Contents

Welcome to Klein Bicycles, model year 2001.

This year's manual brings more technical information than ever before. You'll learn about the invention of the first oversized aluminum bike, what's new this year, how to service older Klein bikes, and you'll hear from Gary on materials and bike fit.

As with our earlier manuals, we have listed every detail on parts fit that any mechanic could ask for.

And for the people who are selling Klein's we have included detailed explanations of our new road bike geometries, our new full suspension mountain bike design, and the host of new component technology used in 2001 including Tubeless Compatible wheels, more disc brakes, and more Rolf wheel groups.

We have also refined our Direct Fit system to better describe how our bikes fit your riders.

As a reminder, we have most of this information, and more, on our web site at www.kleinbikes.com. Please cybersurf over, and send your customers, too!

Klein: The Early Days

An introduction to bicycles

Gary Klein has always loved bicycles. As a child, Gary's bike was the tool for his freedom. His first bike was a balloon tired Columbia. Gary learned to ride on his parents' tree farm outside of Cleveland, Texas. There he enjoyed exploring and riding in the forest and on the roads and footpaths.

From there Gary's family moved to Newton, Massachusetts where he graduated to a 3 speed Huffy. A cherished memory is taking the Huffy fishing along the Charles River.

When Gary's family moved to Palo Alto, California, his parents purchased a Gold Schwinn Varsity for him. Like any new bicycle owner Gary thought the Varsity was the best bike ever made, despite the heavy steel frame. It had chrome fenders and baskets. It also had ten speeds, a big improvement over the 3 speed Huffy. He rode the Varsity regularly commuting to school, chess club and tennis matches.

A growing interest

Attending the University of California at Davis in 1970, Gary became more seriously interested in bicycles. The Davis campus was closed to motor vehicles during school hours, and the students and staff transported themselves by bicycle or by foot. Gary joined the U.C. Davis bicycle club, which included a student-run bike shop. This meant he was able to use the special bike tools and easily purchase parts.

The bike club put on a bike ride every spring called the Davis Double. It was a 200 mile (320 km) ride including some mountainous terrain. As kind of a dorm challenge, Gary decided to participate in the ride, intrigued with the idea of riding a bike that far. Gary was shocked to learn that one of the students in another dorm had a bike called a Masi which cost $300.

With the fenders and baskets removed from the old Varsity, Gary "trained" the week before by riding about 20 miles, at the time the longest distance he had ever ridden.

As that year's 54 registered riders rolled out before dawn, Gary was really excited. The excitement wore off as the ride progressed, and 17 hours later he finished. The next day Gary could not sit down very well. Even so, at that point he was hooked on cycling.

Continuing education

When Gary transferred to Massachusetts Institute of Technology, there was little cycling activity within the school. Gary and another fellow started the MIT Wheelmen, a new school bike club. Gary purchased a Fuji Finest and began to participate in races.

He also operated a student bike shop, supplying bikes and parts to students. Many of the suppliers to this bike shop later supplied his early frame manufacturing business.

Building bikes

In 1973 while an undergraduate student at MIT, Gary was part of a group during the January Independent Activities Period. This group thought that aluminum might be used to make a bike frame superior to high strength steel frames predominantly used at the time. The group started by collecting and analyzing a number of contemporary frames, attempting to determine what the most desirable and important qualities of the frame were. They were trying to figure out what strengths and stiffnesses were most critical, and what the tradeoffs and optimums were between strength, stiffness and weight reduction. The group attempted to figure out the major factors that influence ride, handling and overall bike performance.

Failure analysis

The group first looked at frames that had broken from use. Many of these were the result of being hit by a car, or riding into a curb or pothole. From analyzing these crashed frames, it was clear the yield strength around the head tube was important to consider.

They also found broken frames which had not been crashed. On these frames, there were failures all over which were evidenced as fatigue cracks. They found failures at the seat lug fitting, rear dropout, and near the head tube and bottom bracket. These indicated that the repetitive loading on the frame from normal pedaling and riding forces were enough to start and grow cracks in the frame. These cracks were usually at or very near a joint. There were some failures where the steel tubing had rusted through from the inside. Boston, where M.I.T. is located, puts salt on the roads in the winter, so this was not a big surprise. Occasionally there was a crack further away from the joint in the frame tube where the butting began. There were even two cases where a crack started as a result of a defect in the butted steel tubing. By looking at where these failures occurred, the type of failure, the diameter and thickness of the tube material at the point of failure, and looking up the material strength for the type of material used, the group approximated the type and level of loading that caused the failure. This reverse engineered information would later be used to design their aluminum frames.

> "The excitement wore off as the ride progressed, and 17 hours later he finished. The next day Gary could not sit down very well."

Performance tests

The group also tried to devise some stiffness tests that would correlate to how well the frame would perform in a hill climb or sprint. Devising a simple method for analyzing frame flex, they clamped some sticks with markers on the ends to the seat and down tube. As the frame was ridden and the frame tubes flexed, the markers would trace how far the frame flexed, kind of like a ground tremor recorder. They had a good sprinter use the bike for a while, and recorded how far the frame flexed under his peak sprints. They also observed how the frame flexed when the pedals were loaded in a static situation.

From these measurements the group devised two stiffness tests and a long term fatigue test. They found the major frame deflections were in torsion between the head tube and the bottom bracket, and in a combination of bending and torsion between the head tube and the rear dropouts as the bottom bracket was loaded.

Gary was racing at the time, and he kept hearing racers talk about their frames going dead or losing stiffness after a season of use. So the group performed the 2 stiffness tests on a frame, then set the frame up with an eccentric cam and a motor to repeatedly deflect it to the maximum deflection recorded by their sprinter. They ran the fatigue test for over 1 million cycles, then removed the frame and retested the frame for stiffness.

> "To Gary, having a density one third of steel is the single most important feature of aluminum alloys."

There were no cracks visible, and the stiffness did not change after the fatigue test. The group did not solve the question of whether brazed steel frames lose stiffness with normal use, but felt confident that their aluminum frames would not.

Early aluminum bikes

Aluminum had been used previously in the Monarch bicycles produced in the US, back in the mid 40's. They used hexagonal tubing and cast lugs. The frame was beautifully styled and polished but not competition oriented.

Alan of Italy was making aluminum frames out of standard diameter tubing, 1 inch and 1 1/8 inch, with threaded and bonded lugs. The frames were light weight but not as rigid as a good competition steel frame. Controlling frame flex under the racing cyclists exertions appeared to be a critical criteria of a good competition frameset. By using the same size tubing as conventional steel frames, the appearance of the Alan was similar to a steel frame, but the performance suffered.

At the time Gary's group was producing their first frames, the aluminum alloy choices available for manufacturing a bike frame were pretty limited. Although some of the tubing stock lists suggested that 7075 and 2024 were available in a small number of sizes, in reality the choices were 6061 and 6063. This was the only material available in the appropriate tubing diameters and wall thicknesses for use in bicycle frames. So the initial frames made by the group were made of 6061 seamless drawn tube, the strongest tube material available to them.

The frames most of the students produced were of 1.25 inch diameter, .083 wall straight gauge tubing. This resulted in a frame that was lighter than most steel frames, and stiffer and stronger (with skillful welding) than a typical light weight, high quality steel frame.

The first Kleins

Klein was started as an official MIT Innovation center project when Gary was in graduate school. A professor and 3 students put together a business plan and submitted it to the innovation center. The innovation center gave the group's bicycle project a $20,000 grant to see if there was a business there. Each of the partners put up $1,000 and they began to produce, promote and market small batches of aluminum bike frames in the machine shops and their basement office at MIT.

Learning from his previous mistakes, Gary designed a lighter weight and more rigid frame which took advantage of aluminum's low density. To Gary, having a density one third of steel is the single most important feature of aluminum alloys. By increasing the tubing diameters to 1.5 inches and reducing the wall thicknesses to .050 to .060 inches, Gary's goals were easily met. The key to this design was that the only way to achieve the best properties in a welded aluminum frame was to perform a full T6 solution quench and artificial age on the frame after welding.

The group built some prototypes and displayed their first bikes at the International cycle show in New York in February of 1975. They were welded and with fully heat treated construction.

A business begins

After a year and a half, the batch sizes had grown. The two active partners, Jim Williams and Gary, had bought out the inactive partners. These two were hiring students to help machine parts for the frames. As the business grew, they needed a more commercial location.

Gary borrowed some money from his parents, purchased some used tools and an old truck, loaded up their jigs and belongings. They moved to San Martin, California, just south of San Francisco. Gary's parents let him use some abandoned dehydrator buildings on their former orchard. The free rent was needed, as at that point the racers whom they had targeted as their market were not buying many frames. The feedback from the recreational riders indicated that they thought the big tubes and lumpy welds were ugly. It seemed just making a technically superior product was not enough. Science without art did not sell well, so Gary and Jim began to work at improving the appearances of their bikes as well as the performance.

Gary becomes Klein

During this period of low income, Jim and Gary split up. Since Gary had invested the most, he ended up with the business. Gary was making too little money on the frames, and the customers wanted him to spend even more time and effort on the frames. Things were slow, income was almost non-existent, and so Gary started looking for an engineering job.

With the end of his business in sight, he figured that raising the price would dry up the orders and would make the decision to close the business easy. He almost doubled the price of the frames they were making from $325 to $575. Instead of reducing the demand for the Klein frames, the orders increased markedly. At a premium above the steel frames, somehow the technical advantages of the aluminum frames were more credible to the typical purchaser.

> "Improving the visual appeal turned out to be a crucial element in creating a viable business. By 1980, Gary was building custom frames for over $2000 each."

Gary had to hire some help and increase production. He worked to make the frames more custom and to improve the cosmetics. Improving the visual appeal turned out to be a crucial element in creating a viable business. By 1980, Gary was building custom frames for over $2000 each.

The move to Chehalis

In 1980 Gary moved the business to its current location in Chehalis, Washington. This move was needed to reduce the costs of factory space and labor in the sky high pricing of Silicon Valley.

Demand for Klein frames was high, and custom frame orders took too long. Using the fit information gathered by creating all those custom bikes, he started making production runs of road frames in the early 80’s and mountain bikes in the mid 80’s. These production models became very popular and completely changed the nature of the business. By the late 80’s they were mostly producing mountain bikes, but the road models have come back significantly since then.

Oversized aluminum becomes the standard

Since Klein pioneered the large diameter aluminum frame structure, it has become the standard in the industry. Gary estimates that about 90% of the highest performance competition frames are currently made of large diameter aluminum alloy. The rest are made of carbon fiber composite, titanium alloy, and high strength steel alloy.

Klein bicycles today

Gary has constantly refined his designs, seeking more strength, better ride, and even lower weight. Klein currently makes road frames weighing around 2.8 pounds and mountain bike frames around 3 pounds.

> “Even while sharpening his focus on low weight, Gary has found ways to increase the quality of ride, cosmetics, and overall function of the bicycle.”

As he has taken weight out of the frames, the strength levels have actually gone up. This has occurred because of better understanding of the frame structure and loads, the manufacturing process and its effect on the strength, and improved methods of metal fabrication that allow Klein to optimize the material placement in the frame. Even while sharpening his focus on low weight, Gary has found ways to increase the quality of ride, cosmetics, and overall function of the bicycle. Thanks to 25 years of constant refinement, nothing else rides like a Klein!

Gary Talks Aluminum

Does aluminum last?

It should be common knowledge that most modern aircraft use aluminum exclusively for their primary structures (internal frames and bulkheads) and 95% or better of their exterior surfaces, including load bearing skins. The aircraft industry has been using these alloys for several decades. I have recently been a passenger on some planes that I estimate were made no later than the 60's. So aluminum alloys have certainly proved their long term durability and high performance in the aircraft industry. The occasional failure that has occurred has typically been due to a design or manufacturing defect or improper maintenance.

> "Steel is only the better material if you don't care how much your bike weighs."

Why do airplanes use aluminum?

The aircraft companies have picked aluminum because it offers the best combination of material properties and processing capability in order to create high performance, light weight, robust aircraft. Prior to the widespread use of aluminum alloys in airframes, Cro-Moly steel was used in many cases for structural members and coated fabric was used for skins.

