sitting stationary on the bike. The spring force required to offer this resistance to the rider's weight is called the preload, and is adjustable by varying the spring rate.

With a linear steel spring, this does not affect the spring rate or spring curve. For an elastomeric spring, the amount of preload will affect the position on the curve where the suspension travel begins, thus slightly altering the shape of the useful curve. But the curve itself is not altered.

With an air spring, the preload is typically adjusted by adjusting the starting air pressure. This adjustment substantially changes the spring curve. For example, if the preload is increased by 10%, the spring curve will typically be more than 10% higher everywhere else. In practice, the reason we would change the preload would be to adjust for a rider of different weight. When adjusting for rider weight we also would like to change the shape of the whole spring curve, so preloading an air shock tends to give the correct spring curve for a given rider.

The rate debate

Another hot area of debate for suspension designs is Falling rate vs. Rising rate. Like Active vs Inactive, these are more terms being tossed around without anyone agreeing on what they mean. Is it the rate of compression of a shock unit with a constant rate of deflection of the rear wheel? Or is it the effective spring rate of the rear wheel (including the structure)?

A good suspension design blends spring rates, spring curves, wheel travel, damping, and shock compression ratios to achieve a certain feel and function. Since all of these factors play into how a suspension system works, its unrealistic and inaccurate to pull just one of the design parameters out and use it as a single standard for evaluation of a system.

Here's an example: If a system uses a falling (shock compression) rate, but with a shock which has a very progressive spring curve, the net effect could be a rising rate suspension when considering the whole structure. But if you were to substitute a linear coil spring shock, the situation would be very different, and the bike would ride very differently.

The amount of travel greatly effects the total shock absorption capacity of a system. Given two systems with the same travel, if one system is more plush on small bumps, it will need to rise (get stiffer) quickly to provide enough shock absorption over big bumps to avoid bottoming out. Conversely, the system that is not very plush can offer a smoother stroke over big bumps, since the system which is plush on small bumps will have to spike (get stiff quickly) to avoid bottoming. By adding shock linkages which change the shock compression rates there are an almost infinite number of choices between these two examples.

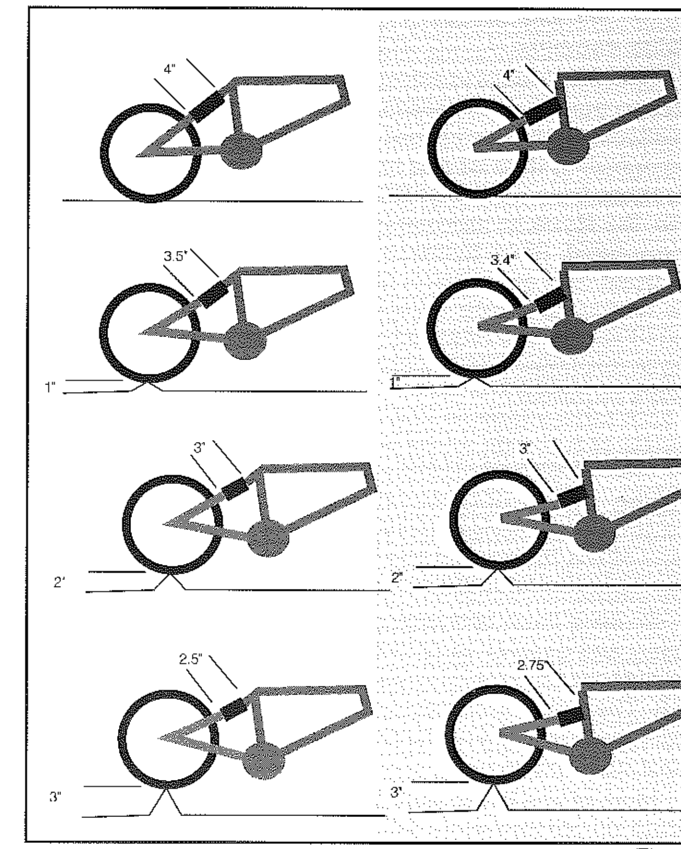

Fig. 63

Which is better? It depends on how you ride.

Damping

As a shock is compressed, an amount of energy is changed to heat through friction (you don't lose energy, its only changed into different kinds of energy). This change in energy results in less energy being returned by the spring, thus slowing the springs rebound down.

This effect, whether great or small, is called damping. In a highly engineered system, damping is matched to the spring to yield higher quality suspension action.

Depending on the design, damping can also come from bushing friction or seal friction, all adding to the damping. With an elastomer shock, the damping friction may simply be from elastomer molecules bumping into one another plus the elastomer rubbing on the inside of the shock, an effect called hysteresis.

With hydraulic damping, a fluid is forced through tiny holes called valves as the shock is compressed or rebounds. The fluids commonly used are either oil or air. Either one can be designed and built to function well. The oil unit needs to have high quality construction, surfaces and seals in order to not leak or wear in service. The air damper is not as likely to oil your floor for you, but it also needs to have the same level of construction, surfaces, and seals to not leak the gas working fluid and provide high quality damping.

Damping valves are designed to provide varying resistance to fluid flow, depending on the pressure exerted on the shock. With careful tuning of sophisticated designs, a suspension system can be made so that it resists low forces, like those from a rider pedaling. Yet the same valves can allow the shock to move very fast when a big bump is encountered. Since hydraulic damping is engineered, there is a great deal of variation possible, with great control. For this reason, hydraulic damping is used where more sophisticated shocks are required. Fortunately, bicycles are fairly simple machines and the expense of hydraulic damping isn't always required.

The importance of travel

The amount of impact energy is determined by the factors inducing vertical motion of the wheel; the size and angle of the bump, and the speed and weight of the rider/bike combination.

To keep from bottoming out, the combination of the spring and damper must be able to store and/or dissipate the highest amount of impact energy a given rider deals with. The amount of travel offered by a suspension system is the most important factor in providing higher levels of shock absorption.

Most of the bump energy is typically stored in the spring on compression. To avoid bottoming out the suspension over a bump, the suspension must have a sufficient combination of spring rate and suspension stroke to store this energy in the spring. There are two ways to make a suspension system store more energy; make the spring stiffer, or make it with more travel. The downside of a stiffer spring is that to preclude bottoming out, the spring may have to be so stiff that the suspension does not do an adequate job of isolating the rider on smaller bumps and keeping the rear wheel hooked up with the ground. The downside of a longer stroke (more travel) is that if the suspension is not balanced with respect to the rider's pedaling forces, additional travel may allow more of the riders energy to go into pedaling induced suspension movement.

Engineering Sidebar

For a linear spring, the integral F x d where the force F(x) 3D Kx results in BD Kx^2. Increasing the spring rate will increase the energy stored. However, increasing the stroke of the suspension has a squared effect on increasing the energy stored. So longer stroke is more effective to prevent bottoming out than a stiffer spring.

Matching rider to bike

Most suspension systems offer some features which are good. Your job is to determine what the good points of a bike are, and how a given rider would benefit from them.

From this discussion, it should be evident that there are many factors which effect how a suspension bike works. To only consider one design issue when choosing a bike would be a gross over-simplification. But if you understand suspension at all, you also see that every bike makes some compromises. The secret in matching a suspension bike to a customer is finding the design which makes sacrifices your customer can overlook, but also gives them the benefits they need for their type of riding.

Adjusting the suspension

Any suspension bike will ride better if its tuned to the rider. The rider's position and the suspension adjustment must be done together. If the rider is positioned with the rear suspension set up too soft and then you crank up the spring preload, the angle of the saddle and position over the bottom bracket can change drastically. Conversely, sliding the saddle back a mere centimeter can greatly increase the sag.

The key to proper preload adjustment is sag, or shock compression (of both the forks and the rear shock) by only the rider's weight on the bike. Generally you want more sag on shocks which have more travel. Something like 25% of the shocks total travel should be used in sag, although a cross country racer wanting a Porsche ride may want less than this.

A rider with a very smooth pedaling style can ride with more sag without bobbing. If a rider is not accustomed to the motion of a full suspension bike, higher preload (and less sag) will help quiet any small amount of bobbing.

Once the correct sag is established, consider damping. If the suspension has damping adjustment, start with the damping set at minimum. The bike may be a bit of a handful to control. Increase the damping until the bike rides right, without loss of control in extreme conditions. You do not need more damping than is required for control of the bike.

Good damping needs to be matched to the spring rate and the specific suspension design. We work closely with our rear shock suppliers, setting the damping to match both the spring rates of our bikes, and also the overall suspension design. If you change the shock from a Mantra with an off-the-shelf shock it will likely have a much higher damping rate.

A unique look for a good reason

All the components of the Mantra frame serve a purpose. Each design detail is there to accomplish a task. From the big fat top tube to the precise placement of the seatpost, all the design details are there to increase the bike's performance in three distinct areas. Rather than focus on designing a pretty bike, Gary designed the Mantra purely for function, and as a result it outperforms other designs in three ways; efficient transfer of power from the rider to the rear wheel whether seated or standing, maintaining the rider's momentum and traction over obstacles, and overall handling.

Unified rear triangle

The Mantra uses a Unified Rear Triangle (URT) type suspension design with Spot-On™ pivot location. A well designed URT offers four basic structural advantages over multiple pivot designs: less flex, less wear, less maintenance, and less weight.

The pivots on a suspension bike are subject to a lot of lateral loading. If everything else is equal, like the tolerances and the materials, a bushing's resistance to flex is determined by its width and diameter. The wide, large diameter pivot on the Mantra resists flex very well.

If it resists flex, it will also resist wear. Again, the Mantra wins. It's very durable, and essentially sealed to any grit, which increases its life span. We use very high tech pivot and axle materials, which are light and do not require any lubrication. So no maintenance, no squeaks, no worry. And, as you would expect from a Klein, the entire assembly is very light weight.

True full suspension

Normal suspension bike designs are often merely adapted rigid bikes. But the Mantra is not a normal suspension bike. Don't look at the Mantra as having front and rear suspension; it is true full suspension.

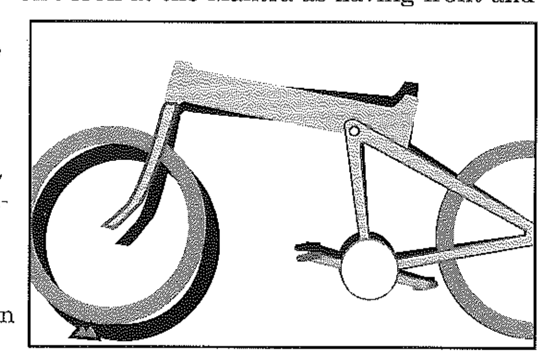

Fig. 64

Riding a Mantra with a rigid fork really illustrates the way the suspension operates. When a rigid forked Mantra hits a bump, the front wheel moves up and over the bump (Fig. 56). This upward force on the wheel pushes up on the front of the bike, trying to lift the rider. But the rider's weight resists that motion, so the force instead see-saws through the frame pivot, compressing the rear shock. This was part of the original design concept; the whole frame works to smooth bumps at the front and rear wheels.

Lots of travel

There is 7" of rear wheel travel. Thanks to the Mantra's true full suspension design, you also get more suspension action from the front of the bike than you'd expect, since the suspension fork is complimented by the action of the frame and rear shock. The rear shock absorbs some of a front wheel impact, so the fork feels like its got 20 or 30mm more travel than it actually offers. With the Mantra's design, you get excellent big bump performance without the weight penalty, energy loss when climbing, or decreased steering precision of a long travel fork.

Maintaining momentum

Its really the Spot-On™ geometry that makes the bike unique in its efficiency and ability to maintain momentum. With the Mantra's high pivot location, the axle path moves somewhat rearward as it moves up. As the rear wheel hits a sharp bump, this axle path allows the rider's center of gravity to continue forwards. With a low-forward pivot, the axle path actually moves forward as it moves up. As the wheel moves forward, the rear wheel 'hangs' on a big bump and slows the rider's mass. To regain momentum after slowing down, the rider uses more energy. With the Mantra, momentum is easily maintained. This is what makes the Mantra so fast, and also what allows it outclimb a hardtail in rough terrain.

Excellent tunability

The Mantra's full-suspension design shares shock absorption between the front and rear of the bike, and this lets you balance the suspension from front to rear. Making the rear shock stiffer will work the front fork more, while softening the rear shock allows it to absorb more of the bumps hitting the front wheel.

Another unique feature of the Mantra is that it rides equally well ridden stiff or soft. As a stiffly sprung racer, the Mantra offers incredible handling, keeping the tires plastered to the ground for rail-like turns and letting you pedal through rough terrain without slowing you down.

In super plush mode, the Mantra offers a cloud-like level of comfort and the ability to roll over some incredibly big stuff without losing wheel contact. Because of the Mantra's sophisticated design, it rides very well with minimum damping. This lets the rider take full advantage of all that travel.

Light weight

The Mantra gets the same engineering and manufacturing expertise as any Klein. With frame details like Gradient tubing its light, tough, and rides great. Considering the amount of travel offered by the Mantra, and the excellent torsional rigidity, the new carbon Mantra is probably the lightest full suspension bike in its class.

Optimum handling

The lateral stiffness of the Mantra, part of why it handles so well, comes from the Torque Tube design of that big fat front end combined with a very stiff, truss design rear triangle. Then there's a very wide, very large diameter pivot assembly joining the front to the rear.

With a rider sitting on a Mantra adjusted to its recommended 25% sag, the geometry is very close to that of the Adroit. It has very precise and quick steering. With a short wheelbase and relatively steep head angle, it gets through corners in a heartbeat. When worked side to side through tight turns, the frame stiffness makes the Mantra very predictable. And with a generous cockpit, the rider can move his or her weight to compliment the steering precision in any terrain.

There is an additional handling benefit which comes from the Mantra's true full-suspension nature. As the Mantra suspension is loaded or compressed, there is a change in the bike's attitude to the ground, which includes increasing the wheelbase and the trail as well. So the Mantra becomes more stable when the suspension reacts. The rougher the trail, the longer the wheelbase, and the more stable the bike. The benefit is staying upright, even though you may have landed poorly.

Mantra Science

You're probably wondering how the Mantra lives up to all these claims. To understand the Mantra, we have to go into at least a little physics. Gary would be talking equations and force vectors, but here we'll try to keep it simple.

The Center of Gravity, or CG, represents the point where the mass of an object is focused. Think of it this way: If you had two hammers which both weighed exactly 4 pounds, but one had a 3 pound head on it while the other used a 1 pound head, which one would you want for driving a great big nail? The hammer with the 3 pound head has its CG closer to the head, so as you swing it, its energy is focused in the head where it will best transmit its energy to the head of the nail. As that 3 pound hammer head meets the nail, which weighs a few ounces at most, the larger mass of the hammer punches the nail's smaller mass into the board. The force of the hammer's CG doesn't move sideways, but moves in a line into the nail (assuming you hit it straight, of course). The resistance of a mass to change in speed or direction is called inertia, another important concept.

Spot-On™ pivot location

The relationship of the rider's CG to the pivot is critical to make it work. That's why you must be fussy about the fit of the bike. Some riders want to show a lot of seatpost for fashion. On a Mantra if they sit too high above the pivot they won't get the performance intended.

If a rider could sit perfectly still while pedaling, the pivot vector (a line from the tire contact patch through the pivot) should bisect the combined CG or rider and bike. This would neutralize the acceleration forces of each pedal stroke with respect to the shock loads, so there would be no bobbing no matter how hard the rider pedaled. But in real life, the rider moves up and down a lot when pedaling hard, and tends to lean forward and down when accelerating. So Gary put the pivot vector a little below the normal CG for best performance in a variety of conditions. This allows very good suspension action over bumps in the 1/2" to 6" range.

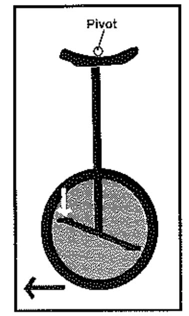

Fig. 65

The Spot-On™ pivot location also prevents bobbing from pedaling, either sitting or standing. Think about what would happen if someone on a unicycle pedaled hard from a standing position (Fig. 57). The wheel wants to move forward while their body stays put due to inertia.

With the pivot of the Mantra moved forward (Fig. 58), the wheel still wants to move forward when you pedal hard, and now the wheel can travel vertically over bumps. Getting the perfect angle for our Spot-On™ geometry required a lot of calculations and experimenting, but its why the Mantra can actually out climb a hard tail, in or out of the saddle.

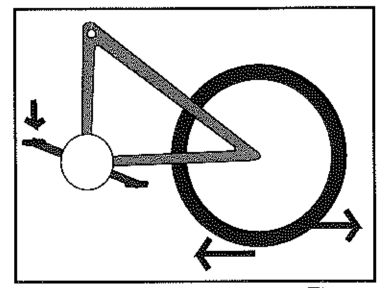
Fig. 66

Standing and pedaling on a Mantra

First lets talk about standing and pedaling. When you stand, you're mass moves up and down more, so you need more resistance to bobbing. As you stand, your mass moves above the pivot vector. The higher your CG, the more the rear wheel will want to 'crawl under you' when you pedal hard.

Correct bike fit is critical

Let's think about that unicycle again. The higher in the air the rider is, the more that wheel will want to roll forward from under the rider when power is put to the pedals (Fig. 59).

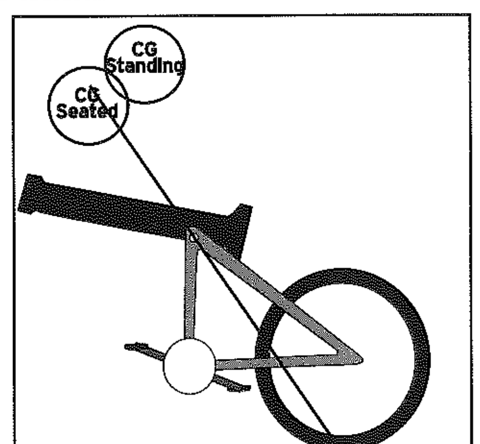

Fig. 67

Same thing with our Spot-On™ geometry. If the rider sits too high on the bike, the critical balancing of rider CG and the pivot vector will be incorrect, and suspension action will be thrown off. If the rider is too big for the frame size, placing their CG too high, they will get bobbing.

For 1999, we've introduced a second swingarm size for the Large and Extra large Mantras to more precisely locate the Spot-On™ pivot for bigger riders. It costs more to build bikes with size-specific swingarms, but the improved performance is well worth it.

From within our recommendations for a given body height for each size, the variety of CG locations between a barrel chested body builder and a large legged sprinter can be tuned with the suspension adjustments. But let us emphasize again; bike fit is critical.

Descending on a Mantra

When descending, most of us stand. When standing, your CG is in your torso, but your connection to the bike is focused on the pedals and thus on the Mantra's bottom bracket. When an impact starts to push up on the Mantra's rear wheel, the lighter parts of wheels, fork, and frame can be more easily moved than your body's CG, which has more mass. The bottom bracket, with your CG focused there, resists the upward movement of the rear wheel. The bump causes the Mantra's parts to pivot around the bottom bracket (Fig. 60).

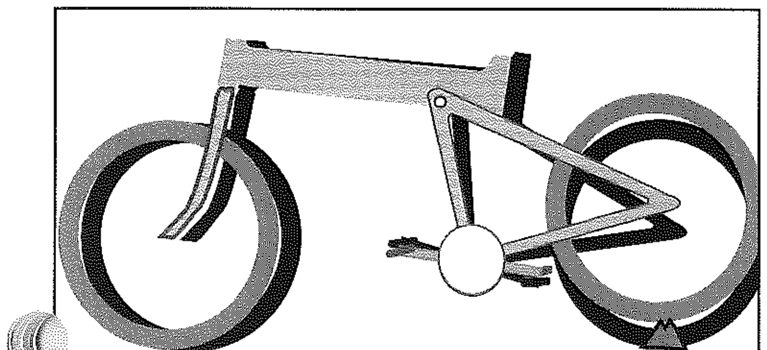
Fig. 68

This action is really an advantage. Since the bottom bracket moves less, your CG takes a smoother line and momentum is maintained. There is less deceleration over bumps and the Mantra flys. Then comes the bonus; as the Mantra pivots around its CG, the geometry changes and, the bike becomes more stable.

Standing to climb on a Mantra

Its true that as you stand, or pedal really hard while seated, that you are applying your mass to the forward part of the swingarm. In some URT systems with a very forward pivot, the rider's mass is close to the middle of the swingarm and this can almost completely overcome the suspensions ability to move upwards over a bump.

But with the Mantra, something else happens. The front end of the swing arm cannot move down, except by compressing the front fork. So the rear wheel cannot lift without lifting your weight on the BB. This makes the standing suspension very stiff so pedaling is more efficient and its also fairly easy to bunny hop.

But remember this; the suspension action of the Mantra is rarely confined to just one mode. Usually many different forces are working on the bike at once, so many of these actions occur simultaneously. In other words, although the suspension can be stiff to resists bobbing, it can also allow the rear wheel to follow the ground better at the same time, and also maintaining momentum better. This lets the Mantra scream over rough terrain, because the rider can apply full power, seated or standing with good suspension action.

Sitting on a Mantra

When on the saddle your CG is lower, and depending on your build and position on the bike, its located somewhere between and above the saddle and the handlebars. With your CG in this position, the Mantra suspension is more supple and will react to the lower forces of smaller bumps or lower speeds. Like when standing, you can move your CG forward or backward to influence the suspension action.

Different suspension for seated or standing

Some people criticize suspension systems that change between seated and standing positions. We feel that such a change is appropriate.

When you are standing, your legs and arms supply lots of suspension. And impacts will be focused on muscle tissue which can easily deal with it. In addition, when standing you tend to move your CG up and down more, or may need to do maneuvers like bunny hopping, and for this reason you need firmer suspension.

But when seated, your weight is on the saddle, and your tender underside take the brunt of any impact. It makes sense to supply a softer ride when impact force is going to be directed at soft tissue or bones instead of muscle.

Seat height change

Since your feet can more readily take more severe shocks than your butt, it is desirable to tune the saddle slightly softer than the cranks for most riding conditions, such as XC use and easy to technical trail conditions. The slightly stiffer suspension action at the cranks allows the rider to maneuver and handle the bike more readily when they need to, such as clearing obstacles or jumping the bike, yet allowing a really plush saddle action for sitting down speed action. If you have doubts about this, would you like to ride a bike where the cranks were very supple suspended and the saddle was stiffer?

New for 1999

For 99, we have completely redesigned the Mantra. There are now four sizes to fit a wider range of riders. The sizes have been matched to Klein hardtails so its easier to determine the correct Mantra size.

All 1999 Mantra models have a new swingarm in 2 sizes. The two new swingarms feature two different pivot locations for better suspension action on the Large and XL frames. The swingarm on the Small and Medium frames uses the same geometry and pivot location as all three sizes of the '98 Mantras. The swingarm also includes a Hayes type disc brake mount, and a replaceable derailleur hanger.

The rear wheel travel has been increased to 7 inches in order to provide a more supple action in the normal working range. More travel means the suspension action is better with increased overall energy capacity See Suspension Primer, pages 34-40 for more information about suspension.

We have brought back the Klein Airheadset™ system to the Mantras, further improving handling and durability.

Mantra Pivot Service

General Lubrication

The Mantra uses Teflon-impregnated bushings which do not require lubrication. Any lubrication added to the pivot is likely to attract abrasive dirt, so should be avoided. The most an owner will need to do is keep the area clean with a little water, or a mild solution of soapy water.

After a period of time, it may become necessary to replace bushings. The following indicate that the bushings need to be replaced:

1) If there is noticeable lateral movement of the swingarm. Test for this by first removing the rear wheel. Grasp the swingarm by the dropouts and try to move it back and forth across the bike's centerline. If there is noticeable play or any sound of looseness, it may indicate the bushings need replacement.