Doesn't frequent flexing break aluminum?

The example given of repeatedly bending a small piece of metal like a coat hanger is not relevant to the durability or reliability of a bicycle frame. When you permanently deform the material as in the example you are yielding it. This is not what fatigue strength or fatigue life refers to or is about. It has no relation to fatigue strength. Some of the highest fatigue strength materials I have used are carbon fiber and boron fiber. They will not take a significant permanent set, breaking instead at a high force level. So these extremely high fatigue strength fibers would rate near zero by the coat hanger test. The optimum material for this reversing yield property might be a low carbon (low yield strength) or mild steel alloy. These types of steels have not proven to be a good choice for high performance bike frames.

Won't a steel frame last longer?

The statement "Aluminum has a shorter fatigue life than steel" demonstrates a shortage of material knowledge and understanding. Sure, a high strength steel alloy will exhibit a longer fatigue life at a high, fully reversing load level. But remember, these numbers always reflect performance for a unit volume. Steel weighs 3 times as much as aluminum for the same volume. In other words, if these statistics were based on weight instead of volume, steel would have to exhibit 3 times the fatigue strength of aluminum to be considered stronger, and it doesn't. Steel is only the better material if you don't care how much your bike weighs.

What causes fatigue failures?

All metal bike frames,whether they're made of steel, aluminum or titanium alloy, have millions of small cracks. It is inherent in their metal structure. Most metals are made up of very small metal crystals or grains. There are inherently a lot of flaws in the microstructure. The concentration of these cracks is higher where the metal has been welded or brazed, such as at the joints.

Failure of a structure due to repeated stress cycles has two main components. These are crack initiation and crack propagation. For a bike designer, it may seem obvious to design to prevent crack initiation. In theory, if no cracks can start, then we don't need to worry about crack propagation, or fracture toughness. But this does not work in real life.

A tough material will allow the bike to perform adequately for a long time with a crack in it that is below a certain crack size. The tougher the material, the larger the allowable crack. Below this critical size, the crack will grow so slowly that it will not become a problem.

Is toughness more important than fatigue resistance?

Fatigue behavior of a given material is not at all well defined by any single number. Fatigue behavior for a material is more accurately portrayed by a series of curves. The behavior (and number of cycles it can withstand) will vary considerably depending on whether the load is only applied in one direction, both directions, or is applied in addition to a static or constant load. For each type of loading condition described above, the material will exhibit a range of fatigue cycles to failure depending on the level of load applied.

How is fatigue evaluated?

The most commonly used test is the fully reversed load without static load. It is a simple test to perform. The fatigue life increases as the stress level is reduced. Common steel alloys and common aluminum alloys have differently shaped curves. The curve for steel under fully reversed loading is approximately a constant downward slope (plotted on a logarithmic cycles scale) until about one million cycles, where the curve abruptly becomes horizontal. It has a well defined corner in it. This is called the endurance limit for steel. The curve for aluminum does not have this sharp corner. The curve continues to decrease very slowly well past one million cycles and becomes horizontal at five hundred million cycles. So the fatigue limit for aluminum alloys is typically measured at 500 x 10^6 cycles, where the curve is no longer decreasing. A bicycle will never see this many cycles. (I should also add that there is typically a lot of scatter in fatigue data. Often the curves may be represented by a thick band showing the range of cycles that the material withstood.)

So which material is better?

The shape of the curve gives aluminum an advantage in the fatigue mode. I think the real high stress cycles that a bike sees are more likely to be around 10,000 cycles during its expected lifetime (about 20 years). Aluminum's published data is typically measured at 500 million cycles, so it is considerably stronger through the lower cycles expected in real life. Steel is also stronger at lower cycles, but since it was measured at one million cycles, the strength improvement at 10,000 is probably not as great as in the aluminum.

Haven't a lot of aluminum bike frames broken?

This discussion has all been theory and laboratory testing, assuming pure alloys and flawless construction. The reality of aluminum frame durability has been a little rockier.

As aluminum frames have become available at a wide range of price points, the variation in quality has become equally wide. Even as much as I like aluminum, I would much rather ride a medium quality steel frame than a poorly designed and manufactured aluminum frame. In other words, the material is not nearly as important as the design, engineering and construction of the bike frame.

Why do you like aluminum?

Aluminum is a great material to work with. Its light weight, or more accurately, low density. One cubic inch weighs one tenth of a pound. Contrast that to steel, where the same cubic inch weighs three times that amount. I can use twice the volume of metal that a good steel frame uses and the steel frame will still weigh 50% more than my aluminum frame.

Aluminum provides a great ride, if you use it to its optimum. Aluminum's low density and high formability allows me to tailor the stiffness of each part of the frame through tubing and joint design. And the lighter weight positively affects the ride quality. When I ride a high quality steel frame (which is not very often) it usually feels a little clunky and slightly harsh by comparison.

Aluminum is very strong. It is possible to achieve significantly higher strength properties in the aluminum structure per weight than I could in steel. Part of this comes from the basic material properties. I can use more material, and more easily form the material, so I can put just the amount and shape I need into the bike. This is the basis of our Gradient tubing which exhibits long, but radical tapered walls, external forming, and our patented frame dimples (for an explanation of these features, see Klein Details). I use the low density to create shapes and sections that resist the bottom bracket and rear wheel twisting under the riders pedaling strokes. Thus more of the cyclists energy goes into forward motion.

> "Aluminum's low density and high formability allows me to tailor the stiffness of each part of the frame through tubing and joint design. And the lighter weight positively affects the ride quality."

Part of the higher strength occurs because we fully heat treat the frames after welding. We solution quench and artificially age harden them up to full strength T6 condition. While it is conceivable that welded alloy steel frames could be hardened and tempered to improve their strength, I am not aware of any production frames using this technique. But the largest contributor to high strength is engineering and design. The low density and high formability of aluminum allows me to design our Gradient tubing with increased wall thickness, complex shapes and larger sections where I want to achieve high strength properties in the overall structure.

Are all aluminum alloys basically the same?

Some of the highest strength aluminum alloys, particularly in the 7000 series, have low toughness, or resistance to crack propagation. We use alloy systems specially selected for high toughness. This is important for overall strength and fatigue resistance. It also means that with higher toughness, we need less material resulting in a lighter bike. Finally, without the high toughness of our alloys, the extreme tube manipulations used to create our Gradient tubing would not be possible.

> "The material is not nearly as important as the design, engineering and construction of the bike frame."

Is aluminum the best frame material?

When you say the "best", I feel a need to quantify what is meant. Aluminum is not the best at everything. But its combination of features puts it in the lead for bicycle frames. Consider the following:

Great ride feel: Better than steel and titanium, competitive with lightweight carbon

Light weight: Lighter than steel and titanium, competitive with carbon

Power Train Efficiency: Better than steel, titanium or carbon

Fatigue strength: Better than steel, competitive with carbon and titanium

Impact strength: Better than carbon or Titanium, competitive with steel

Yield Strength: Better than steel or titanium, competitive with carbon

Corrosion resistance: Better than steel, competitive with carbon, below titanium

Cost: Better than carbon or titanium, slightly more than steel

> "The low density and high formability of aluminum allows me to design our Gradient tubing with increased wall thickness, complex shapes and larger sections where I want to achieve high strength properties in the overall structure."

Comparing materials

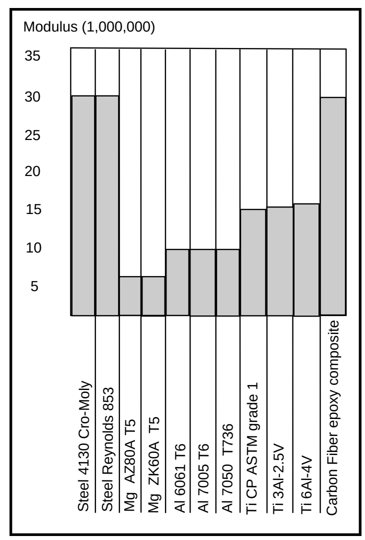
When comparing materials, its a mistake to only consider one of the many properties that define a material. Every property must meet the needs of the structure you want to build. Ideally a bike should have a blend of stiffness and strength that make it light with good feel. It should be stiff for efficiency. It should last a long time. It needs to be economic to manufacture.

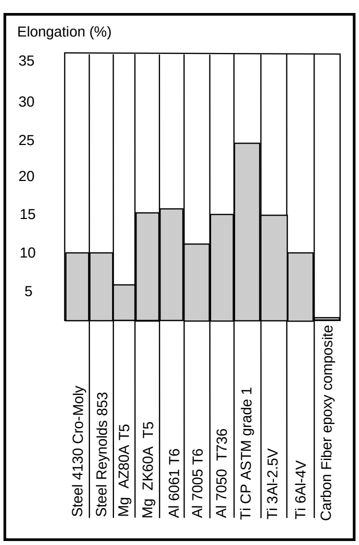
There are other considerations as well. In some cases, one material works best for a certain part of the bike, and in other areas another material might be better. But its difficult to inventory and control quality if you use too many materials from too many places.

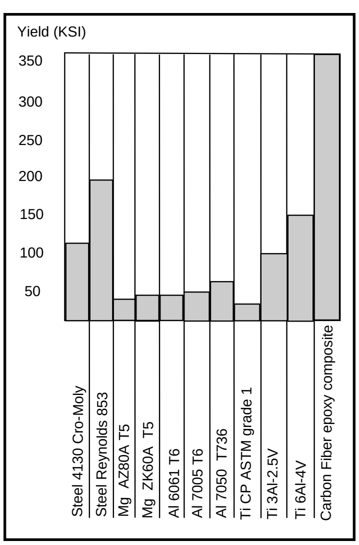
Nonetheless, I know people want to see how things compare, so the following charts should help. Please remember that this data is derived from laboratory tests using solid blocks or rods of material. They do not tell how strong a structure is when built with that material. In other words, an aluminum bike can be made to be harsh and stiff, or soft and compliant. It can be robust and strong, or fragile. Its what the designer and manufacturer do with the material that counts.

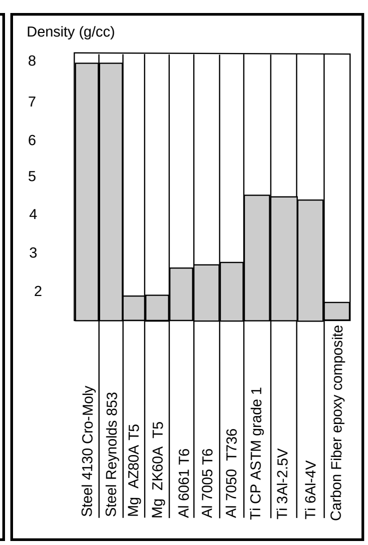
Are all aluminum bicycles the same?

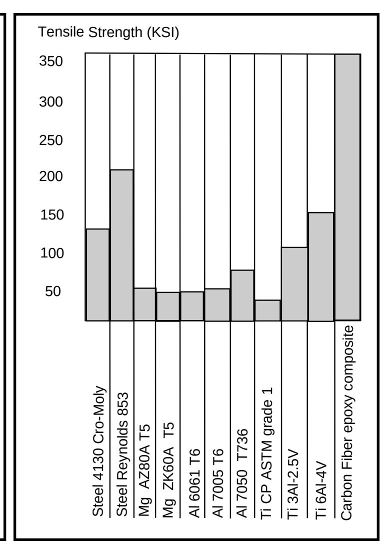
There is a huge difference in ride between even an above average aluminum bike and a Klein. Hopefully you've learned a bit about aluminum and see where its possible for two bikes with the same geometry and material to have huge differences. Every step, from the alloying of the metal to heat treat and finish will provide opportunities for a manufacturer to add quality or save cost. You simply have to ride the bike to feel the difference. We have chosen the best materials and then taken every opportunity to maximize the potential of the material we use. That's why nothing else rides like a Klein.











Gary Talks Fit

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. The studies these systems are based on all derive from a study by the Italian cycling federation comparing young, elite, male road racers. Do not count on any of these measurement-based systems to fit cyclists unless they fit that definition of 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 standard 'rules' out there do not make any sense when analyzed or applied to the non-average person."