2. With the bike supported by its seatpost in a workstand, remove the rear wheel. Then remove the rear shock. Attempt to move the swingarm up and down. If the swingarm does not move smoothly and freely, the bushings may need replacement.

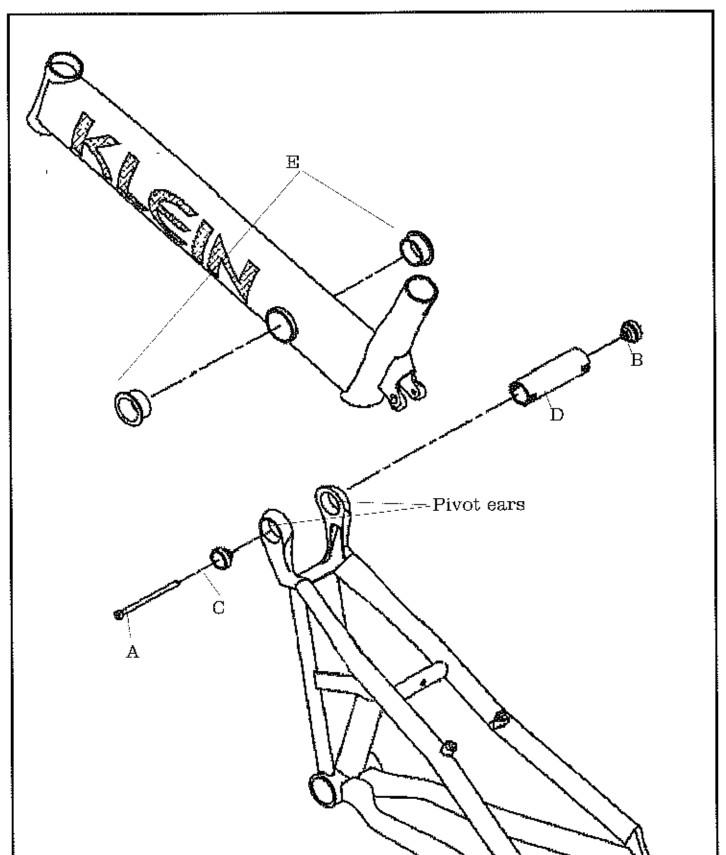

Fig. 69

All 1999 Mantras, '98 and previous Mantra Comp/Race

Removal

1. Remove the pivot nut.
2. Unscrew the pivot bolt (A) slightly and tap out the threaded pivot cone (B) as you would a stem bolt and wedge.
3. Use the pivot bolt or another similar object to tap out the remaining unthreaded pivot cone (C).
4. Carefully support the pivot ears with a vice or c-clamp.
5. Use a 1" headset removal tool and plastic mallet to drive the pivot tube (D) out of the frame and swingarm.

NOTE: FAILURE TO FULLY SUPPORT THE PIVOT EAR CAN RESULT IN FRAME DESTRUCTION.

6. The rear triangle will now separate from the main beam.
7. Drive the pivot bushings (E) from the main tube with a headset removal tool and plastic mallet.

Installation

1. Press the new pivot bushings (E) into place.
2. While carefully supporting the pivot ears, press the pivot tube into place. It may be necessary to tap the pivot tube lightly with a plastic mallet.
3. Lightly grease the contact surfaces of the pivot cones (C) and slide the pivot cones into place.
4. Using a padded vice or C clamp, squeeze the pivot ears tight against the main beam.
5. Apply a few drops of Loctite 242 (blue) to the threads of the pivot bolt.
6. Install and tighten the pivot bolt and nut. Tighten the bolt to 45-50 lb•in (5-6.7 Nm).

1996/1997 Mantra Pro

The Mantra Pro pivot is installed with a very tight interference fit. Removal/assembly will take a lot of pressure and care. At the factory we use an overhead press to achieve the necessary force.

Removal.

1. Unscrew the axle bolt (A) a few threads.
2. Carefully support the pivot ears with a carpenter's C clamp or padded vice.
3. Tap on the slightly unscrewed bolt as you would a stem bolt, to remove the threaded pivot tie (B).
4. Once the threaded pivot tie is removed, use a bolt or similar object to tap the non-threaded pivot tie (C) out the frame.

NOTE: FAILURE TO FULLY SUPPORT THE PIVOT EAR COULD RESULT IN FRAME DESTRUCTION.

5. Slide the rear triangle off the main tube.
6. Use a headset removal tool and plastic mallet to drive the pivot bushings (D) from the main tube.

Installation

1. Press the pivot bearings (D) into the main tube.
2. Align the holes in the main tube and rear triangle.
3. Press the pivot ties (A and B) into the ears. If necessary, use a plastic mallet for additional force.
4. Apply a few drops of Loctite 242 (Blue) to the axle bolt (A). With the washer on the bolt, thread through C into B..
5. Before tightening the pivot bolt, make sure the swingarm ears are in contact with the pivot bushings. If not, it may be necessary to lightly press them together in a padded vise or with a C clamp using precautions to avoid paint damage.

6) Tighten the axle bolt (A) to 45-50 lb•in (5-6.7 Nm) Allow the Loctite to cure for 24 hours before riding.

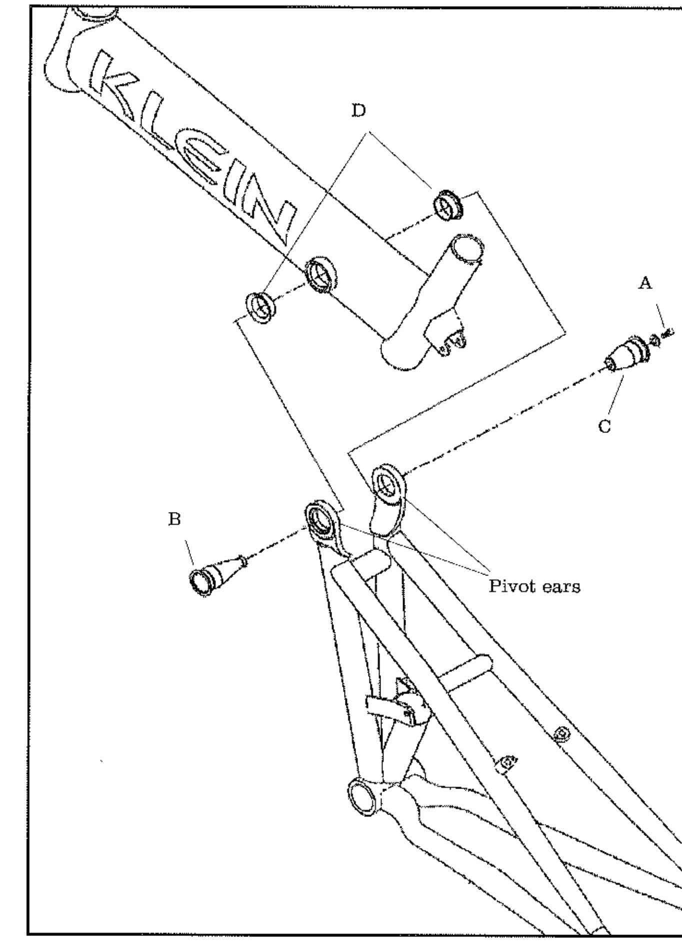

Fig. 62

Carbon Mantra Frame Specs

Rider Profile

The rider of the Carbon Mantra is the same as for the aluminum Mantra. This rider may be a cross-country racer, but is more likely a performance oriented rider of all terrains and technical difficulties. The Mantra is not designed as a Downhill bike, even though it does have loads of rear wheel travel. Instead, the Mantra offers lots of travel because the quality of the suspension action is enhanced by the additional travel.

The Mantra is more of a singletrack enthusiasts dream. Its quick, precise, and agile. Its comfortable. And the suspension really provides a rider with better control through increased handling. This is largely thanks to frame rigidity, but can also be attributed to increased traction since the tires follow the ground so well. And of course having the responsiveness of an Adroit doesn't hurt.

So what's the difference between a Carbon Mantra customer and an aluminum Mantra customer? Really its only a matter of cost and weight. If a rider is dying to have the lightest bike possible, they'll find the extra cash to get the very best- a Carbon Mantra.

Klein Feature List:

For more information, see Klein Details, pages 8-11, Spot-On Geometry, pages 41-43, and Frame Materials, page 4)

- Spot-On™ Geometry
- Airheadset™
- Reinforced Headtube/Downtube Junction
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- MicroDrops
- Klein Heat Treating
- Gradient Chainstays
- OCLV HC
- Aerospace Grade Aluminum
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

- Carbon boom
- Swingarm with size specific pivot placement
- Replaceable derailleur hanger
- Plate style (only) front derailleur attachment
- Tubeset for swingarm
- Airheadset™
- Designed for longer fork
- 4 sizes
- New geometry to match Adroit fit
- More travel
- Hayes disc mount on swingarm

Carbon Mantra Geometry

Frame size	S	M	L	XL
Head angle	71.2	71.7	71.8	71.8
Seat angle	64.6	66.1	65.1	66.4
MM				
Standover	726	738	778	791
Seattube	444	448	489	533
Headtube	105	105	125	165
Eff. top tube	573	594	610	626
Chainstay	417	417	417	417
BB height	310	315	319	323
Fork offset	38	38	38	38
Trail	74	71	70	70
Wheelbase	1042	1062	1076	1095
INCH				
Standover	28.6	29.1	30.6	31.1
Seat tube	17.5	17.6	19.3	21.0
Head tube	4.1	4.1	4.9	6.5
Eff. top tube	22.6	23.4	24.0	24.6
Chainstay	16.4	16.4	16.4	16.4
BB height	12.2	12.4	12.6	12.7
Fork offset	1.5	1.5	1.5	1.5
Trail	2.9	2.8	2.8	2.8
Wheelbase	41.0	41.8	42.4	43.1

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	39.85mm
Headset size	33.3/1.75-2.0"/39.7 ATB Airhead
Fork length	443mm
Front derailleur	Direct E-type (only) Down pull
Bottom bracket	73mm, E-type
Shock length	7.875"
Shock eye width	7/8" top and bottom
Shock eye ID	6mm
Shock stroke	2.5"
Rear wheel travel	7"
Rear hub OLD	135mm
Cable stops	3 cables
Disc brake mount	Hayes type
Bottle mounts	1 frame
Rack mounts	No

Parts list

		Part Number
Pivot axle set		68169
Bushing set		68170
Seatpost clamp		992560
Bottom bracket cable guide		963350
Replaceable derailleur hanger		991364
CCD		971753
Airhead bearings	(lower)	971604
	(upper)	971605
Airhead Top Cap (MC3)		993828
	Starfangled nut	992585
	Lower seal	971642
	Top bearing spacer	993774
	10mm spacer	992576
	5mm spacer	992575

Seatposts

With carbon Mantras DO NOT grease the seatpost. A fiberglass sleeve bonded into the carbon seat tube prevents galvanic corrosion of the seatpost and carbon, so no grease is needed, nor recommended. If grease is applied, it may be very difficult to get adequate clamping force to hold the seatpost. If you have accidentally greased a carbon Mantra frame, use a cloth with some degreaser to remove the grease, using normal caution to protect bearings and paint.

Mantras are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

Front derailleur

The new frame will only fit a plate-style, down pull front derailleur. The plate style derailleur allows us to reduce frame weight by eliminating a false 'seat tube' for a band clamp. It also is very easy to set up, and provides a measure of protection against frame damage if the chain overshifts to the inside.

Airhead

The carbon Mantra uses Klein's exclusive Airheadset™ steering system. For more information on this system and its maintenance, see Klein Details, pages 8-11 and Airheadset™/MC3 Service, pages 13-19

CCD (Chain Control Device)

To adjust the CCD, loosen the CCD attachment bolts and place the CCD plate so that there is between 0.5 and 1.0 mm clearance between the plate and any part of the chain rings, including "pickup teeth" on the sides of the chainrings. Tighten the CCD bolts to 20-25 lb•in (2.3-2.8 NM), and then rotate the cranks fully while rechecking for correct clearance. Any bottom bracket work or tightening of the right crank arm may require readjustment of the CCD plate.