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 head tube 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 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."

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 somewhere near the pedal axle. But its certainly doesn’t define a good 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 its best.

#1 is Fit

First and foremost the bike must fit well. The relationships between the saddle, the pedals, and the handlebars define the fit. The location of these three parts describe the Rider Contact Triangle, the points of contact between rider and bike. Most geometry charts fail to locate these points, making the charts virtually useless for fit information.

This triangle defines a rider's comfort, places their center of gravity for optimum handling, and determines their muscular economy when pedaling. A properly fitted bike does more than set the leg extension; it creates a synergy between bike and rider that results in better rider comfort, more powerful pedaling and optimized handling.

The old way to fit a bike

You'll notice that the list of the three points of rider contact 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. Those bikes had a fairly narrow range of bottom bracket heights, and their stems were pretty similar in the amount of height adjustment they offered. This 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 bottom bracket to the handlebars. At best, 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. Even the forks come in different lengths. 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, a performance issue.

The right way to fit a bike

So how do you fit a bike? 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 most of your customers already know their overall height, and it leaves out sophisticated measuring techniques which tend to be inconsistent if done by untrained personnel.

> "Every fit decision on a bike involves some compromise."

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, 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.

The easiest of these adjustments to perform, with the widest possible adjustment, is the seat height. For this reason, seat tube length should be the least of our worries when choosing a frame. 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 needs (or 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.

> "Its usually required that the bike fit well for it to ride its best."

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 his/her body changes as they put in miles. With increased miles a rider will likely increase leg, arm, and back strength while becoming more flexible in the hips. As they gain fitness, the bike that used to fit comfortably with a 120 stem may need a 130 and more saddle setback to accommodate the fit rider's new body and the increased pedal power they produce.

So what tells you where the handlebars are?

In this year's technical manual we have included a dimension called Direct Fit. This is the distance from the center of the bottom bracket to the hand position, modified for riding style. On a mountain bike the hand position is the center of the grip. On a road bike, its the intersection of the handlebar top and the brake lever hoods.

Combined with the angle of this distance, the Direct Fit number describes the fit of the bike. The angle is important, because as the rider position becomes more upright, their hands naturally move further away from their feet. As an example, compare the position of a rider on a road racing bike with that of a rider on a hybrid. The bent forward, aero position puts the hands much closer to the feet. But when the rider sits upright on a hybrid, not only do their hands move away from their feet, the angle between the feet and hands changes. We've established a series of equations to describe this change so that the fit of both bike styles can be described with a single Direct Fit sizing. We've also approximated this fit in a chart with overall height to make the process easy for you on the sales floor.

If your first pick of bike size was not satisfactory for the customer, you have three alternatives. You can move to a different size or angle, select a different model which offers the desired size, or customize a bike to achieve the desired size. Customization is usually done by simply changing the stem height, or changing the stem. Both of these adjustments change the distance from the bottom bracket to the hand position, and thus the Direct Fit size.

Once the size of bike is chosen, fine-tuning the saddle position will create a professionally adjusted bike. This level of service is what sets you apart from big box stores. Direct Fit makes it easy.

Fitting compromises

Every fit decision on a bike involves some compromise. Looking at this another way; most people can realistically fit at least two, if not three frame sizes. This was generally accepted as true using other fit systems, and we haven't changed the bikes, just the way we describe their fit.

Using Direct Fit, we will attempt to steer you to the best fitting frame of the several which could be made to fit. However, a good fitter will "read into" this information to further fit the customer and match the compromises they desire.

Pretty much every rider has a range of fit which might be acceptable for both performance and comfort. Within that range there is room for fit tweaks to accommodate personal preference, physical issues, or performance desires. As an example, if the rider has a stiff back, the bars can be raised slightly. If the rider has problems on descending steep terrain on a mountain bike, the bars could be moved rearward. If the rider specializes in time trials on the road, the hands can be moved down and forward for better aerodynamics. From a centered position, each of these changes can be made while staying within the rider's ideal fit range. But each of these changes is in fact changing the fit of the bike.

Fitting variables

Basing the Direct Fit selection on overall height is a simplification to make it faster and easier to size people in your store. In reality, there are other factors which weigh in, not the least of them being personal preference. Each person has a range of fit where they will be relatively efficient and comfortable. We attempt to describe the center of the fit range. You can then adjust to accommodate the rider's needs, desires, or preferences.

> "Comfort is more important than aerodynamics for the average rider and will do more to increase their speed."

While considering your customer's overall height, there are some other factors that are easy to factor into selecting the best Direct Fit. You can anticipate some fitting tweaks as you help a rider get fit. As an example, if a person is not in racing trim, they will likely be happier in a more upright position. In these cases, not only will they be more comfortable, they will probably be more efficient because they will be in a more ergonomic position with less overall muscle tension. If you put them in a deeply aero position, their body may be so tense that the pedaling muscles won't get the oxygen they need to do their job.

We list a few of the more obvious fit factors here, with explanations:

Women comprise almost half the population. A woman's pelvic construction places her center of gravity well behind her hip sockets. This means that when a woman pulls on the handlebars, she's working at about a 15% mechanical disadvantage compared to a man. For this reason, she needs the handlebars to be closer to the hips and higher to reduce stress on the lower back. Moving the handlebars back relative to the bottom bracket creates a steeper Direct Fit angle. Moving the bars up creates a greater distance from the bottom bracket to the hand position. Women tend to need slightly bigger Direct Fit bikes.

Heavy set people generally cannot bend over as much without using a lot of muscle power to support the additional weight. Those supporting muscles need oxygen, but they aren't making the bike go faster. Putting these folks in a more upright position allows them to move the oxygen to their pedaling muscles. Select a slightly bigger, more upright bike for heavy body types.

Strong, lean, and flexible people (we sometimes refer to these folks as the 'shaved leg' crowd) can bend over efficiently. They also produce a lot of pedal force. As they push hard on the pedals, they need something to hold them steady on the bike. The hands provide the opposition necessary to keep the rider steady on the bike. If the rider is pedaling extra hard, they need extra opposition. Placing the hands lower provides the required opposition without making the arm muscles flex and consume extra oxygen. Put these riders on a smaller Direct Fit bike with a lower Direct Fit angle.

Injuries and pain can create a lot of fit problems for people. It should be a basic step in fitting to ask the customer if they have experienced pain on a bike in the past. And it may be truly surprising how many people have torn a ligament, sprained a tendon, or broken a bone. If someone complains of discomfort, it may save you a lot of time to ask them if they've had an injury that is interfering with the bike fit. Then adapt the fit accordingly. Remember that comfort is more important than aerodynamics for the average rider and will do more to increase their speed.

Defining the Fit

Its easy to define the Direct Fit of a bike; its a calculation based on physical measurements. However, it is NOT easy to define the size of a rider. In other words, Direct Fit applies to measuring bikes, it does not apply to measuring people.

Using the Fit Charts

When using the fit charts supplied with each model, bear in mind that the Rider Heights given are for an average fit for an average rider using the bike in an average way. Most of us are not average, so to be truly successful using Direct Fit you need to apply a little intelligence to the chart.

The charts are based on averages gained by measuring riders and the way they set up their bikes. The Direct Fit listed (and the Rider Height derived from that) is based on the highest stem position possible on a given bike using the parts we spec'd. In other words, we measure all the bike with the stem at its top. If you move it down, the bike gets smaller.

Second, the bike will fit in the middle of the fit range of an average person of the height listed. If the chart says a bike's Rider Height is 5'11", a 5'10" rider will probably also fit the bike, even without any changes. So will an average 6' rider. However, if a 5'11" rider is NOT average, they may not fit this size.

The 'Small Rider Height' figure calculates the Direct Fit if you are switching to one size shorter stem and moving all the spacers above the stem. Just like Rider Height, this is not an absolute. Its the average height of a rider for whom the handlebars will be in the center of their fit range. Someone shorter than the Small Rider Height will likely fit the bike, especially if they like a more upright position. The Large Rider Height calculates for one size larger stem than the one we spec'd, again on an average.

To summarize, if the Small Rider Height is 5'9 and the Large Rider Height is 6'1", you should be able to fit most normal riders from 5'8" to 6'2" on the bike by playing with the stems.

Adjusting for Physical Variation

Along with the Direct Fit, we list the angle of each bike. This angle helps a great deal in fitting because it tells you whether the position on the bike is upright or laid out. Fit, young, lean, male riders generally can ride a flatter position. Heavier set folks, those with flexibility problems in the back or neck, and females generally require a more upright position to be comfortable. Using this information when choosing between two frame sizes will allow you to achieve the best position for the rider.

How riders and Direct Fit interact

Each rider has a range of fit inside which they will be reasonably comfortable and efficient. In Figure 1, the hand position is shown graphically, as well as the Direct fit angle. Notice that all sizes are spec'd to have a similar angle.

The grey circles indicate the fit range acceptable for riders A, B, and C. Rider B has a larger range than rider C. This could be due to B's flexibility and strength, or C's old back injury. The center of both B and C is around 49 degrees of Direct Fit angle. Rider A is a racer who fits a lower hand position in the 47 degree range.

Rider C is the hardest fit due to their small tolerance for misfit. This might be common with an injury. Rider B can ride a variety of frame sizes from 52 to 54. Its simply a matter of figuring out which frame will put them closest to their preference. Rider A needs a low position, and this can only be fulfilled with 2 frame sizes.

Next consider what changing stems does to custom fit rider A. By putting a longer stem on the bike (without changing the stem angle), the Direct fit grows slightly, and the Direct Fit angle decreases (Fig. 2). This is what the Large Rider Height hand position would look like on the fit charts. To fit rider A, putting a longer stem on the 54 puts the bars closer to the middle of their fit range. A shorter stem of the 56 would put the bars in a much higher Direct Fit angle.

What about the seat angle and top tube length?

Some fit systems place a great emphasis on the top tube length. However, without a lot more data, top tube doesn't describe fit. As an example, consider how three bike with different top tube lengths (Fig. 3). By using different seat tube angles, these three frames offer different top tube lengths while providing the exact same fit.

Why Direct Fit works

The Rider Contact Triangle has three sides that must fit correctly for the bike to fit the rider. The side of the triangle with the most adjustment is the distance from the saddle to the pedals. Next is the distance from the saddle to the bars. The critical fit element with the least adjustment is the distance from the pedals (bottom bracket) to the bars (hand position).

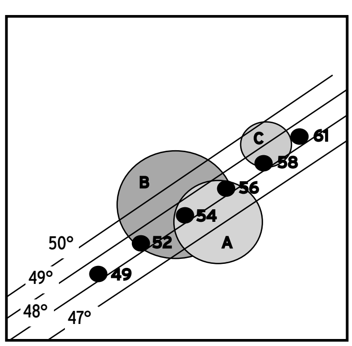


Fig. 1

By locating the handlebars first, the rider's center of gravity is placed over the wheels for optimum handling. This part of fitting the bike is overlooked by most traditional fit systems.

Once the hand position is established, it is relatively easy to position the saddle to the rider. Saddle height and setback together control torso position and shape, as well as leg extension and weight balance between the hands and seat. The result is a better riding bike.

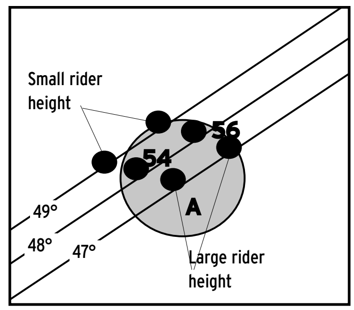


Fig. 2

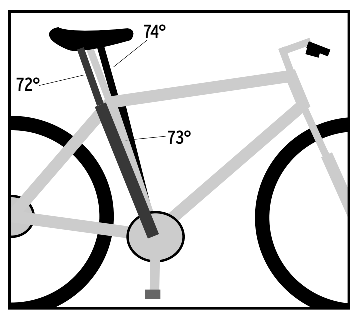


Fig. 3

Geometry

In addition to defining the fit, 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, particularly in the important relationship to the rider's center of gravity. 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 fit on it and then actually try it to see how the whole package interacts with you on it.