Dual crown suspension forks

Dual crown, or triple clamp, suspension forks put additional stress on a bike frame applied by extra length and the extra stiffness. For this reason, triple clamp forks should not be put on any Klein other than the '98 and newer dual suspension frames.

New fork length

This new frame is designed around an 80mm travel fork, longer than earlier Mantras.

Fitting the Mantra

To best fit the Mantra frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch, and preferably slightly more. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position. Remember that the relationship between the handlebars and the saddle will change when the suspension sags. Also the saddle angle will change, since the rear sags more than the front.

Suspension set up

As important as understanding the theory behind a suspension design is knowing how to sell the suspension feel, starting with how to set it up. For most riding we recommend that the Mantras be set up with between 5 and 10mm of front fork sag, and 7-13mm of rear shock sag (measured at the shock). The net result of this sag should be around 8-10mm of bottom bracket sag.

However, when setting up a bike for a test ride, find out how much experience a rider has with full suspension. If its little, explain to the customer that you are going to show them the bike twice; once set up with little sag to mimic the feel of their non-full suspension bike.

If you set the Mantra up with lots of sag, you should explain to the customer that the Mantra design is very sensitive. Using the front brake with too much force can cause the suspension to compress and the front of the bike to dive. While this is not a problem if you are used to it, it can be a surprise to someone who isn't. Knowing what to expect will do a lot to ward off any complaints from the inexperienced rider.

After a short ride, readjust to the above recommendations. If you skip this step, you could lose a sale to someone who does not realize that plush is a benefit on suspension.

Mantra Pro

25.1lbs./11.40kg

Our Price $______

Frameset	Honeycomb carbon fiber composite
Main tubes	Honeycomb carbon fiber composite
Stays	Klein Gradient aluminum
Fork	Manitou SX-Ti w/Lok-Out, 80mm
Rear shock	Fox Air Vanilla RC air/oil, adjustable rebound, lockout lever
Headset	Klein Airhead
Handlebars	Bontrager Race Lite, 5° bend
Stem	Klein Mission Control
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano XTR RapidFire SL
Front derailleur	Shimano XTR
Rear derailleur	Shimano XTR
Front Brake	Shimano XTR V
Rear brake	Shimano XTR V
Brake levers	Integrated brake/shift
Crankset	Shimano XTR 4 arm 46/34/24
Bottom bracket	Shimano XTR, 73 x 112.5
Pedals	Time Atac Carbon, clipless, 9/16" axle
Cassette	Shimano XTR 12-34, 9spd
Chain	Shimano Dura-Ace, 108 L, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 24° Radial, 252 Rear 28° 3x/Radial, 268/250 (D/ND)
Saddle	SDG Ventura Comp, Ti/leather
Seatpost	Thomson +12° 1 piece machined
Seat binder	Alloy w/integral bolt

Wheelset	Bontrager Race Lite
Front hub	Chris King
Rear hub	Chris King
Front tire	Bontrager Revolt Super-X folding, 49/48
Rear tire	Bontrager Revolt Super-X folding, 49/48
Spokes	DT Competition 2.0/1.5, alloy nips
Tubes	Presta valve, ultra light

Additionals	1 water bottle mount, CCD, shock pump
Colors	Jade Chameleon/ Jade Chameleon fork • White logo

Bike sizes	S	M	L	XL
Rider height		67-70	70-73	73-78
Handlebar width	580	580	580	580
Stem length	90/6°	120/6°	135/6°	135/6°
Crank length	170	175	175	180
Seatpost length	290	370	370	370
Steerer length	193	193	213	253
MM Reach	655	703	733	749
Handlebar height	804	817	839	878
IN Reach	25.8	27.7	28.9	29.5
Handlebar height	31.7	32.2	33.0	34.5

Mantra Race

25.7lbs./11.67kg

Our Price $______

Frameset	Honeycomb carbon fiber composite
Main tubes	Honeycomb carbon fiber composite
Stays	Klein Gradient aluminum
Fork	Manitou SX w/Lok-Out, 80mm
Rear shock	Fox Air Vanilla R air/oil, adjustable rebound
Headset	Klein Airhead
Handlebars	Bontrager Comp II, 5° bend
Stem	Klein Mission Control
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano Deore XT RapidFire SL
Front derailleur	Shimano Deore XT
Rear derailleur	Shimano XTR
Front Brake	Shimano Deore XT V
Rear brake	Shimano Deore XT V
Brake levers	Integrated brake/shift
Crankset	Bontrager Race Lite 4 arm 44/32/22
Bottom bracket	Shimano BB-UN72E, 73 x 113
Pedals	Time Atac, clipless, 9/16" axle
Cassette	Shimano XT 11-34, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 24° Radial, 255 Rear 28° 3x/Radial, 267/251 (D/ND)
Saddle	SDG BelAir Comp, CrMo/leather
Seatpost	Thomson +12° 1 piece machined
Seat binder	Alloy w/integral bolt

Wheelset	Bontrager Race
Front tire	Bontrager Revolt ST-2, folding, 49/53
Rear tire	Bontrager Revolt ST-2, folding, 46/50
Spokes	DT Competition 2.0/1.8, alloy nips
Tubes	Presta valve, ultra light

Additionals	1 water bottle mount, CCD, shock pump
Colors	Team Gloss Black/ Red fork • Red logo

Bike sizes	S	M	L	XL
Rider height		67-70	70-73	73-78
Handlebar width	580	580	580	580
Stem length	90/6°	120/6°	135/6°	135/6°
Crank length	170	175	175	175
Seatpost length	290	370	370	370
Steerer length	193	193	213	253
MM Reach	655	703	733	749
Handlebar height	804	817	839	873
IN Reach	25.8	27.7	28.9	29.5
Handlebar height	31.7	32.2	33.0	34.4

Aluminum Mantra Frame Specs

Rider Profile

This rider may be a cross-country racer, but is more likely a performance oriented rider of all terrains and technical difficulties. The Mantra is not designed as a Downhill bike, even though it does have loads of rear wheel travel. Instead, the Mantra offers lots of travel because the quality of the suspension action is enhanced by the additional travel.

The Mantra is more of a singletrack enthusiasts dream. Its quick, precise, and agile. Its comfortable. And the suspension really provides a rider with better control through increased handling. This is largely thanks to frame rigidity, but can also be attributed to increased traction since the tires follow the ground so well. And of course having the responsiveness of an Adroit doesn't hurt.

Klein Feature List:

For more information, see Klein Details, pages 8-11, Spot-On Geometry, pages 41-43, and Frame Materials, page 4)

- Reinforced Headtube/Downtube Junction
- Spot-On™ Geometry
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- Gradient Seat Tube
- Klein Seatstays
- MicroDrops
- Klein Heat Treating
- Aerospace Grade Tubing
- Gradient Chainstays
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

- Swingarm with size specific pivot placement
- Replaceable derailleur hanger
- Plate style (only) front derailleur attachment
- New tubeset for swingarm
- Designed for longer fork
- 4 sizes
- New geometry to match Adroit fit
- Changed cable routing
- More travel
- Hayes disc mount on swingarm

Aluminum Mantra Geometry

Frame size	S	M	L	XL
Head angle	71.2	71.7	71.8	71.8
Seat angle	64.6	66.1	65.1	66.4
MM				
Standover	726	738	778	791
Seattube	444	448	489	533
Headtube	105	105	125	165
Eff. top tube	573	594	610	626
Chainstay	417	417	417	417
BB height	310	315	319	323
Fork offset	38	38	38	38
Trail	74	71	70	70
Wheelbase	1042	1062	1076	1095
INCH				
Standover	28.6	29.1	30.6	31.1
Seat tube	17.5	17.6	19.3	21.0
Head tube	4.1	4.1	4.9	6.5
Eff. top tube	22.6	23.4	24.0	24.6
Chainstay	16.4	16.4	16.4	16.4
BB height	12.2	12.4	12.6	12.7
Fork offset	1.5	1.5	1.5	1.5
Trail	2.9	2.8	2.8	2.8
Wheelbase	41.0	41.8	42.4	43.1

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	37.4mm
Headset size	25.4/34.0/30.0
Fork length	443mm
Front derailleur	Direct E-type (only) Down pull
Bottom bracket	73mm, E-type
Shock length	7.875"
Shock eye width	7/8" top and bottom
Shock eye ID	6mm
Shock stroke	2.5"
Rear wheel travel	7"
Rear hub OLD	135mm
Cable stops	3 cables
Disc brake mount	Hayes type
Bottle mounts	1 frame
Rack mounts	No

Parts list

	Part Number
Pivot axle set	68169
Bushing set	68170
Seatpost clamp with bolt	972756
Bottom bracket cable guide	963350
Replaceable derailleur hanger	991364
CCD	971753

Seatposts

Mantras are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation. The seatpost should be lubricated with a thin layer of grease to prevent is from seizing in the frameset.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

Front derailleur

The new frame will only fit a plate-style, down pull front derailleur. The plate style derailleur allows us to reduce frame weight by eliminating a false 'seat tube' for a band clamp. It also is very easy to set up, and provides a measure of protection against frame damage if the chain overshifts to the inside.

CCD (Chain Control Device)

To adjust the CCD, loosen the CCD attachment bolts and place the CCD plate so that there is between 0.5 and 1.0 mm clearance between the plate and any part of the chain rings, including "pickup teeth" on the sides of the chainrings. Tighten the CCD bolts to 20-25 lb•in (2.3-2.8 NM), and then rotate the cranks fully while rechecking for correct clearance. Any bottom bracket work or tightening of the right crank arm may require readjustment of the CCD plate.

Dual crown suspension forks

Dual crown, or triple clamp, suspension forks put additional stress on a bike frame applied by extra length and the extra stiffness. For this reason, triple clamp forks should not be put on any Klein other than the '98 and newer dual suspension frames.

New fork length

This new frame is designed around an 80mm travel fork, longer than earlier Mantras.

Fitting the Mantra

To best fit the Mantra frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch, and preferably slightly more. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position. Remember that the relationship between the handlebars and the saddle will change when the suspension sags. Also the saddle angle will change, since the rear sags more than the front.

Suspension set up

As important as understanding the theory behind a suspension design is knowing how to sell the suspension feel, starting with how to set it up. For most riding we recommend that the Mantras be set up with between 5 and 10mm of front fork sag, and 7-13mm of rear shock sag (measured at the shock). The net result of this sag should be around 8-10mm of bottom bracket sag.

However, when setting up a bike for a test ride, find out how much experience a rider has with full suspension. If its little, explain to the customer that you are going to show them the bike twice; once set up with little sag to mimic the feel of their non-full suspension bike.

If you set the Mantra up with lots of sag, you should explain to the customer that the Mantra design is very sensitive. Using the front brake with too much force can cause the suspension to compress and the front of the bike to dive. While this is not a problem if you are used to it, it can be a surprise to someone who isn't. Knowing what to expect will do a lot to ward off any complaints from the inexperienced rider.

After a short ride, readjust to the above recommendations. If you skip this step, you could lose a sale to someone who does not realize that plush is a benefit on suspension.

Mantra Comp

26.8lbs./12.17kg

Our Price $______

Frameset	Klein Gradient aluminum
Main tubes	Klein Power tubing
Stays	Klein Gradient aluminum
Fork	Manitou SX w/Lok-Out, 80mm
Rear shock	Fox Air Vanilla R air/oil, adjustable rebound
Headset	Dia-Compe SA Aheadset, alloy
Handlebars	Bontrager Crowbar Comp, 9° bend, 40mm rise
Stem	Bontrager Race AHS, direct connect
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano Deore LX RapidFire+
Front derailleur	Shimano Deore LX
Rear derailleur	Shimano XTR
Front Brake	Avid Single Digit 20, direct pull
Rear brake	Avid Single Digit 20, direct pull
Brake levers	Avid SD-1.9 L, long pull
Crankset	Shimano Deore LX 4 arm 44/32/22
Bottom bracket	Shimano BB-UN52E, 73 x 113
Pedals	Bontrager RE-1, clipless, 9/16" axle
Cassette	Shimano HG70 11-32, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 24° Radial, 255 Rear 28° 3x/Radial, 267/251 (D/ND)
Saddle	SDG BelAir Comp, CrMo rails
Seatpost	Thomson +12° 1 piece machined
Seat binder	Alloy w/quick release
Wheelset	Bontrager Race
Front tire	Bontrager Revolt ST-2, folding, 49/53
Rear tire	Bontrager Revolt ST-2, folding, 46/50
Spokes	DT Competition 2.0/1.8, alloy nips
Tubes	Presta valve, ultra light
Additionals	1 water bottle mount, CCD, shock pump
Colors	Light Blue /Dark Blue linear fade / Black rear/ Blue fork • White logo

Bike sizes	S	M	L	XL
Rider height	64-67	67-70	70-73	73-78
Handlebar width	630	630	630	630
Stem length	105/7°	120/7°	135/7°	135/7°°
Crank length	170	175	175	175
Seatpost length	290	370	370	370
Steerer length	193	193	213	253
MM Reach	668	702	732	748
Handlebar height	851	859	880	914
IN Reach	26.3	27.7	28.8	29.5
Handlebar height	33.5	33.8	34.7	36.0

Mantra

27.9lbs./12.67kg

Our Price $______

Frameset	Klein Gradient aluminum
Main tubes	Klein Power tubing
Stays	Klein Gradient aluminum
Fork	Manitou SX-E, 80mm
Rear shock	Fox Air Vanilla air/oil
Headset	Dia-Compe ST Aheadset
Handlebars	Bontrager Crowbar Comp, 9° bend, 40mm rise
Stem	Bontrager Race AHS, direct connect
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano Deore LX RapidFire+
Front derailleur	Shimano Deore LX
Rear derailleur	Shimano Deore XT SGS
Front Brake	Avid Single Digit 10, direct pull
Rear brake	Avid Single Digit 10, direct pull
Brake levers	Avid AD-1.0 L, long pull
Crankset	Shimano Deore LX 4 arm 44/32/22
Bottom bracket	Shimano BB-UN52E, 73 x 113
Pedals	Bontrager RE-1, clipless, 9/16" axle
Cassette	Shimano HG70 11-32, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 28° Radial, 254 Rear 32° 3x, 264/265 (D/ND)
Saddle	SDG Ventura Comp, Cro-Moly rails
Seatpost	SP-312 alloy micro-adjust
Seat binder	Alloy w/quick release
Front rim	Bontrager Corvair
Rear rim	Bontrager Corvair ASYM
Front hub	Bontrager Comp II
Rear hub	Bontrager Comp II
Front tire	Bontrager Jones, folding, 49/53
Rear tire	Bontrager Jones, folding, 46/50
Spokes	DT 15G stainless
Tubes	Presta valve, ultra light
Additionals	1 water bottle mount, CCD, shock pump
Colors	Silver Cloud/ Black fork • Black/Red logo

Bike sizes	S	M	L	XL
Rider height	64-67	67-70	70-73	73-78
Handlebar width	630	630	630	630
Stem length	90/7°	105/7°	120/7°	135/7°
Crank length	170	175	175	175
Seatpost length	320	370	370	370
Steerer length	192	192	212	252
MM Reach	654	689	719	748
Handlebar height	843	850	872	912
IN Reach	25.7	27.1	28.3	29.5
Handlebar height	33.2	33.5	34.3	35.9

Adroit Frame Specs

Rider Profile

The Adroit is designed to be the ultimate cross country racing bike. It is one of the lightest fuselages (frame/fork/headset/stem) on the planet. Even so, it offers incredible frame stiffness for point-and-shoot handling precision.

With such precise handling, the Adroit is also a great singletrack machine, and its low weight makes it easier for riders to handle technical terrain.

Like other Klein bikes, the Adroit is jam packed with features which enhance its usability. Lots of tire clearance, well designed fit, and incredibly artistic paint schemes all go to making this the ultimate hardtail.

Klein Feature List:

(for more information, see Klein Details, pages 8-11, and Frame Materials, page 4)

- Airheadset™
- Internal Cable Routing
- Reinforced Headtube/Downtube Junction
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- Gradient Seat Tube
- Klein Seatstays
- MicroDrops
- Klein Heat Treating
- Aerospace Grade Tubing
- Gradient Chainstays
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

- Revised Airheadset™
- Replaceable derailleur hanger
- Designed for longer fork
- Hayes disc mount on chainstay

Adroit Geometry

Frame size	XS	S	M	L	XL
Head angle	70.7	71.2	71.7	71.8	71.8
Seat angle	73.2	73.2	73.2	73.2	73.2
MM					
Standover	669	703	735	772	814
Seattube	356	400	445	489	533
Headtube	90	105	105	125	165
Eff. top tube	550	573	594	610	626
Chainstay	417	417	417	417	417
BB height	287	292	297	300	302
Fork offset	38	38	38	38	38
Trail	77	74	71	70	70
Wheelbase	1014	1035	1053	1069	1087
INCH					
Standover	26.3	27.7	28.9	30.4	32.0
Seat tube	14.0	15.7	17.5	19.3	21.0
Head tube	3.5	4.1	4.1	4.9	6.5
Eff. top tube	21.7	22.6	23.4	24.0	24.6
Chainstay	16.4	16.4	16.4	16.4	16.4
BB height	11.3	11.5	11.7	11.8	11.9
Fork offset	1.5	1.5	1.5	1.5	1.5
Trail	3.0	2.9	2.8	2.8	2.8
Wheelbase	39.9	40.7	41.5	42.1	42.8

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	33.3/1.75-2.0"/39.7 ATB Airhead
Fork length	432mm
Front derailleur	34.9mm Down pull
Bottom bracket	73mm
Rear hub OLD	135mm
Cable stops	3 cables
Disc brake mount	Hayes type
Bottle mounts	3 frame
Rack mounts	No

Parts list

	Part Number
Seatpost clamp	970605
Bottom bracket cable guide	963350
Replaceable derailleur hanger	991364
CCD	971753
Airhead bearings (lower)	971604
(upper)	971605
Airhead Top plug (MC3)	992583
Starfangled nut	992585
Lower seal	971642
Top bearing spacer	992580
10mm spacer	992576
5mm spacer	992575

Seatposts

Mantras are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation. The seatpost should be lubricated with a thin layer of grease to prevent is from seizing in the frameset.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

Internal Cable Routing

The Adroit features Klein's exclusive internal cable routing. For a detailed discussion, see Klein Details, pages 8-11.

To install the original cable set, or a new cable, follow these instructions:

1) Insert the cable sleeves into the forward cable entry holes with the 'mushroom' head last.

2) Guide the cable sleeve through the exit hole by rotating the sleeve until it aligns with the hole. If needed, create a slight bend in the sleeve at its step to encourage it to set into the exit hole at the right time.

3) Once the 'mushroom' is seated in the housing stop, cut the sleeve so that it extends about one inch (25mm) past the exit hole. This is to protect the paint from cable rub.

4) Insert the cable as normal. No lubrication of the cable is needed, nor recommended.

CCD (Chain Control Device)

To adjust the CCD, loosen the CCD attachment bolts and place the CCD plate so that there is between 0.5 and 1.0 mm clearance between the plate and any part of the chain rings, including "pickup teeth" on the sides of the chainrings. Tighten the CCD bolts to 20-25 lb•in (2.3-2.8 NM), and then rotate the cranks fully while rechecking for correct clearance. Any bottom bracket work or tightening of the right crank arm may require readjustment of the CCD plate.

Dual crown suspension forks

Dual crown, or triple clamp, suspension forks put additional stress on a bike frame applied by extra length and the extra stiffness. For this reason, triple clamp forks should not be put on any Klein other than the '98 and newer dual suspension frames. Do not install dual crown forks on a Klein Adroit frame.

Airheadset™

The Adroit uses Klein's exclusive Airheadset™. For more information on this system and its maintenance, see Klein Details, page 8-11 and Airheadset™/MC3 Service, pages 13-19

Front derailleur

The Adroit uses a high performance Gradient seat tube, which is very thin to eliminate unnecessary weight. Do not tighten the front derailleur clamp bolt more than 20 lb•in (2.3 NM) to avoid damaging the derailleur or frame.

New fork length

This new frame is designed around an 70mm travel fork, longer than earlier Adroits.

Fitting the Adroit

To best fit the Adroit frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch, and preferably slightly more. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position.

Adroit Pro

22.6lbs./10.26kg

Our Price $________

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Gradient aluminum
Fork	Manitou SX Carbon w/Lok-Out, 70mm
Headset	Klein Airhead
Handlebars	Bontrager Race Lite, 5° bend
Stem	Klein Mission Control
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano XTR RapidFire SL
Front derailleur	Shimano XTR
Rear derailleur	Shimano XTR
Front Brake	Shimano XTR V
Rear brake	Shimano XTR V
Brake levers	Integrated brake/shift
Crankset	Shimano XTR 4 arm 46/34/24
Bottom bracket	Shimano XTR, 73 x 112.5
Pedals	Time Atac Carbon, clipless, 9/16" axle
Cassette	Shimano XTR 12-34, 9spd
Chain	Shimano Dura-Ace, 108 L, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 20° Radial, 250 Rear 24° 2x, 261/260 (D/ND)
Saddle	SDG BelAir Comp, Ti/leather
Seatpost	Thomson 1 piece machined
Seat binder	Alloy w/integral bolt

Wheelset	Rolf Propel XC
Front hub	Rolf/ Hugi
Rear hub	Rolf/ Hugi
Front tire	Bontrager Revolt Super-X folding, 49/48
Rear tire	Bontrager Revolt Super-X folding, 49/48
Tubes	Presta valve, ultra light

Additionals	3 water bottle mounts, CCD
Colors	Red/Yellow/White fade/ Red/Yellow fork • White/Red/Yellow logo

Bike sizes	XS	S	M	L	XL
Rider height	60-64	64-67	67-70	70-73	73-78
Handlebar width	580	580	580	580	580
Stem length	90/6°	105/6°	120/6°	135/6°	135/6°
Crank length	170	175	175	175	180
Seatpost length	250	330	330	330	330
Steerer length	178	193	193	213	253
MM Reach	631	668	703	733	749
Handlebar height	802	824	826	848	889
IN Reach	24.9	26.3	27.7	28.9	29.5
Handlebar height	31.6	32.4	32.5	33.4	35.0

Adroit Race

23.8lbs./10.81kg

Our Price $________

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Gradient aluminum
Fork	Manitou SX-R w/Lok-Out, 70mm
Headset	Klein Airhead
Handlebars	Bontrager Race Lite, 5° bend
Stem	Klein Mission Control
Bar ends	-
Grips	Bontrager dual density
Shifters	Shimano Deore XT RapidFire SL
Front derailleur	Shimano Deore XT
Rear derailleur	Shimano XTR
Front Brake	Shimano Deore XT V
Rear brake	Shimano Deore XT V
Brake levers	Integrated brake/shift
Crankset	Bontrager Race Lite 4 arm 44/32/22
Bottom bracket	Shimano BB-UN72, 73 x 110
Pedals	Time Atac, clipless, 9/16" axle
Cassette	Shimano XT 11-34, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 22mm
Spoke lengths	Front 24° Radial, 252 Rear 28° 3x/Radial, 268/250 (D/ND)
Saddle	SDG BelAir Comp, CrMo
Seatpost	Bontrager Race Lite
Seat binder	Alloy w/integral bolt

Wheelset	Bontrager Race Lite
Front hub	Chris King
Rear hub	Chris King
Front tire	Bontrager Revolt Super-X folding, 49/48
Rear tire	Bontrager Revolt Super-X folding, 49/48
Spokes	DT Competition 2.0/1.5, alloy nips
Tubes	Presta valve, ultra light

Additionals	3 water bottle mounts, CCD
Colors	Jade Chameleon/ Black fork • Black/White logo

Bike sizes	XS	S	M	L	XL
Rider height	60-64	64-67	67-70	70-73	73-78
Handlebar width	580	580	580	580	580
Stem length	90/6°	105/6°	120/6°	135/6°	135/6°
Crank length	170	175	175	175	175
Seatpost length	300	390	390	390	390
Steerer length	178	193	193	213	253
MM Reach	631	668	703	733	749
Handlebar height	802	824	826	848	884
IN Reach	24.9	26.3	27.7	28.9	29.5
Handlebar height	31.6	32.4	32.5	33.4	34.8

Attitude Frame Specs

Rider Profile

The Attitude shares many of the design features of the Adroit, which is designed to be the ultimate cross country racing bike. It also shares much of the frame tubing, with the exception of internal cable routing, Airheadset™, and the Attitude uses a top pull front derailleur.