Trail 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 (Fig. 4). It is the effect of fork rake combined with head tube angle. In actual riding of the bike, trail if further defined by the interaction with the rider's Center of Gravity

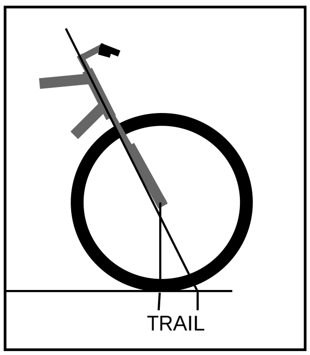


Fig. 4

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).

The weight on the wheel affects trail. The more weight placed on the wheel, the stronger the effect of the trail. So if you take a quick steering bike and puts lots of weight on the bars (like adding front panniers to a touring bike), 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 or riding no hands) the front end may feel too light to control. To accommodate this effect, Klein bikes are built with size-specific steering. On both road and mountain bikes, we adjust head tube angles and fork rake (where possible) to adjust the trail. This means 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 the center of gravity is to the ground, the harder it can be to move the wheels 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.

Bottom bracket height also affects pedal clearance. For road bikes, this can affect 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. With improper bottom bracket height, a bike loses one of the advantages of full suspension.

Handlebar height (head tube length + stem reach and rise + fork length + headset stack and spacers + handlebar style) 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 head tube and other components 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 head tube length is in fitting a bike. Some bikes use the same head tube length on all sizes, making a range of good fit very difficult.

> "Geometry charts only refer to centerlines in a two dimensional drawing. Many more things go into making a bike handle the way it does."

Front/center is the distance from the bottom bracket to the front wheel axle. Since a rider should first be positioned relative to the handlebars for optimum balance on the bike, 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. Usually people consider the front end stability only on a steep descent but this stability comes into play even on the flats.

Weight distribution is how the rider's weight is spread over the two wheels, and where the center of mass is located. 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, manufacturing quality, frame flex, and alignment all affect how a bike rides. Geometry charts only refer to centerlines 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.

And don't forget that the rider does not touch the frame. There are a lot of parts between the rider and the frame which each have an effect on how the bike rides. These include subtle things like headset stack height, handlebar shape, tire casing width, and even grip shape. More obvious interfaces include fork length, seat height and setback, stem reach and rise, and handlebar rise.

If there was such a thing as the perfectly designed frame, its benefits could easily be lost through improper parts selection that created a poorly fitting machine.

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.

> "Understanding what each bike does well will help you match your customer to the bikes on your floor."

Klein Details

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' at meal time; you're never exactly sure what you're going to get.

> "What goes into shaping the tubing is more important than the raw material itself."

'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.

Large Diameter Frame Tubing

Gary Klein is the pioneer of using large diameter aluminum 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 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.

Gradient 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 Gradient Tubing. This is a Klein exclusive feature which leads to lighter, stronger, better riding bikes. Instead of focusing simply on weight or stiffness, Gary's design philosophy includes overall ride quality. Gradient tubing is one of the keys to Gary's success.

> "Thanks to Gradient tubing, even after 90 miles a Klein remains comfortable."

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.

The result of Klein's Gradient tubing? The lightest and strongest production frames available--3 lb. ATBs and 2.8 lb. road frames. All that metal manipulation places the aluminum just where its needed for strength and stiffness. So while Kleins are superlight, they are also extremely efficient. Pedal power becomes forward motion. Rider input at the controls results in razor-sharp handling. Thanks to Gradient tubing, even after 90 miles a Klein remains comfortable. Klein custom tubing; another example of the obsessive detail that makes a Klein a Klein.

> "Instead of focusing simply on weight or stiffness, Gary's design philosophy includes overall ride quality. Gradient tubing is one of the keys to Gary's success."

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. Seatposts fit better, and lateral rigidity of the saddle is enhanced resulting in better power transmission and handling. Your customers may not always notice, but Gary Klein insists on perfecting every detail. Note that the large diameter seatpost results in a noticeable change in saddle feel. A 31.6mm seatpost is almost twice as stiff as a 27.2mm post. In a short test ride, this stiffness may be perceived as yielding a harsh ride. However, thanks to Gradient tubing and the host of other Klein features, a Klein will actually be more comfortable than many bikes on a long ride. Meanwhile, the rider's power isn't being wasted by flexing the seatpost.

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 mountain chainstays 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 business, 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.

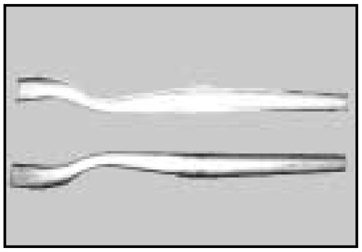


Fig. 5

These remarkable chainstays allow for an ultra short chainstay length, keeping the rear wheel under the rider for superior climbing traction and control. Klein bicycles consistently receive rave reviews for their climbing capabilities. The rigidity achieved with the Gradient chainstays is one of the reasons. And don't forget the tight, precisely placed bends make for gobs of mud clearance, even when using 2.35 tires.

"Our chainstay assembly alone costs more than many complete off-the-shelf aluminum frames."

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 inch 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.

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

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

Reinforced Head tube/Down tube Junction

Much like a boxer that leads with his chin, the head tube/down tube 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.

"Klein bicycles consistently receive rave reviews for their climbing capabilities. The rigidity achieved with the Gradient chainstays is one of the reasons."

To add front end strength, Klein starts with a light-weight internally tapered head tube, which is heavily reinforced around the bearing races. This extra material prevents bearing shock loads from ovalizing the tube.

Note the distinctive barrel-shaped profile of the standard Klein ATB head tube, or the even larger diameter head tube of the Airhead tube. 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. These large diameters also increase front end rigidity, adding steering control in rough or harsh terrain.

What you don't see is the robust tubing wall thickness in the head tube region, the full penetration welds, 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.

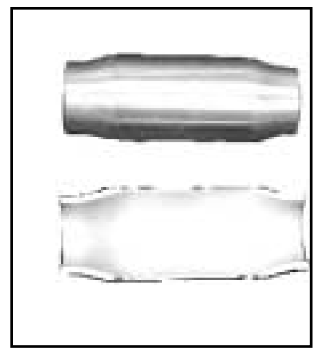


Fig. 6

Airheadset™

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

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' 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 the 2001 Klein Adroit Race, 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. For the 2001 Mantra, the Airheadset™ will 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,

Fig. 7

the adapter makes the Klein Airheadset™ totally interchangeable with any fork on the market.

Internal Cable Routing

Kleins are beautiful looking bikes, helped by the fact that the gear and brake cables are concealed. The internal cable routing also makes a Klein more comfortable and even stronger.

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 head tube stresses along 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? It may seem that a hole in a tube would be a potential stress riser, or weak point. The way most holes are put in frame tubes, this is true. 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.

Fig. 8

The top tube and down tube are predominantly loaded by the front fork, in plane with the frame tubes (Fig. 9). 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 head tube.

The sides of both tubes are predominantly loaded in shear (Fig. 10). 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.

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.

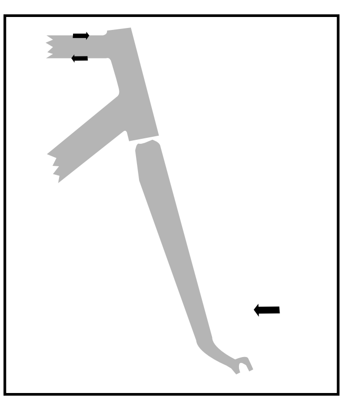


Fig. 9

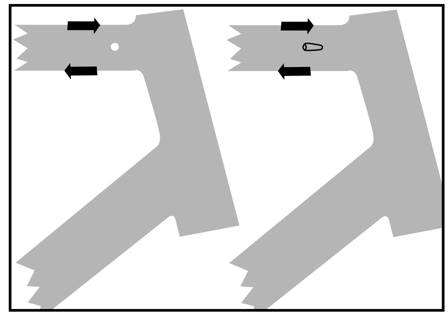


Fig. 10

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.

> "The internal cable routing also makes a Klein more comfortable and even stronger."

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 head tube 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 head tube may be contributing to the "ride". To explain this we have to talk about a common bicycle design myth, that the length of the chainstays or their shape 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 head tube joints (40 years ago this was similarly accomplished with lots of fork rake). The problem is that without Klein dimples, adding flex to the head tube area of another bike will likely reduce its impact and fatigue strength, possible causing premature failure.

Ride a Klein and you'll see. Klein frames are very laterally stiff for drivetrain efficiency, yet Klein dimples allow the frame to flex more vertically and be surprisingly comfortable. 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.

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 chainstay to the derailleur mounting bolt is about 85mm. On a Klein its about 45mm. By shortening the hanger, dramatic increases in hanger strength and stiffness are accomplished, which increases shifting accuracy. Not only that, but the dropout itself is much stronger.

Klein teams new to the design, 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. The Re-Entry ramps really do work to line up the axle and QR for quick engagement.

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.

We overheard one mechanic say he thought MicroDrops were dangerous because the wheel would fall out if the QR was not adequately tightened. 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. Even if you bounce the bike on its rear wheel with the QR undone, the rear wheel stays in MicroDrops.

Fig. 11

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 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. 12), wrap a single finger around the chain immediately in front of the top of the cog (Fig. 13), and lift the chain off the cog.

The chain lift is more positive and reliable than having the derailleur hold the chain. With traditional dropouts, sometimes the chain comes off of the jockey pulleys and a snarl is created.

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 and lighter dropouts, more accurate shifting, a stronger and lighter frame with both increased rigidity and better tire clearance, and faster, easier wheel installation and removal. All in a single design detail.

Void-Free Welds

While you are inspecting the finer design points of a Klein frame, take a moment to admire the fine welds. If you disassemble the bike, inside of the head tube 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 receive only a light cosmetic dressing, no grinding or putty. 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.

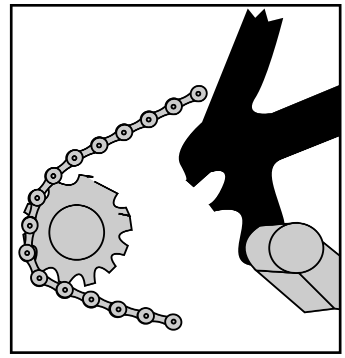


Fig. 12

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!

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 aluminum 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.

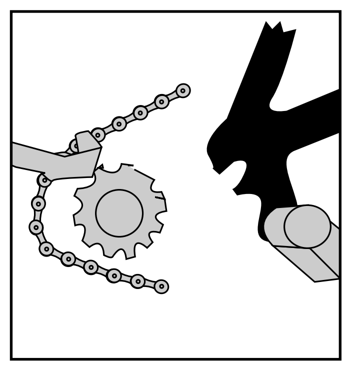


Fig. 13

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

> "By shortening the hanger, dramatic increases in hanger strength and stiffness are accomplished, which increases shifting accuracy."

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 spot on or the frame is scrapped. This is very expensive, but we refuse to sell a bike that we know is less than perfect.

"Klein has gone far beyond any other frame manufacturer to increase strength and minimize weight, right down to the dropouts and cable stops."

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.

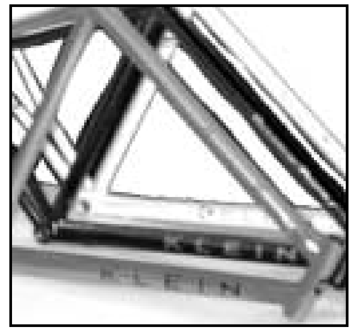


Fig. 14

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 down tube 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. This is very expensive, but we demand a finish that is worthy of the best frames in the world. At Klein, we cover our 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 bicycle frame available is worth the price. Because nothing rides like a Klein.

Command Geometry

Improving the best

Klein road bikes are renowned for their excellent ride. Stock Kleins have been ridden to the podium in European Pro road races as well as the Olympics. The Quantum series gives the rider the winning edge by saving pedaling energy through excellent drivetrain efficiency and stiffness, while providing the all day ride comfort needed to win long road races. And light weight? The Quantum Pro is about the lightest stock fuselage (frame, headset, fork, and stem) on the planet.