With the same precise handling as the Adroit, the Attitude is a great singletrack machine, and its low weight makes it easy for riders to handle technical terrain.

Klein Feature List:

(for more information, see Klein Details, pages 8-11, and Frame Materials, page 4)

- Reinforced Headtube/Downtube Junction
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- Gradient Seat Tube
- Klein Seatstays
- MicroDrops
- Klein Heat Treating
- Aerospace Grade Tubing
- Gradient Chainstays
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

- Top-route cables
- Replaceable derailleur hanger
- Designed for longer fork
- Hayes disc mount on swingarm

Attitude Geometry

Frame size	XS	S	M	L	XL
Head angle	70.7	71.2	71.7	71.8	71.8
Seat angle	73.2	73.2	73.2	73.2	73.2
MM					
Standover	684	703	735	772	814
Seattube	396	420	445	484	533
Headtube	90	105	105	125	165
Eff. top tube	550	573	594	610	626
Chainstay	417	417	417	417	417
BB height	287	292	297	300	302
Fork offset	38	38	38	38	38
Trail	77	74	71	70	70
Wheelbase	1014	1035	1052	1059	1087
INCH					
Standover	26.9	27.7	28.9	30.4	32.0
Seat tube	15.6	16.5	17.5	19.1	21.0
Head tube	3.5	4.1	4.1	4.9	6.5
Eff. top tube	21.7	22.6	23.4	24.0	24.6
Chainstay	16.4	16.4	16.4	16.4	16.4
BB height	11.3	11.5	11.7	11.8	11.9
Fork offset	1.5	1.5	1.5	1.5	1.5
Trail	3.0	2.9	2.8	2.8	2.8
Wheelbase	39.9	40.7	41.4	41.7	42.8

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	25.4/34.0/30.0
Fork length	432mm
Front derailleur	34.9mm Top pull
Bottom bracket	73mm
Rear hub OLD	135mm
Cable stops	3 cables
Disc brake mount	Hayes type
Bottle mounts	3 frame
Rack mounts	No

Parts list

	Part Number
Seatpost clamp	970605
Bottom bracket cable guide	963350
Replaceable derailleur hanger	991364
CCD	971753

Seatposts

Attitudes are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation. The seatpost should be lubricated with a thin layer of grease to prevent is from seizing in the frameset.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

CCD (Chain Control Device)

To adjust the CCD, loosen the CCD attachment bolts and place the CCD plate so that there is between 0.5 and 1.0 mm clearance between the plate and any part of the chain rings, including "pickup teeth" on the sides of the chainrings. Tighten the CCD bolts to 20-25 lb•in (2.3-2.8 NM), and then rotate the cranks fully while rechecking for correct clearance. Any bottom bracket work or tightening of the right crank arm may require readjustment of the CCD plate.

Dual crown suspension forks

Dual crown, or triple clamp, suspension forks put additional stress on a bike frame applied by extra length and the extra stiffness. For this reason, triple clamp forks should not be put on any Klein other than the '98 and newer dual suspension frames. Do not install dual crown forks on a Klein Attitude frame.

Front derailleur

The Attitude uses a high performance Gradient seat tube, which is very thin to eliminate unnecessary weight. Do not tighten the front derailleur clamp bolt more than 20 lb•in (2.3 NM) to avoid damaging the derailleur or frame.

New fork length

This new frame is designed around an 70mm travel fork, longer than earlier Attitudes.

Fitting the Attitude

To best fit the Attitude frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch, and preferably slightly more. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position.

Attitude Race

24.0lbs./10.90kg

Our Price $______

Frameset Klein Gradient aluminum

Main tubes Klein Power tubing
Stays Klein Gradient aluminum
Fork Manitou SX w/Lok-Out, 70mm

Headset Dia-Compe SA Aheadset, alloy
Handlebars Bontrager Race, 5° bend
Stem Bontrager Race AHS, direct connect
Bar ends -
Grips Bontrager dual density
Shifters Shimano Deore LX RapidFire+
Front derailleur Shimano Deore LX
Rear derailleur Shimano XTR
Front Brake Avid Single Digit 20, direct pull
Rear brake Avid Single Digit 20, direct pull
Brake levers Avid SD-1.9 L, long pull
Crankset Shimano Deore LX 4 arm 44/32/22
Bottom bracket Shimano BB-UN52, 73 x 113
Pedals Bontrager RE-1, clipless, 9/16" axle
Cassette Shimano HG70 11-32, 9spd
Chain Shimano HG72, 108 length, 9 speed
Rim strips Velox 22mm
Spoke lengths Front 24° Radial, 255
Rear 28° 3x/Radial, 267/251 (D/ND)
Saddle SDG BelAir Comp, CrMo/leather
Seatpost Bontrager Comp
Seat binder Alloy w/integral bolt

Wheelset Bontrager Race
Front tire Bontrager Revolt ST-2, folding, 49/53
Rear tire Bontrager Revolt ST-2, folding, 46/50
Spokes DT Competition 2.0/1.8, alloy nips
Tubes Presta valve, ultra light

Additionals 3 water bottle mounts, CCD, seat post QR

Colors Team Gloss black/ Red chainstay/ Red fork • White/Red logo

Bike sizes	XS	S	M	L	XL
Rider height	60-64	64-67	67-70	70-73	73-78
Handlebar width	580	580	580	580	580
Stem length	90/7°	105/7°	120/7°	120/7°	135/7°
Crank length	170	175	175	175	175
Seatpost length	320	370	370	370	370
Steerer length	178	193	193	213	253
MM Reach	631	668	702	719	748
Handlebar height	804	826	828	845	887
IN Reach	24.8	26.3	27.7	28.3	29.5
Handlebar height	31.7	32.5	32.6	33.2	34.9

Attitude Comp

25.6lbs./11.62kg

Our Price $______

Frameset Klein Gradient aluminum

Main tubes Klein Power tubing
Stays Klein Gradient aluminum
Fork Manitou SX-E, 70mm

Headset Dia-Compe ST Aheadset
Handlebars Bontrager Crowbar Race Modified, 9° bend, 40mm rise
Stem Bontrager Race AHS, direct connect
Bar ends -
Grips Bontrager Race
Shifters Shimano Deore LX RapidFire+
Front derailleur Shimano Deore LX
Rear derailleur Shimano Deore XT SGS
Front Brake Avid Single Digit 10, direct pull
Rear brake Avid Single Digit 10, direct pull
Brake levers Avid AD-1.0 L, long pull
Crankset Shimano Deore LX 4 arm 44/32/22
Bottom bracket Shimano BB-UN52, 73 x 113
Pedals Bontrager RE-1, clipless, 9/16" axle
Cassette Shimano HG70 11-32, 9spd
Chain Shimano HG72, 108 length, 9 speed
Rim strips Velox 22mm
Spoke lengths Front 28° Radial, 254
Rear 32° 3x, 264/265 (D/ND)
Saddle SDG Ventura Comp, CrMo rails
Seatpost SP-312 alloy micro-adjust
Seat binder Alloy w/quick release

Front rim Bontrager Corvair
Rear rim Bontrager Corvair ASYM
Front hub Bontrager Comp II
Rear hub Bontrager Comp II
Front tire Bontrager Jones, folding, 49/53
Rear tire Bontrager Jones, folding, 46/50
Spokes DT 15G stainless
Tubes Presta valve, ultra light

Additionals 3 water bottle mounts, CCD

Colors Light Blue to Dark Blue linear fade/ Blue fork • White/Red logo

Bike sizes	XS	S	M	L	XL
Rider height	60-64	64-67	67-70	70-73	73-78
Handlebar width	630	630	630	630	630
Stem length	90/7°	105/7°	120/7°	120/7°	135/7°
Crank length	170	175	175	175	175
Seatpost length	320	370	370	370	370
Steerer length	175	191	191	210	250
MM Reach	631	668	702	719	748
Handlebar height	840	862	864	881	923
IN Reach	24.8	26.3	27.7	28.3	29.5
Handlebar height	33.1	33.9	34.0	34.7	36.3

Quantum Pro Frame Specs

Rider Profile

The Quantum Pro is probably the lightest fuselage (combination of frame, fork, headset, and stem) on the planet. Even so, it offers an incredible level of performance. Many ultra-light bikes lack frame rigidity and can be whippy. The Quantum, on the other hand, has the kind of frame rigidity and drivetrain efficiency that will satisfy even the biggest and most powerful riders.

With all that stiffness, is the Quantum uncomfortable? Gary Klein has worked for years to milk the highest level of performance from aluminum frames. One of the results of Gary's experience is an incredibly silky ride from a laterally rigid frame. Its one of a kind. Its no wonder that when the Once team rode Klein bikes, they were happy with totally stock Quantum frames.

That statement should also tell you that the Quantum Pro is an incredible racing machine, suitable for European stage racing, or American criteriums. And since Gary engineered comfort into such a high performance machine, the Quantum also works for the recreational go-fast rider or club century rider looking for a PR.

Klein Feature List:

(for more information, see Klein Details, pages 8-11, and Frame Materials, page 4)

- Airheadset™
- Internal Cable Routing
- Reinforced Headtube/Downtube Junction
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- Gradient Seat Tube
- Klein Aeros carbon fiber composite fork
- Klein Seatstays
- MicroDrops
- Klein Heat Treating
- Aerospace Grade Tubing
- Gradient Chainstays
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

- Revised Airheadset™

Quantum Pro Geometry

Frame size	51	53	55	57	59	61	63
Head angle	73.5	73.5	73.5	74.0	74.0	74.0	74.0
Seat angle	74.0	74.0	74.0	74.0	74.0	74.0	74.0
MM							
Standover	757	777	800	823	843	866	884
Seattube	539	559	571	597	616	635	648
Headtube	90	113	135	156	179	201	221
Eff. top tube	535	547	559	571	583	595	607
Chainstay	414	414	414	414	414	414	414
BB height	267	267	272	274	277	279	279
Fork offset	38	38	38	38	38	38	38
Trail	61	61	61	58	58	58	58
Wheelbase	975	987	1000	1008	1023	1033	1046
INCH							
Standover	29.8	30.6	31.5	32.4	33.2	34.1	34.8
Seat tube	21.2	22.0	22.5	23.5	24.3	25.0	25.5
Head tube	3.5	4.4	5.3	6.1	7.0	7.9	8.7
Eff. top tube	21.1	21.5	22.0	22.5	23.0	23.4	23.9
Chainstay	16.3	16.3	16.3	16.3	16.3	16.3	16.3
BB height	10.5	10.5	10.7	10.8	10.9	11.0	11.0
Fork offset	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Trail	2.4	2.4	2.4	2.3	2.3	2.3	2.3
Wheelbase	38.4	38.9	39.4	39.7	40.3	40.7	41.2

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	27.0/1.75-1.5"/33.4 Road Airhead
Fork length	390mm
Front derailleur	Braze-on type w/ 34.9mm clamp Down pull
Bottom bracket	68mm
Rear hub OLD	130mm
Cable stops	Internal cables
Bottle mounts	2 frame
Rack mounts	No

Parts list

	Part Number
Seatpost clamp	970605
Bottom bracket cable guide	963350
STI lever barrel adjusters	972589
Downtube barrel adjusters	69158
Airhead MC3 Top plug	992584
Top bearing spacer	992581
10mm spacer	992578
5mm spacer	992577
Lower seal	971664
Lower bearing	971605
Upper bearing	971641

Shift cable barrel adjusters

Klein road bikes with internally routed shift cables share a unique feature. Not only does the internal routing look beautiful and keep the cables out of the environment, the frame holes actually ADD strength and fatigue resistance. However, this style of cable routing does not provide for placement of the Shimano downtube barrel adjusters. So we've come up with a better way- put the adjusters on the shifters, where they are more easily accessed (but we also put some barrel adjusters in the frame, just in case).

Seatposts

Quantums are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation. The seatpost should be lubricated with a thin layer of grease to prevent is from seizing in the frameset.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

Internal Cable Routing

The Quantum features Klein's exclusive internal cable routing. For a detailed discussion, see Klein Details, pages 8-11.

To install the original cable set, or a new cable, follow these instructions:

1) Insert the cable sleeves into the forward cable entry holes with the 'mushroom' head last.

2) Guide the cable sleeve through the exit hole by rotating the sleeve until it aligns with the hole. If needed, create a slight bend in the sleeve at its step to encourage it to set into the exit hole at the right time.

3) Once the 'mushroom' is seated in the housing stop, cut the sleeve so that it extends about one inch (25mm) past the exit hole. This is to protect the paint from cable rub.

4) Insert the cable as normal. No lubrication of the cable is needed, nor recommended.

Front derailleur

The Quantum uses a high performance Gradient seat tube, which is very thin to eliminate unnecessary weight. Do not tighten the front derailleur clamp bolt more than 20 lb•in (2.3 NM) to avoid damaging the

Airhead

The Quantum Pro uses Klein's exclusive Airheadset™. For more information on this system and its maintenance, see Klein Details, pages 8-11 and Airheadset™/MC3 Service, pages 13-19.

Fitting the Quantum Pro

To best fit the Quantum Pro frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position.

Quantum Pro

18.1lbs./8.22kg

Our Price $________

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Power tubing
Fork	Klein Aeros Carbon
Headset	Klein Airhead
Handlebars	ICON Stash Ergo, 7075 aluminum
Stem	Klein Mission Control
Grips	ICON Powercork
Shifters	Shimano Dura-Ace STI
Front derailleur	Shimano Dura-Ace
Rear derailleur	Shimano Dura-Ace
Front Brake	Shimano Dura-Ace
Rear brake	Shimano Dura-Ace
Brake levers	Integrated brake/shift
Crankset	Shimano Dura-Ace 53/39
Bottom bracket	Shimano Ultegra, 68 x 109.5
Pedals	Shimano Dura-Ace SPD-R, clipless, 9/16" axle
Cassette	Shimano Dura-Ace 12-23, 9 spd
Chain	Shimano Dura-Ace, 108 L, 9 speed
Rim strips	Velox 16mm
Spoke lengths	Front 14° Radial, 280 Rear 16° 1x, 286/284 (D/ND)
Saddle	Giro Fi'zi:k Pave, Ti/leather
Seatpost	Thomson 1 piece machined
Seat binder	Alloy w/integral bolt

Wheelset	Rolf Vector Pro
Front hub	Rolf/ Hugi
Rear hub	Rolf/ Hugi
Front tire	Continental Grand Prix 3000 folding, 700 x 25c
Rear tire	Continental Grand Prix 3000 folding, 700 x 25c
Spokes	DT Blades, locking alloy nips
Tubes	Presta valve, 48mm stem
Additionals	2 water bottle mounts
Colors	Silver Cloud • Silver/Red logo

Bike sizes	51	53	55	57	59	61	63
Rider height	62-64	64-66	66-68	68-71	71-73	73-75	75-77
Handlebar width	420	420	440	440	440	460	460
Stem length	70/7°	90/7°	110/0°	110/0°	120/0°	120/0°	130/0°
Crank length	170	170	172.5	172.5	172.5	175	175
Seatpost length	250	250	250	250	250	250	250
Steerer length	176	197	220	240	262	284	304
MM Reach	599	630	664	677	698	710	732
Handlebar height	790	820	834	852	874	896	918
IN Reach	23.6	24.8	26.2	26.6	27.5	28.0	28.8
Handlebar height	31.1	32.3	32.8	33.6	34.4	35.3	36.1

Quantum Frame Specs

Rider Profile

The Quantum shares most of the frame features of the Quantum Pro, except the Airheadset™. As such, it offers an incredible level of performance. Many ultra-light bikes lack frame rigidity and can be whippy. The Quantum, on the other hand, has the kind of frame rigidity and drive-train efficiency that will satisfy even the biggest riders.

With all that stiffness, is the Quantum uncomfortable? Gary Klein has worked for years to milk the highest level of performance from aluminum frames. Part of Gary's experience is an incredibly silky ride from a laterally rigid frame. Its one of a kind racing machine, suitable for European stage racing, or American criteriums. And since Gary engineered comfort into such a high performance machine, the Quantum also works for the recreational go-fast rider or club century rider looking for a PR.

Klein Feature List:

(for more information, see Klein Details, pages 8-11, and Frame Materials, page 4)

- Reinforced Headtube/Downtube Junction
- Gradient and Power Tubing
- Large Diameter Frame Tubing
- Gradient Seat Tube
- Klein Seatstays
- MicroDrops
- Klein Heat Treating
- Aerospace Grade Tubing
- Gradient Chainstays
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

New for 1999

Quantum Pro level tubeset

Quantum Geometry

Frame size	51	53	55	57	59	61	63
Head angle	73.5	73.5	73.5	74.0	74.0	74.0	74.0
Seat angle	74.0	74.0	74.0	74.0	74.0	74.0	74.0
MM							
Standover	757	777	800	823	843	866	884
Seattube	539	559	571	597	616	635	648
Headtube	91	113	136	157	181	201	221
Eff. top tube	535	547	559	571	583	595	607
Chainstay	414	414	414	414	414	414	414
BB height	267	267	272	274	277	279	279
Fork offset	47	47	43	43	43	43	43
Trail	51	51	56	53	53	53	53
Wheelbase	975	987	1000	1008	1023	1033	1046
INCH							
Standover	29.8	30.6	31.5	32.4	33.2	34.1	34.8
Seat tube	21.2	22.0	22.5	23.5	24.3	25.0	25.5
Head tube	3.6	4.4	5.4	6.2	7.1	7.9	8.7
Eff. top tube	21.1	21.5	22.0	22.5	23.0	23.4	23.9
Chainstay	16.3	16.3	16.3	16.3	16.3	16.3	16.3
BB height	10.5	10.5	10.7	10.8	10.9	11.0	11.0
Fork offset	1.9	1.9	1.7	1.7	1.7	1.7	1.7
Trail	2.0	2.0	2.2	2.1	2.1	2.1	2.1
Wheelbase	38.4	38.9	39.4	39.7	40.3	40.7	41.2

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	22.2/30.2/26.4
Fork length	390mm
Front derailleur	Braze-on type w/ 34.9mm clamp Down pull
Bottom bracket	68mm
Rear hub OLD	130mm
Cable stops	Internal cables
Bottle mounts	2 frame
Rack mounts	No

Parts list

	Part Number
Seatpost clamp	970605
Bottom bracket cable guide	963350
STI lever barrel adjusters	972589
Downtube barrel adjusters	69158

Shift cable barrel adjusters

Klein road bikes with internally routed shift cables share a unique feature. Not only does the internal routing look beautiful and keep the cables out of the environment, the frame holes actually ADD strength and fatigue resistance. However, this style of cable routing does not provide for placement of the Shimano downtube barrel adjusters. So we've come up with a better way- put the adjusters on the shifters, where they are more easily accessed (but we also put some barrel adjusters in the frame, just in case).

Seatposts

Quantums are designed to accept 31.6 mm seat posts with a tolerance of 31.45 mm to 31.60 mm outer diameter. Measure the seatpost for conformity to this tolerance prior to installation. The seatpost should be lubricated with a thin layer of grease to prevent is from seizing in the frameset.

A minimum length of 100mm (4 inches) seatpost must be inserted in the frame. The seatpost may be raised to this point without damaging the frame.

Bottom Bracket

Be sure bottom bracket threads are clean and well greased before insertion. Failure to do so may cause galling of the threads, especially when inserting into an aluminum bottom bracket shell.

Internal Cable Routing

The Quantum features Klein's exclusive internal cable routing. For a detailed discussion, see Klein Details, pages 8-11.

To install the original cable set, or a new cable, follow these instructions:

1) Insert the cable sleeves into the forward cable entry holes with the 'mushroom' head last.

2) Guide the cable sleeve through the exit hole by rotating the sleeve until it aligns with the hole. If needed, create a slight bend in the sleeve at its step to encourage it to set into the exit hole at the right time.

3) Once the 'mushroom' is seated in the housing stop, cut the sleeve so that it extends about one inch (25mm) past the exit hole. This is to protect the paint from cable rub.

4) Insert the cable as normal. No lubrication of the cable is needed, nor recommended.

Front derailleur

The Quantum uses a high performance Gradient seat tube, which is very thin to eliminate unnecessary weight. Do not tighten the front derailleur clamp bolt more than 20 lb•in (2.3 NM) to avoid damaging the

Fitting the Quantum

To best fit the Quantum frames, start with our recommendations for overall body height. Next pay attention to the reach and handlebar height listed in this manual. Once you've found the bike which most closely gives the desired fit, check that the standover is at least one inch. Then you can adjust the bar height using the 20mm of spacers, and adjust the saddle position.

19.1lbs./8.67kg

Quantum Race

Our Price $________

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Power tubing
Fork	ICON Air Rail
Headset	Cane Creek Aheadset
Handlebars	ICON Stash Ergo, 7075 aluminum
Stem	ICON Havana,direct connect
Grips	ICON Powercork
Shifters	Shimano Ultegra STI Flite Deck compatible
Front derailleur	Shimano Ultegra
Rear derailleur	Shimano Ultegra
Front Brake	Shimano Ultegra
Rear brake	Shimano Ultegra
Brake levers	Integrated brake/shift
Crankset	Shimano Ultegra 53/39
Bottom bracket	Shimano Ultegra, 68 x 109.5
Pedals	ICON De La Sole, clipless, 9/16" axle
Cassette	Shimano Ultegra 12-25, 9spd
Chain	Shimano HG92, 108 length, 9 speed
Rim strips	Velox 16mm
Spoke lengths	Front 18° Radial, 270 Rear 20° 2x, 290/288 (D/ND)
Saddle	Giro Fi'zi:k Pave, CrMo/leather (Vitesse on 51)
Seatpost	ICON Oz, 2014 Al
Seat binder	Alloy w/integral bolt
Wheelset	Rolf Vector Comp
Front hub	Rolf
Rear hub	Rolf
Front tire	Continental Grand Prix 3000 folding, 700 x 25c
Rear tire	Continental Grand Prix 3000 folding, 700 x 25c
Spokes	DT Aero stainless, alloy nips
Tubes	Presta valve, 48mm stem
Additionals	2 water bottle mounts
Colors	Koi • Black/Red logo

	Bike sizes	51	53	55	57	59	61	63
	Rider height	62-64	64-66	66-68	68-71	71-73	73-75	75-77
	Handlebar width	400	400	420	420	440	440	440
	Stem length	60/0°	90/0°	110/0°	110/0°	110/0°	130/0°	130/0°
	Crank length	170	170	172.5	172.5	172.5	175	175
	Seatpost length	270	270	270	270	270	270	270
	Steerer length	173	195	218	239	263	283	303
MM	**Reach**	593	633	664	677	689	720	732
	Handlebar height	781	810	836	854	874	900	919
IN	**Reach**	23.3	24.9	26.2	26.6	27.1	28.3	28.8
	Handlebar height	30.7	31.9	32.9	33.6	34.4	35.4	36.2