So how does one improve on what is arguably the best road bike ever built? By evolving the design along with the sport and new technology.

Inch-and-an-eighth headsets

The new Quantum series (not the Quantum Pro) is moving to the “1 1/8” steerer size popularized by mountain bikes. This change in diameter provides a lighter, stiffer, and stronger structure to the critical head tube area. The larger diameter bearing races allow more balls to support the same load, increasing the life of the headset. The larger diameter of the head tube provides extra strength through increased weld area. The larger tubing diameter of the steerer adds stiffness. And the big steerer allows aluminum to replace steel, reducing weight.

Is Klein following fashion? Hardly. Its more like the mainstream is accepting Gary Klein‘s lead. As proof, the Quantum Pro has featured a Klein Airheadset with all these features (only better) for years.

Corrected geometry for Direct Connect stems

Last year’s Tour de France saw an explosion of Direct Connect type stems on racers bikes. Part of this phenomenon coincides with the use of aluminum steerers and the weight gains won. Part of the acceptance is the increased rigidity of the steering components and increased control. Remember, Tour riders commonly descend narrow, twisty roads at speeds in excess of 50MPH.

However, for most of us simply sticking a Direct Connect stem on an existing bike will end up leaving the handlebars uncomfortably low. The new Command geometry is adjusted to place the handlebars at the correct height while using the lower stack of an Aheadset and without the vertical rise provided by a standard quill stem. Actually, the Command geometry places the handlebars higher than they were in 2000. For 2001, the specs call for flip-flop stems plus 30mm of spacers, resulting in lots more height adjustment than possible with modern quill road stems.

Built for speed

Riders seem to be going faster these days (maybe its those Rolf wheels!). To make the Quantum handle optimally at higher speeds, Gary lowered the rider’s center of gravity a bit. The Command geometry does this primarily by lowering the bottom bracket. The result is a more stable ride, and the new Quantum rocks on the descents!

Focus on small frame fit

Gary’s a big guy. At over 6 feet tall and with long legs, he rides a 61cm Quantum Pro. Gary readily admits he designs for himself first, so its no wonder that the big bikes are totally dialed. With pressure from his young daughters to refine the small bike fit, those smaller frame sizes got Gary’s full attention for 2001. The fit is more precise, with more even sizing increments through the entire line (see the section on Direct Fit).

Refined Steering Geometry

Klein road bikes are famed for responsive and solid handling. For 2001, several changes have been made to the fork designs and steering geometry to actually make them handle better.

On the Quantum series, the ICON AirRail OD fork uses a 1 1/8” steerer. The increased diameter allows this fork to use an aluminum steerer, yet have the same strength and stiffness as the 1” steel steerer used on the 2000 models. The switch to aluminum also takes off 125 grams. Using a Direct Connect stem results in further weight reduction, and in sum a total increase in steering control.

The Klein Aeros carbon fiber fork on the Quantum Pro has been redesigned to reduce weight. We also made it stronger. And while we were at it, we also gave it size-specific offsets. By creating exactly the right fork rake for every head angle, each frame size has its trail dialed. This means handling is optimized on every size for rider weight and weight distribution.

Classic Klein frame features

Of course, it takes more than just geometry to make a Klein. Every detail counts. The Quantums still get the full spectrum of Klein details from Gradient tubing to the industry’s best paint jobs (for a detailed list, see Klein Details).

Klein Frameset Care

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.

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.

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 tube is very important.

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.

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 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.

Rolf wheels set a new standard in wheel performance with patented Paired Spoke Technology (PST). Paired Spoke Technology 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 Technology. 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. 15). 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.

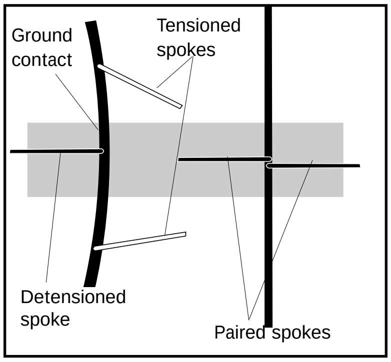


Fig. 15

"Every rider will appreciate that Rolf design means less wheel truing and maintenance."

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 Technology, 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. A rider may not feel the efficiency of a Rolf wheel, and spoke fatigue may take years to cause problems, but every rider will appreciate that Rolf design means less wheel truing and maintenance.

Rolf wheels attack this problem in three ways. First, Paired Spoke Technology 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 Technology 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.

"With Paired Spoke Technology, the rim runs straight because the pairs of spokes do not exert unbalanced force on the rim."

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.

Other Rolf Details

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. 16). Rolf had spokes specially made with a smooth flare, removing the large stress riser created by the abrupt transition found on other spokes.

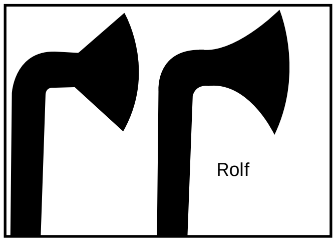


Fig. 16

After looking at Rolf's design, DT is in the process of changing all their spokes to this low-fatigue design.

Why not 'Straight Pull' spokes?

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. Each cyclic torque load to the hub would flex the spoke at its exit point from the hub, incurring fatigue.

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 Technology 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. However, the Rolf tensionometer is calibrated to work with these higher tensions. 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 Technology 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 Technology 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.

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

2001 Rolf Models

Vector Pro

Full bladed 13 gauge spokes and hidden nipples mean only 132 grams total aerodynamic drag at 30MPH. PST means a strong, efficient, durable wheel

750 g front, 930 g rear 14° front/16° rear

Carbon Vector Pro (tubular tires only)

In incredible 397 grams lighter!

That’s almost a pound!

Sestriere

For climbing mountain passes or accelerating quickly to win field sprints, weight can be the most important factor in wheel selection. However, most ultra-light wheels are flexy, wasting power. Rolf Sestriere wheels solve the flex problem with Paired Spoke Technology. And they’re up to 100 grams lighter than the competition.

DT Revolution 14/17 spokes coupled to alloy nipples are built into a special Rolf rim extrusion. Rather than beef up the rim weight to support spokes which are tightly paired, the spokes are spread out just a bit. This lets Rolf decrease the rim weight, and therefore the inertial mass of the wheel is decreased. This also allows the use of a normal, external spoke wrench should the wheels need maintenance.

650 g front, 840 g rear 20° front/24° rear

Vector Comp

The same rim as the Vector Pro, but with standard aero spokes and external nipples. A worthwhile tradeoff for easy maintenance, since the Comps allow the use of a conventional spoke wrench.

18° front/20° rear 820 g front, 1083 g rear

Vector

Paired Spoke Technology at an affordable price. These wheels still offer increased durability, lower maintenance, and reduced drag compared to the ‘standard’ wheels used on most bikes costing hundreds of dollars more.

20° front/24° rear 825 g front, 1097 g rear

Propel XC, tubeless compatible

The ultimate mountain bike wheelset. Rolf PST means stiff wheels for control. Strong wheels for durability. Solid wheels for low maintenance. Ceramic sidewalls resist brake pad wear for long rim life. Tubeless compatible technology. DT Revolution 14/17g. spokes in front and rear left side, 14/15g. on rear drive side, all with alloy nipples.

20° front/24° rear 625 g front, 825g rear

Urraco and Urraco Disc

PST, full labyrinth and contact sealed hubs, tubeless compatible technology.

18° front/20° rear 675 g front, 940 g rear

Dolomite and Dolomite Disc

PST, sealed hubs, tubeless compatible technology.

20° front/24° rear 710 g front, 1010 g rear

Satellite

PST, sealed hubs. These wheels still offer increased durability and lower maintenance compared to the ‘standard’ wheels used on most bikes costing hundreds of dollars more.

20° front/24° rear 830 g front, 1110 g rear

Technical Specifications

For detailed technical specifications, wheel building instructions, spoke lengths, tensions, and hub maintenance information, please refer to the Rolf Wheel Building Manual, Rolf Service Manual, or cybersurf to www.rolf.com.

Disc brake technology

New for bikes

A few years ago, disc brakes were an oddity in the bike industry, mostly isolated to a few odd downhill bikes. Today there are many brands and models of disc brakes on the market. While this proliferation has some benefits, the relative youth of this portion of the industry also has led to some myths as well as some really lousy product making a bad name for some really excellent brakes. Here we will try to cover some of the important issues you should know when selling disc brakes, but our remarks will be addressed to the good brakes; those we have chosen for specification on our bikes.

Disc brake benefits

The main focus on most marketing of disc brakes is stopping power. Its true that good disc brake stop really well. But so do good V type brakes. There are a lot of other benefits from using disc brakes, and we'll list a few of them here.

> "Before providing a test ride on a bike with new disc brakes, explain to the customer that full stopping power will only happen after a dozen or so hard, hot stops have fully burned in the rotor and pads."

Disc brakes work in pretty much all conditions. They don't seem to mind wet, mud, or even snow. Certainly these conditions can degrade their stopping performance, but not to nearly the degree that a rim brake will suffer. If a rider is anticipating wet or snow, or simply an occasional creek crossing, they can get almost the same stopping power with wet discs as dry.

Disc brakes are easy to adjust. And they are not very sensitive to the quality of adjustment. Although adjustment was more of an issue with cantilever brakes than V type brakes, there can still be a loss of performance with a V type brake if it is not set up correctly. Due to the way they work, and their small tolerance for misalignment, its hard to set up a disc brake so it won't work right.

Disc brakes have little fade. When rim brakes are used hard, the heat generated by the rim-pad contact tends to degrade their stopping power.

Heavy use doesn't require constant cable barrel adjustment. With rim brakes in high wear conditions, sometimes a rider will have to adjust the brake cable barrel adjusters several times on a single ride. They may even have to use an allen key to re-adjust the cable length. With a cable actuated disc brake, it only takes a few turns of the adjuster to go from brand new to completely worn out pads. With a Hayes full hydraulic brake, pad adjustment is automatically adjusted simply by opening and closing the lever.

Common rim brake problems can be avoided because disc brakes are hard to set up wrong (at least without knowing it). As an example, a poorly set up rim brake can dive under the rim. Worse yet, as the pads wear they can slide above the rim and wear a hole in the tire sidewall.

Disc brakes do not wear the rim. With rim brakes, its just a matter of time before the rim wears out and has to be replaced. This is especially true with off road bikes ridden in wet conditions, but even happens to bikes ridden exclusively in the desert.

Wheel requirements for disc brakes

Rims on disc brake wheels can be designed to be lower weight. Since the rim no longer needs braking flats, the rim can be made trimmer. Also, the rim designer does not have to anticipate the loss of strength as the pads wear away the rim material.

Disc brake wheels need to have spokes tangential (or close to tangential) to the hub. This allows transfer of braking torque from the hub to the rim and tire.

Disc brake wheels need heavy duty quick releases. Lightweight quick releases may not provide adequate clamping force. As the brake is applied, the wheel will try to rotate around the disc brake pad. Under heavy loads, this force is significant. Should the rotational force exceed the clamping force of the quick release, it could be possible in some cases for the wheel to be pulled from the dropout.

Spacing/bolt pattern information

We saw the advantages of disc brakes early enough to add disc brake mounts to many framesets before the disc brake market was fully mature (not that it is now, but its a lot closer). Unfortunately, those early mounts may not accept some of the newer brakes. Our newer designs are moving to what's being referred to as the "International standard" which places the brake attachment bolts for the front and rear brakes perpendicular to the bike centerline, or parallel with the wheel axles. In some cases it will be necessary to use an adapter to mount the brake to the frame or fork. Make sure the adapter you use correctly positions the brake on the rotor so the pads make full engagement of the rotor, and that the rotor does not contact the caliper body (through correct selection of the rotor outside diameter). Usually this is best accomplished by using the rotor supplied by the brake manufacturer. If you choose to intermix brake and rotor brands, pay attention; they do vary!

This new standard also dictates the bolt hole circle for the rotor/hub attachment. We were already using the 44mm rotor bolt PCD. The last fit issue is the spacing from the centerline of the bike. Our hubs have either conformed to this standard, or used adapters to meet it.

Use caution with disc brakes

With every new technology, there is a learning curve. Make sure you are aware of the issues, and discuss them with your customers. We have included this information in the bicycle Owner's Manual, but you should still try to discuss it with your customer.

Disc brakes get hot. Very hot. After a hard stop, the disc brake rotor can get up into the 300 to 350 degree (F) range.

Avoid rotating parts on a bike, like disc rotors. The rotors are steel, and quite unforgiving should you insert a finger into one while the wheel is spinning.

Make sure all disc brake bolts are tight. This includes brake attachment bolts, brake adapter bolts, and rotor attachment bolts. It should be obvious that loose bolts would not be a good thing.

Make sure the brakes, adapters, and rotors are installed with the correct length of bolts. This is especially a concern when using spacers between the rotor and the hub. Make sure the bolts have adequate engagement in the hub. Not only are short bolts more likely to loosen prematurely, they could potentially strip the hub threads.

Keep the brakes clean, but avoid getting cleaning material on the brakes. Chain lube or other common chemicals used on bikes can contaminate the pads such that the brake will squeal or lose stopping power. Should the rotor or brake pads become contaminated, the only solution may be to replace both the pads and rotor. Before you do so, try using isopropyl alcohol as a cleaner. DO NOT use degreaser or other cleaning agents containing petroleum. Hydraulic fluid can also contaminate the brake. Any time you are going to clean the bike or bleed the brakes, make sure the wheel is removed, and also remove the brake pads.

With rim brakes, pad wear is usually easy to see, even from a distance. This makes it easy to monitor pad wear. With a disc brake, the pads are inside the caliper, so they require a little more vigilance. Replace disc brake pads if they are less than 1mm thick.

A few words about new brakes

When a disc brake is brand new, its likely that they will not stop really well. This is because the rotor is steel, and the new brake pads do not exactly conform to the smooth surface of the rotor. As the brakes "burn in", pad material is transferred to the rotor on a microscopic level. As this occurs, the brake pads will wear to exactly match the surface of the rotor. Also, pad material will be embedded in the rotor, and the coefficient of friction goes way up.

Before providing a test ride on a bike with new disc brakes, explain to the customer that full stopping power will only happen after a dozen or so hard, hot stops have fully burned in the rotor and pads.

During this burn in time, its best to avoid wet weather riding which may impede the burn-in process.

Cable operated mechanical disc brakes

The new generation of cable operated, mechanical disc brakes work really well. They can be tuned to provide good feel and modulation, and meet the expectations of riders who are accustomed to rim brakes in regards to feel and lever travel prior to pad contact. They can even be made to match the feel of a V-type brake used on the rear, if so desired. However, even though the two feel the same at the lever, the mechanical disc brake will stop better once the rotor is burned in.

So if they feel the same, what's the benefit? The disc brake will stop better, works in all conditions, is easy to adjust and maintain adjustment, and does not wear the rim.

Full Hydraulic disc brakes

The full hydraulic disc brake is the most powerful of the brakes we spec. This extra power exists even when the rotor and brake pads are identical between a mechanical disc and hydraulic disc. Its thought that the difference is mostly cable friction and housing compression. It probably also is the result of differences in mechanical advantage, and the need for return springs on the mechanical brake.

Some experienced riders do not like the feel of full hydraulic brakes due to their very short lever throw. People experienced with motorcycle brakes say this is how brakes should be. Why the difference? With a rim brake, its necessary for the brake to open a large distance for the rim to allow debris or mud to pass by, or to allow an out-of-true wheel to rotate freely. With a disc brake, these are not issues. So instead of wasting time moving the lever a long ways prior to pad contact, a full hydraulic brake gives almost instant response. They still offer reach adjustment, so the lever can be adjusted so the stopping power is applied where the hands have the most strength.

Some riders object to full hydraulic brakes because they simply do not understand them. They have a comfort level with the traditional brake cable and housing. For these riders, its important to explain that hydraulic brakes do not have to be bled all the time. Bleeding is normally only necessary when the fluid has been degraded due to heat over a period of time, which on a bike would normally be several years. And actually the whole bleeding procedure is fairly simple. Also explain that the brake hose is very durable.

Lastly, if the extra stopping power isn't enough of an advantage, full hydraulic brakes are actually lighter than most cable operated disc brake systems.

Tubeless Compatible Technology

Snakebite

One of the more common mechanical problems encountered by a rider on a mountain bike ride is the pinch flat. With their tire pressure set on the soft side to enhance traction, the rider runs over a sharp object, like a rock. The soft tire is compressed between the rock and the rim, another hard spot. Caught in the middle of this squeeze play is the tire and the lowly inner tube, made of soft rubber. The tire can resist the compression because it is fairly thick, and has reinforcing threads running through it. The poor inner tube has nothing. Under pressure, the inner tube rubber separates and gets treated to the mountain bikers' nemesis: snakebite, denoted by a pair of matched holes in the inner tube.

> "You can use a conventional tire on our tubeless compatible rims, you just have to use a tube."

A cure for snakebite

Until recently, the only cure for snakebite was to increase the air pressure in the tire. Unfortunately, this solution causes its own problem; reduced traction. To solve this problem, a consortium of rim and tire builders came up with a novel approach; why not eliminate the tube? Following this path they came up with design using a dedicated tire to seal to a dedicated rim and hold air without a tube, dubbed UST.

The downside of UST

The UST 'solution' has a host of its own problems. First, its very expensive. The key to UST is a rim without spoke holes through its outer wall. This design requires a special method of rim manufacturing and spoke installation. Second, this special wheel doesn't use conventional spokes, so to get UST benefits the rider has to buy an entire wheel. Third, a UST rim will not work with a standard tire. And lastly, there is a very limited selection of tires and tread patterns that will fit this special rim.

A second opinion

We considered the pros and cons of UST tubeless technology and saw that there was room for improvement. By finding a different method of containing the air, we were able to use conventional wheel building practices. Not only does this make it less expensive to buy into the system, it also means the wheels are fully serviceable at your local dealer; a real plus for the rider. Second, our rim design is compatible with standard mountain bike tires, given that the rider use an inner tube. With both UST and our Tubeless Compatible system, going tubeless requires a special tire that has a sealing layer on the inside of its casing to prevent the air from simply rushing out. Conventional tires don't have this layer. But again, you can use a conventional tire on our tubeless compatible rims, you just have to use a tube. In addition, with our system you can use the UST tubeless tires.

How did we do it?

The key to our Tubeless Compatible system is a special rim and its mated rim strip. This rim strip is made of a thermoplastic rubber material, so its impervious to air. Installed correctly in the special mated rim, it seals tightly to prevent air escaping through the spoke holes. The rim's hook allows greater contact with the tubeless tire's smooth, enlarged bead so these two surfaces also seal up tight. The inside of the tubeless tire has a special coating to prevent air from escaping through the tire casing. When these features are all in order, no tube is needed. Just install a special presta valve stem into the rim, and inflate.

Does the system absolutely eliminate air leakage?

Have you ever noticed that you occasionally have to pump up your tires (well, really its your tubes), even if they don't have a puncture? In a similar fashion, a properly mounted tubeless tire can 'bleed' air. We expect that this will amount to about 4PSI per day.

For display purposes, 2001 complete bikes with tubeless tires will include an installed inner tube. Since inner tubes have a slower bleed rate, the store won't have lots of bikes sitting on the sales floor with soft tires.

What if I run over a nail with tubeless tires?

A tubeless tire functions like a tire with a tube in it. Its just that the tire holds the air, not the tube. So if you run over a large, sharp object that can penetrate the tire casing, its will probably flat the tire just like with an inner tube.

Also like an inner tube, you can probably patch the hole (from the inside of the tire). The difficulty lies in determining where a tire is punctured. An inner tube is basically fully enclosed. A tubeless tire is not. If the source of the air leak is not immediately obvious, you may have a problem getting the tire inflated enough to locate the puncture. However, if you puncture out on the trail its an easy matter to simply remove the special tubeless valve stem and install a tube.

That's not that bad. anything else that could be considered a down side?

To inflate a tubeless tire, it must be in contact with the rim, tight enough to make full contact with the rim when at the bottom of the rim well. So the tires have to fit on the rim a little tighter. This makes them somewhat harder to install. The good side of this is that it does not take a compressor to initially seat the tire beads. A good hand pump will do. Or an air cartridge.

> "Under pressure, the inner tube rubber separates and gets treated to the mountain bikers' nemesis: snakebite."

With a tire that fits this snug, you might not be able to install it barehanded. If you choose to use tire levers for installation or removal, its important that you do not damage the rim or abrade the tire bead. If either surface is damaged, the roughened surface will likely allow a greater rate of air bleed from the mounted tire.

Klein Custom Program

So you already know Kleins ride great, but were looking for something a little more, uh, exclusive?

Don’t settle for a unique bike that rides less than perfect. Get a custom Klein and you’ll have it all.

So what makes a mass produced Klein unique?

If its a look you want, the Klein Custom program lets you pick from 14 different color and graphics packages.

> “Only Gary has the experience to blend all the Klein frame features to make a bike ride like a Klein.”

‘Graphics’, please.

You may wonder why we say ‘graphics’ and not ‘decals’. Klein graphics are painted on in what we call ‘debossing’. There are NO decals. The custom price includes your choice of custom lettering featuring your name, team, or club affiliations. You can even add Gary’s signature. Again, its NOT a decal.

Which colors are available?

There are 14 colors, which include all stock 2001 colors. For those willing to pay a touch more, the artisans in the Klein custom shop will apply one of several choice Klein ‘memorabilia’ colors from the past, like Nightstorm, or Klein Team graphics.

Can I design my own frame?

There are many things that make a Klein a Klein. One of them is Gary’s proven geometry. While we’re willing to recognize that some people really do know a lot about geometry, those same people will agree that its more than a list of angles that makes a bike ride the way it does. Only Gary has the experience to blend all the Klein frame features to make a bike ride like a Klein.

However, when Klein was a smaller frame shop, Gary spent a lot of time doing just that; designing custom frames for people who either weren’t satisfied with “off the shelf” of couldn’t get comfortably fit. Gary knows the standard size offering misses some of the taller and shorter folks. Unfortunately he’s simply too busy these days in R&D to build one-offs. So within the custom program are frame sizes not available as an offering in standard models, like a 64cm road bike.

What is a Fuselage?

In aircraft terminology, a fuselage is the part of a plane that actually flies. Its the part that has aerodynamics, provides lift, and defines how the bird will act. In other words, its the body of the craft.

On a bike, the frame only specifies a part of the bike fit. The fork further describes how the bike will fit. But only when you have added the stem, do you really know how a bike fits. For years, this was how Klein sold frames (we didn’t sell complete assembled bikes until 1995). A fuselage consists of the frame, fork, and stem, plus the headset joining the parts into a single unit.

> “We are committed to meeting a schedule of 30 day delivery.”

In the custom program, the term Fuselage also tells you how much is custom painted. In a Fuselage, the stem, frame, and fork are all painted to match. To make sure the bike fits, you also get to choose the reach and rise of stem included with the fuselage. Of course, all Fuselages include the Klein Airheadset (see Klein Frame Details).

So exactly which bikes are available in the custom program for 2001?

Quantum Pro

fuselage (frame, fork, MC3 stem, Airheadset)

Quantum Race

frame and fork

Attitude Race

frame only

Adroit Race

fuselage, (frame, Manitou Mars Elite fork, MC3 stem, Airheadset)

Adept Pro

frame, with Fox Float RC rear shock

How long does it take to get a custom Klein?

We are committed to meeting a schedule of 30 day delivery to the dealer from receipt of an order. Considering shipping can take over a week, we hope that’s quick enough!

> “The Klein Custom program lets you pick from 14 different color and graphics packages.”

Need more info?

How much does it cost? Want to see exactly what those custom colors look like? Or you don’t care, you‘re totally sold and want an order form? For further information, contact your sales rep, or cybersurf to www.kleinbikes.com to get the latest.

2001 Klein suspension components

Manitou

For 2001, all Klein mountain bikes use Manitou suspension forks exclusively. Gary believes in plush suspension, and the Manitou suspension forks deliver.