Quantum Race T

19.6lbs./8.90kg

Our Price $

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Power tubing
Fork	ICON Air Rail
Headset	Cane Creek Aheadset
Handlebars	ICON Stash Ergo, 7075 aluminum
Stem	ICON Havana, direct connect
Grips	ICON Powercork
Shifters	Shimano Ultegra STI Flite Deck compatible
Front derailleur	Shimano Ultegra T
Rear derailleur	Shimano Ultegra GS
Front Brake	Shimano Ultegra
Rear brake	Shimano Ultegra
Brake levers	Integrated brake/shift
Crankset	Shimano Ultegra 52/42/30
Bottom bracket	Shimano Ultegra, 68 x 118
Pedals	ICON De La Sole, clipless, 9/16" axle
Cassette	Shimano Ultegra 12-25, 9spd
Chain	Shimano HG92, 108 length, 9 speed
Rim strips	Velox 16mm
Spoke lengths	Front 18° Radial, 270 Rear 20° 2x, 290/288 (D/ND)
Saddle	Giro Fi'zi:k Pave, CrMo/leather (Vitesse on 51)
Seatpost	ICON Oz, 2014 Al
Seat binder	Alloy w/integral bolt

Wheelset	Rolf Vector Comp
Front hub	Rolf
Rear hub	Rolf
Front tire	Continental Grand Prix 3000 folding, 700 x 25c
Rear tire	Continental Grand Prix 3000 folding, 700 x 25c
Spokes	DT Aero stainless, alloy nips
Tubes	Presta valve, 48mm stem
Additionals	2 water bottle mounts
Colors	Koi • Black/Red logo

Bike sizes	51	53	55	57	59	61	63
Rider height	62-64	64-66	66-68	68-71	71-73	73-75	75-77
Handlebar width	400	400	420	420	440	440	440
Stem length	60/0°	90/0°	110/0°	110/0°	110/0°	130/0°	130/0°
Crank length	170	170	172.5	172.5	175	175	175
Seatpost length	270	270	270	270	270	270	270
Steerer length	173	195	218	239	263	283	303
MM Reach	593	633	664	677	689	720	732
Handlebar height	781	810	836	854	877	900	919
IN Reach	23.3	24.9	26.2	26.6	27.1	28.3	28.8
Handlebar height	30.7	31.9	32.9	33.6	34.5	35.4	36.2

Quantum

19.9lbs./9.03kg

Our Price $

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Power tubing
Fork	ICON Air Rail
Headset	Tange Seiki Passage DX, alloy
Handlebars	ICON Swoop Ergo
Stem	ICON Bordeaux
Grips	ICON Powercork
Shifters	Shimano 105 STI Flite Deck compatible
Front derailleur	Shimano 105
Rear derailleur	Shimano 105
Front Brake	Shimano 105
Rear brake	Shimano 105
Brake levers	Integrated brake/shift
Crankset	Shimano 105 53/39
Bottom bracket	Shimano 105, 68 x 109.5
Pedals	ICON De La Sole, clipless, 9/16" axle
Cassette	Shimano HG70 12-25, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 16mm
Spoke lengths	Front 20° Radial, 278 Rear 24° 2x, 288/287 (D/ND)
Saddle	Selle Italia Sphere, manganese rails
Seatpost	ICON Oz, 2014 Al
Seat binder	Alloy w/integral bolt

Wheelset	Rolf Vector
Front hub	Rolf
Rear hub	Rolf
Front tire	Continental Super Sport Ultra folding, 700 x 25c
Rear tire	Continental Super Sport Ultra folding, 700 x 25c
Spokes	DT 14/15G butted stainless
Tubes	Presta valve
Additionals	2 water bottle mounts
Colors	Blue Marlin/Silver linear fade • Black logo

Bike sizes	51	53	55	57	59	61	63
Rider height	62-64	64-66	66-68	68-71	71-73	73-75	75-77
Handlebar width	400	400	420	420	440	440	440
Stem length	70/-17°	90/-17°	110/-17°	110/-17°	120/-17°	130/-17°	130/-17°
Crank length	170	170	172.5	172.5	172.5	175	175
Seatpost length	270	270	270	270	270	270	270
Steerer length	138	160	183	204	228	248	268
MM Reach	605	637	669	681	703	725	737
Handlebar height	795	816	835	854	874	893	912
IN Reach	23.8	25.1	26.3	26.8	27.7	28.5	29.0
Handlebar height	31.3	32.1	32.9	33.6	34.4	35.2	35.9

Quantum T

20.4lbs./9.26kg

Our Price $________

Frameset	Klein Gradient aluminum
Main tubes	Klein Gradient aluminum
Stays	Klein Power tubing
Fork	ICON Air Rail
Headset	Tange Seiki Passage DX, alloy
Handlebars	ICON Swoop Ergo
Stem	ICON Bordeaux
Grips	ICON Powercork
Shifters	Shimano 105 STI Flite Deck compatible
Front derailleur	Shimano 105 T
Rear derailleur	Shimano 105 GS
Front Brake	Shimano 105
Rear brake	Shimano 105
Brake levers	Integrated brake/shift
Crankset	Shimano 105 52/42/30
Bottom bracket	Shimano 105, 68 x 118
Pedals	ICON De La Sole, clipless, 9/16" axle
Cassette	Shimano HG70 12-25, 9spd
Chain	Shimano HG72, 108 length, 9 speed
Rim strips	Velox 16mm
Spoke lengths	Front 20° Radial, 278 Rear 24° 2x, 288/287 (D/ND)
Saddle	Selle Italia Sphere, manganese rails
Seatpost	ICON Oz, 2014 Al
Seat binder	Alloy w/integral bolt

Wheelset	Rolf Vector
Front hub	Rolf
Rear hub	Rolf
Front tire	Continental Super Sport Ultra folding, 700 x 25c
Rear tire	Continental Super Sport Ultra folding, 700 x 25c
Spokes	DT 14/15G butted stainless
Tubes	Presta valve
Additionals	2 water bottle mounts
Colors	Blue Marlin/Silver linear fade • Black logo

Bike sizes	51	53	55	57	59	61	63
Rider height	62-64	64-66	66-68	68-71	71-73	73-75	75-77
Handlebar width	400	400	420	420	440	440	440
Stem length	70/-17°	90/-17°	110/-17°	110/-17°	120/-17°	130/-17°	130/-17°
Crank length	170	170	170	175	175	175	175
Seatpost length	270	270	270	270	270	270	270
Steerer length	138	160	183	204	228	248	268
MM **Reach**	605	637	669	681	703	725	737
Handlebar height	795	816	833	856	876	893	912
IN **Reach**	23.8	25.1	26.3	26.8	27.7	28.5	29.0
Handlebar height	31.3	32.1	32.8	33.7	34.5	35.2	35.9

Torque Specs and Fastener Prep

Item	LB•IN	Nm
Handlebars		
Handlebar clamp bolt, forged stem	150-180	17-20.3
Handlebar clamp bolt, welded stem	100-120	11.3-13.6
Stem expander wedge bolt	175-260	19.8-29.4
Direct connect steerer clamp bolt		
External pinch type	100-120	11.3-13.6
ICON stem w/external bolts	70-90	7.9-10.1
MC3 stem	70-90	7.9-10.1
Mission Control/ MC2 collet nut	300-360	33.9-40.7
Bar end attaching bolts	85-125	9.8-14.1
Seats		
Single seat attaching bolt w/6mm allen	150-250	17-28.3
Double seat attaching w/5mm allen	80-125	9.6-14.1
Double seat attaching w/4mm allen	45-60	5-6.8
Seat post binder bolt	50-180	17-20.3
Cranks		
Crank arm bolt, Shimano	305-435	35-50
Chainring bolt	50-70	5.7-7.9
Pedal attachment	350-380	40.2-42.9
Shimano cartridge fixed cup	435-608	50-70
Wheels		
Shimano cassette lock ring	261-434	30-50
Derailleurs/Shifters		
Front derailleur clamp bolt	20	2.3
Rear derailleur attaching bolt	70-85	7.9-9.6
Front and rear derailleur cable clamp bolt	35-52	3.5-5.9
Shifter clamp bolt	44	5
Combi shift/brake lever attaching bolt	53-69	6-8
Brakes		
Brake lever attaching bolt, standard	44	5
Integrated shift/brake lever attach bolt	53-69	6-8
Brake caliper attaching bolt	69-87	8-10
Cantilever/direct pull brake attach bolt	40-60	4.5-6.8
Caliper brake pad attaching bolt	43-61	5-7
Cantilever/direct pull brake pad attach nut	70-80	7.9-9
Brake cable clamping bolt	50-70	5.7-7.9
Rotor attachment bolt	45-55	5-6.2
Hayes caliper attachment bolt	60	6.8
Frame Attachments		
Water bottle attaching bolt	20-25	2.3-2.8
Derailleur hanger attachment bolt	50-70	5.7-7.9
Mantra		
Shock mount bolts	75-80	8.5-9
Pivot expander bolt	45-50	5-6.7
Suspension Forks		
Brake boss	60	6.8

Loctite Applications

We use Loctite, or similar product, in a variety of applications in fabrication and assembly of Klein bikes, and components on those bikes. Here's a partial list, and the recommended Loctite product:

Crown pinch bolts	242 Blue
Brake arch bolts	242 Blue
Cantilever studs	242 Blue
Pivot axle bolt, left	290 Green
Pivot axle bolt, right	242 Blue
Pivot bushings, frame/swingarm	290 Green
Shock mount bolts	242 Blue
Airhead bearings, aluminum headtube	RC-680

Use Loctite carefully. Follow the instructions on the package, avoiding contact with your skin, or inhaling the vapors. As noted on the package, Loctite contains a known carcinogen.

For Loctite to work correctly, the parts must be clean and dry, with no grease, oil, or dirt. Loctite Kleen 'N Prime is an excellent cleaner and will reduce fixture time.

With blue 242 Loctite, apply to the threads prior to assembly. It will set up in 20 minutes, with full cure taking 24 hours. With green 290 Loctite, application is recommended after assembly. However, this can be impractical with hidden threads, like on the rear suspension pivot bolts, or when using as a fixing agent for Klein bottom brackets or rear suspension bushings. 290 is set in 3 minutes, and again requires 24 hours for a full cure. Please do not confuse Loctite 290 with Loctite 640, which is also green, as 640 can make disassembly much more difficult.

Highly Recommended Grease Applications

Most threaded fasteners will benefit from the application of a light grease-type lubricant. This prevents corrosion and galling, as well as allowing a tighter fit with a given torque. For this reason, it's a good idea to lubricate almost all threaded fasteners. But some fasteners and parts interfaces really need grease. Here are a few:

- Seatpost/seat tube interface - Grease the seatpost where it inserts into the frame on all aluminum and steel frames.
- Bottom bracket threads - We recommend applying grease to all bottom bracket/frame interfaces, as well as the bearing/cup interfaces. This prevents corrosion and will virtually eliminate creaks, a common complaint among riders with cartridge bottom brackets.
- Stem/steerer interface - Grease the quill of conventional stems where they insert into the fork. With Aheadset type stems, a light oil is recommended, as grease may make it difficult to properly secure this type of stem to the steerer.
- Stem/handlebar/bar end pinch bolts - Any and all of these fasteners are small, so corrosion or galling can really cause problems. Its also critically important to the riders safety that they be correctly tightened. Grease both the threads, as well as the bearing surface of the fasteners which rotate against the fixed part.

Places to Avoid Grease

- With carbon Mantras, DO NOT grease the seatpost. A fiberglass sleeve bonded into the seat tube prevents corrosion, and any grease may cause the seatpost to slip, even with correct seatpost binder torque.
- Bottom bracket axle/crank arm interface - Avoid greasing the tapered spindle of a bottom bracket, as this may allow the crank arm to insert an incorrect distance onto the bottom bracket spindle. This can cause crank arm clearance problems with the frame, or incorrect chainline with the specified components. A light oil will adequately prevent any unwanted corrosion in most cases.