TPC

Manitou forks have the most controlled suspension action available with their TPC (Twin Piston Chamber) damping. This exclusive damping system provides a high volume of oil flow. High volume is easier to control with less variation due to temperature or oil contamination. In addition, there is a LOT of oil in the circuit, so a small amount of contamination has little effect, and neither does the natural heat build up of riding in rough terrain. TPC also uses different volumes in the rebound and compression circuits, so each can offer separate qualities. The circuits are separately valved so that they can react to slider speed for a plush feel on small bumps and excellent resistance to big hits. And last, the rebound and compression are individually adjustable (TPC Sport damping settings are factory set for those who want a great ride but don't want to fiddle).

The benefit of the TPC system is a very smooth, reactive fork that really keeps the wheel on the ground nicely. TPC isn't just comfort, but improved control.

MicroLube

Manitou forks are built to last, with easy maintenance provided via the MicroLube system. MicroLube allows a Manitou owner to use a grease gun to inject grease through a sealed port. Old or contaminated grease is pushed out through the bushings and seals. Keeping fresh grease in the system adds years to the useful life of the fork, while keeping it riding like it just got a tune from the Factory Race Room.

For further information including specs, features, or maintenance, please cybersurf to www.answerproducts.com/manitoumain.htm.

Although Manitou does offer some options, for 2001 all Klein mountain bikes are equipped with 80mm travel.

SX

At just 3.6#, the SX is a lightweight. To achieve this low weight, the SX is equipped with 28.6mm alloy stanchions running inside 1-piece cast magnesium lowers. Manitou has constantly strived for a super-smooth finish on the stanchions, and with the MicroLube system, this fork will stay plush for years with just a few minutes of maintenance a month.

The plush feel of the SX is provided by a 147mm coil spring. A 50mm MCU adds progressiveness to the spring curve for an excellent feeling fork that works on all bump sizes. To keep those springs working smoothly and under control, TPC Sport damping gives separate compression and rebound damping circuits.

The SX comes with canti posts, as well as being compatible with disc brakes using post-mounts with a 74mm (International standard) spacing.

SX-R

By substituting an aluminum steerer for the steel one, the SX-R gets down to 3.5#. It also get full-blown TPC damping with externally adjustable compression and rebound.

Mars

This fork is in the ultra-lightweight category, thanks to the full race features. The Mars uses trick racing features like a new forged, hollow crown, and titanium brake posts to trim down to just 2.9#.

> "TPC Sport damping settings are factory set for those who want a great ride but don't want to fiddle."

The Manitou Air Response System helps make the Mars svelte. Air Response uses air springs coupled with positive and negative coil springs. Some air forks are sticky, or require confusing adjustments to work right. With Air Response and TPC Sport damping, the Mars is an air spring fork with the plush feel that made Manitou famous.

The features list includes MicroLube and disc brake mounts using post-mount calipers with 74mm bolt spacing.

Mars Elite

At 3.0#, this fork is a bit heavier than the Mars, but its a fair trade-off for full TPC damping.

Mars Super

The super adds AntiBob to the feature list of the Mars Elite. AntiBob allows the rider to eliminate rider induced fork bounce, like when climbing out of the saddle. But Antibob is not a lockout; in the antibob mode, the fork still allows a slight amount of movement. And if you forget to turn it off on the downhill, AntiBob will allow blowoff so the fork (and the rider) won't get crushed on an un-anticipated bump.

Fox

Fox Racing Shocks has established themselves as a leader in the suspension industry. Visit any venue where shock absorbers make a difference in getting on the podium, and you'll see the Fox logo. They have been heavily involved in motor sports from snowmobiles to motorcycles. They even specialize in desert car racing, like Baja vehicles. And of course, our favorite; mountain bikes.

For 2001, Fox has mainly focused their considerable engineering horsepower to provide added durability. Due to the low weight requirements on bicycle, they can't provide the shielding and sealing used on shocks found on motor vehicles. Given that a bike's shock is normally right in the path of goop coming off the rear wheel, and the notoriously lax maintenance that many rider's give their bikes, keeping a rear shock working smoothly is a challenge.

To meet the challenge, Fox has invested in new manufacturing processes to maintain quality on the finished parts. Tighter fits and smoother surfaces work to keep parts functioning longer. In conjunction with these changes, they have also created better seals and wipers

While some things have changed, the heart of the Fox line has not. Like with the automotive shocks they produce, Fox continues to use oil damping. Oil is non-compressible, so any shock motion instantly creates damping. This gives a more controlled feel to the bike. The oil also works to keep the whole shock lubricated for smooth action.

> "The negative spring in a Fox Float rear shock is automatically set to match the main spring."

Custom tuned for Klein

The Fox shocks used on Kleins has been custom tuned to match the damping rates to the leverage ratios used on our various suspension systems. This means we get the precise suspension action desired.

However, not everyone agrees with the way we think our bikes should ride. for those so inclined, Fox still offers a custom tuning program where a new bike owner can get their shock tuned to their specifications, free of charge.

Air springs

For super plush suspension, some folks prefer coil springs. But for fast, all-round riding, air shocks pare a lot of weight off their coil spring brethren. In addition, air springs are almost infinitely adjustable, so a new bike owner doesn't have to deal with purchasing aftermarket springs to get the ride they desire.

Air springs also provide a progressive spring curve. With both the mantra and the Adept, this nets an ideal overall feel to the suspension.

High tech air

The Fox Float shocks overcome one negative found on older shocks. By using a negative air spring, the initial stroke of a Float rear shock can be quite supple and stiction free.

Some shocks make you tune the negative spring independent of the main spring. This may be an advantage for the technically advanced rider who likes to fiddle with their bike. But for most folks, the extra adjustment creates confusion and hassle.

With the Float, the negative spring has a through-valve from the main spring. Just pump up the shock and compress it a few times. The negative spring in a Fox Float rear shock is automatically set to match the main spring. Don't fiddle, just ride. Its that simple.

Float

The Fox Float is a full feature shock with custom Klein damping, air negative spring, and solid, durable performance.

Float R

The Float R offers the same features as the Float, but with the addition of an external rebound damping control. Simply turn the knob a click or two to dial in the ride you like.

Float RC

The Float RC offers the discriminating rider both rebound and compression damping control.

Need more info?

Want the latest maintenance instructions? Cybersurf to www.foxracingshox.com/mountainbike.

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 much faster 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. And the rider is, at best, only loosely connected to the bike.

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 the 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.

> “At different speeds and through different terrain with different sized riders, suspension has to do different things.”

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).

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.

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.

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 the springs of an exercise machine. 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 the rider's energy and allowing them to stay in control.

Another energy saving device is conservation of the rider's momentum. When a non-suspended bike hits a bump, some of the forward motion of their center of gravity is converted to vertical motion. In other words, they go up. The energy required to make them go up is subtracted from the energy that was making them go forward. So while they go up, they also slow down. You can test this yourself by coasting into a section of washboards and comparing your speed.

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.

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.

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.

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 unwanted 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-

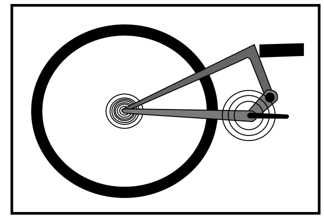


Fig. 17

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.

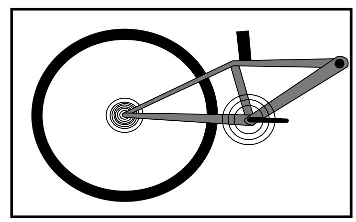


Fig. 18

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. 18) 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-

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 (Fig. 19).

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.

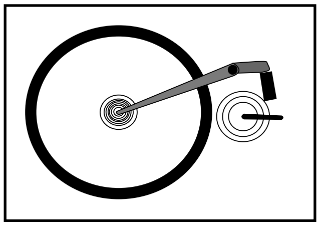


Fig. 19

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-

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. 20). 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 (although the reduced torque applied in higher gears makes this effect less noticeable). 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

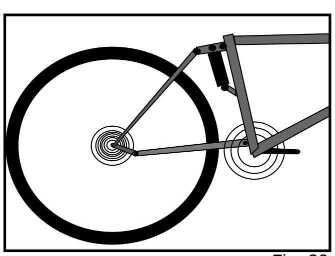


Fig. 20

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

Pivots experience high chain loads

Variations and Hybrids

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.

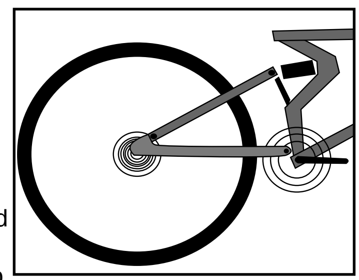


Fig. 21

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. 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 in a suspension design, 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? The best pedal action? 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. so the decrease in torque is not as effective and therefore the effect is less noticeable.

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

> "The more pieces in a suspension design, the greater the weight, flex, & play."

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. 22). 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.

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.

With the fork, the axle path is in a line between the rider's CG and the tire contact patch. If the axle path were perpendicular to this line, the pedaling induced forces would be neutralized and would not activate the suspension.

When the rear wheel encounters a bump, its natural motion to get out of the way is back and up. In the case of rear suspension, its possible to have an axle path perpendicular to a line between the CG and rear tire contact patch. Such a design 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.

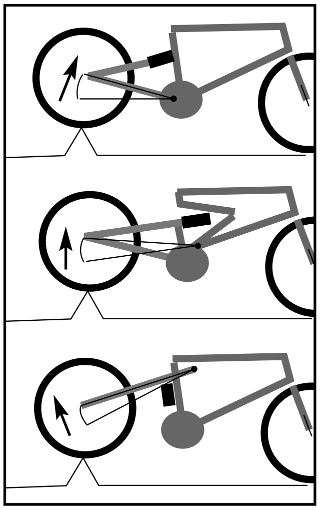


Fig. 22

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. 23). 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.

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 in force, the spring is said to have a Linear spring rate (Fig. 24). 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.

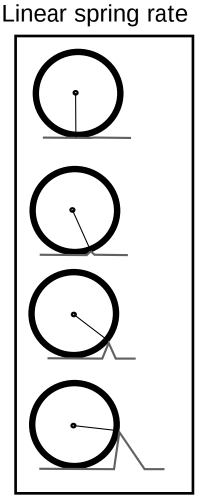


Fig. 23

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.

Metal springs require lots of material, usually steel, so 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 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. 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.

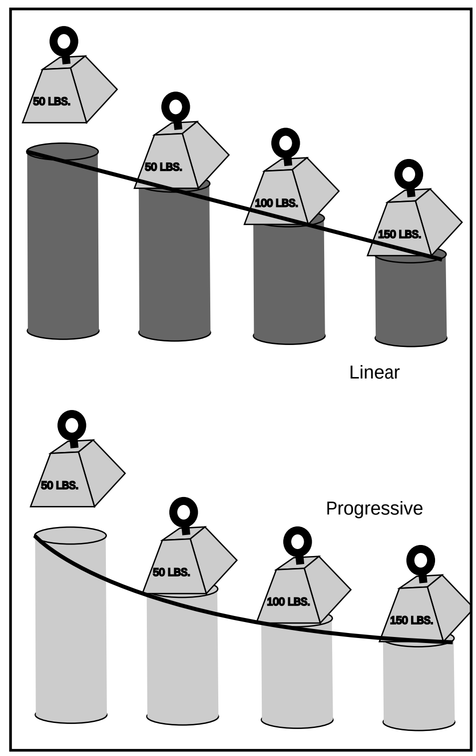


Fig. 24

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. In other words, a long, thin air chamber will provide a very different spring rate then a wide, short air chamber.

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 (sag) 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 a more rising rate (get stiffer) to provide enough shock absorption over big bumps and 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.

Which is better? It depends on how the rider rides, and also what they like.

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

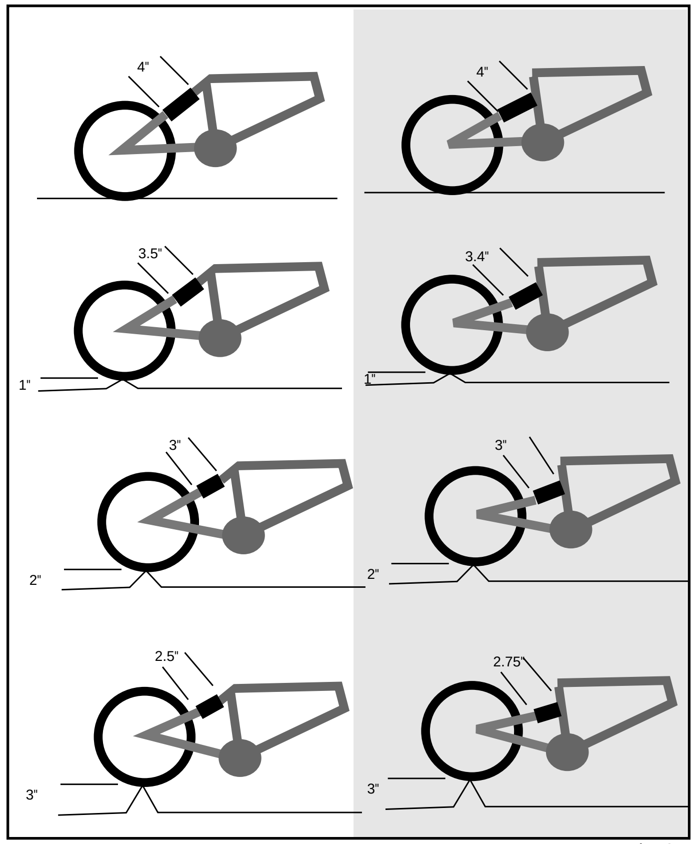


Fig. 25

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 resist 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.

> "If you understand suspension at all, you see that every bike makes some compromises."

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 oversimplification. 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 an Adept with an off-the-shelf shock it will likely have a different damping rate.

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.

> "Any suspension bike will ride better if it's tuned to the rider. "

K*Link

A design departure

The new series of Klein full suspension bikes, the Klein Adepts, are a departure from previous Klein models; its the first Klein that didn't originate solely from the fertile minds in the Klein R&D lab.

But the Adept keeps within another Klein tradition. It comes from Gary riding bikes. Gary was testing an "off-brand" bike (non-Klein), something he frequently does. After riding this competitor's bike, Gary declared he liked the suspension, but he missed the sweet Klein steering response. The rest is history. Gary created a new front end using Adroit geometry. Then he added the B*Link swingarm from the race-proven Fisher Sugar. Presto: the new Klein Adept was born.

Fig. 26

Of course, Gary's never satisfied with how any bike rides. He immediately added rear end stiffness with his new K*Link (Fig. 26). And he's probably already dreaming about how to shave off 10 grams here, a few more over there.....But that's why a Klein is a Klein.

What's so hot about the Adept?

• Hardtail feel. This is the result of the torsional and bending rigidity of the frame. This stiffness partly comes from the K*Link and the use of wide, axle type pivots. It is also the result of incorporating all the outstanding frame features you would expect on a Klein.

• Supple suspension. A near vertical axle path allows the rear wheel to easily move over even small stuff. There is minimal geometry change. The rebound is snappy such that the rider on a properly adjusted Adept does not really feel the suspension activating.

Meanwhile, the Adept uses a slightly falling shock compression rate which combines with the progressive nature of the air shock to yield a more linear suspension. This means you can use all the suspension when its needed, but the bike feels firm under normal pedaling.

A low leverage ratio lets the shock work at its best at low pressures. As an extra benefit, the low preload pressure means its a lot less work to pump up the rear shock.

• Low weight. If you know Klein, you know the weight of the frame went under careful scrutiny. Gary did it again!

• Klein handling. If you asked Gary what makes a Klein handle the way it does, you'd be here all day and night. He'd explain in precise detail that everything is important. There is no single thing that makes a Klein a Klein. Instead, its the perfect execution of every detail.

Suspension design

The Adept uses a low pivot simple swingarm. This type of design provides a fairly vertical axle path, good for feeling supple over smaller bumps. Its also simple; its reliance on large diameter, wide pivots means its durable and low maintenance. Klein technology means the pivot and linkage bushings are tightly sealed and permanently lubricated.

Variations from a standard swingarm

The difference between this bike and other simple swingarm designs is the K*Link. Joined to the frame and the swingarm with lengthy axles, the K*Link creates a rear structure that provides almost as much frame rigidity as an Adroit. Instead of asking a single pivot, or the shock, to control lateral and torsional flex in the rear end, the K*Link doubles the bike's ability to do the job. The K*Link is the key to the hardtail-like steering control.

Fig. 27

Eliminating rear end flex

The "disconnected" feel of a flexy rear end greatly reduces steering precision since the rear wheel isn't running in plane with the rest of the bike. The K*Link design directly opposes twisting and bending forces applied by the rear wheel. This is a very effective design, using the pivots joining that link to the frame and swingarm to bolster the frame's lateral rigidity.

With many suspension designs, all the torsion and flex from the rear wheel has to be controlled by a single pivot. Some designs rely on the rear shock, causing premature seal wear. Others use a collection of narrow pivots, all placed in the load path. The width of the outer bearing surfaces primarily determines the lateral stiffness of a pivot. The K*Link pivots ride on axles as wide as the main pivot of many designs.

Chain tension

With the Adept's low pivot position, chain tension affecting the suspension is used to help the rider. In low gears with the chain on the inner ring, chain tension pulls the wheel downward for increased traction. In higher gears its possible for chain tension to compress the suspension, but pedal torque is low enough in these high gears that any suspension compression is imperceptible. In the middle ring, the pivot location is in line with the chain run, which makes the effect of chain tension almost negligible.

Travel

The Adept has 75mm of rear wheel travel. For a performance rider the Adept offers the perfect blend of shock absorption and pedaling efficiency. The performance rider simply doesn't need more shock protection than this.

Adept Frame Specs

		Frame sizes	S	M	L	XL
		Head angle	70.8	71.3	71.4	71.4
		Seat angle	73.5	73.5	73.5	73.5
MILLIMETERS		Standover	701	708	727	750
		Seat tube	395	445	490	535
		Head tube	90	105	125	165
		Eff top tube	575	596	612	628
		Chainstays	415	415	415	415
		BB height	304	304	304	304
		Offset	38.1	38.1	38.1	38.1
		Trail	77	73	73	73
		Wheelbase	1047	1063	1079	1096
INCHES		Standover	27.6	27.9	28.6	29.5
		Seat tube	15.6	17.5	19.3	21.1
		Head tube	3.5	4.1	4.9	6.5
		Eff top tube	22.6	23.4	24.1	24.7
		Chainstays	16.3	16.3	16.3	16.3
		BB height	12.0	12.0	12.0	12.0
		Offset	1.5	1.5	1.5	1.5
		Trail	3.0	2.9	2.9	2.9
		Wheelbase	41.2	41.8	42.5	43.1

Rider Profile

This rider is more likely an all-round performance oriented rider of all terrains and technical difficulties. They may also be a racer looking for a technical advantage.

The Adept is a singletrack enthusiasts dream. Its quick, precise, and agile. It feels like a hardtail, so it takes zero time for a rider to learn how to ride it. But a rider can go all day with less fatigue, because the suspension takes the hard edges off the terrain.

The excellent handling is largely thanks to frame rigidity, and having a very neutral suspension design. And of course having the responsiveness of an Adroit doesn't hurt.

Klein Feature List:

- K*Link
- Reinforced Head tube/Down tube Junction
- Gradient Tubing
- Large Diameter Frame Tubing
- Internal cable routing
- Klein Heat Treating
- Gradient Chainstays
- Aerospace Grade Aluminum
- Void-Free Welds
- The Finest Paint Jobs
- The Lightest Frames that Money Can Buy

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	25.4/34.0/30.0
Fork length	443mm
Front derailleur	High band clamp (only) Top pull, 34.9mm/ 1 3/8”
Bottom bracket	73mm
Shock length	6.5”
Shock eye width	1/2 and 7/8”
Shock eye ID	6mm at frame, 15.08mm at link axle
Shock stroke	1.5”
Rear wheel travel	75mm
Rear hub OLD	135mm
Cable stops	3 cables
Disc brake mount	International type Adapter required
Bottle mounts	1 frame
Rack mounts	No

Parts list	**Part Number**
Pivot axle set	
Bushing set	
Seatpost clamp	970605
Replaceable derailleur hanger	980116
Disc brake adapter	

Seatposts

Adepts 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 it from seizing in the frameset.

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 Adept frame will only fit high band clamp, top pull front derailleur. 'Top Swing' type derailleurs will not allow correct positioning due to interference with the swingarm pivot.

International disc brake mount

The Adept does not use MicroDrops. The MicroDrop design is not compatible with the international standard for disc brake mounts. With this new brake mount, the disc brake is positioned such that under hard braking loads with a loose rear wheel quick release, the axle could move out of the MicroDrop. With a conventional dropout, the braking force or a disc brake actually moves the axle firmly into the dropout.

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.

Fitting the Adept

To best fit the Adept frames, start with our recommendations for overall body height. 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 30mm 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. To achieve a flat saddle while riding, set the saddle tilt slightly nose down so that the sag will level the saddle.

Suspension set up

When setting up an Adept for a test ride, we suggest between 3 and 4mm of front fork sag, and the same rear shock sag (measured at the shock). This is usually accomplished with about the rider's weight in PSI in the rear shock. The design is not meant to be deeply plush. Instead, it gives a very firm feel to the pedals, much like a hardtail. Except that bumps have been diminished so the rider can pedal smoothly in the saddle, and traction is greatly enhanced in rougher terrain.

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 adjusting the suspension is easy and makes a large difference in its performance. Encourage them to try it with a different setting so they get the ideal ride.

Our Price: $ ________ Adept Comp

Main tubes	Klein Gradient aluminum			
Stays	Aluminum/ OCLV carbon			
Fork	Manitou SX	80mm travel		
Rear shock	Fox Float	1.5"" stroke, 70mm rear wheel travel 6.5" eye to eye, .5 x 7/8, open eyes ends		
Headset	STR Aheadset	25.4/34.0/30.0, 20.5mm stack		
Handlebars	Bontrager Cruiser	25.4mm clamp diameter		
Stem	Bontrager Sport AHS	41.0mm steerer clamp height		
Bar ends	- not supplied -			
Grips	Bontrager Ergo			
Shifters	Shimano Deore RapidFire+			
Front derailleur	Shimano Deore LX	Top pull, 34.9 mm/ 1 3/8", high clamp only		
Rear derailleur	Shimano Deore LX SGS			
Front brake	Shimano M420	V type		
Rear brake	Shimano M420	V type		
Brake levers	Alloy, direct pull			
Crankset	Bontrager Comp 44/32/22	64/104 mm bolt hole circle		
Bottom bracket	Shimano BB-LP27	73 x 113		
Pedals	Shimano SPD M515, clipless	9/16" axle		
Cassette	SRAM 7.0 11-32	9spd		
Chain	SRAM PC-59 Power	106 length, 9 speed		
Front wheel	Rolf Satellite	542 E.R.D., Velox 19mm rim strip		
Rear wheel	Rolf Satellite	HyperGlide cassette, 8/9spd, 135mm O.L.D., 542 E.R.D., Velox 22mm rim strip		
Spokes	DT 14G stainless	20 spoke Radial Front 254	24 spoke 2x Rear 265/263 rear (D/ND)	
Front tire	Bontrager Super-X, folding	49/48		
Rear tire	Bontrager Super-X, folding	49/48		
Tubes	Presta valve, ultra light			
Saddle	Bontrager FS 2000, Cro-Moly rails			
Seatpost	Bontrager Sport	31.6mm diameter		
Seat binder	Alloy w/integral bolt	36.4 clamp diameter		
Additionals	2 water bottle mounts, CCD			
Colors	Jamaican Gold / Black fork • Black logo			

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

27.3 lb.
12.39 kg.

Frame sizes	S	M	L	XL
Handlebar width	580	580	580	580
Stem length	105	120	120	135
Stem angle	15	15	15	15
Crank length	175	175	175	175
Seatpost length	350	350	350	350
Front brake hose				
Rear brake hose				
Steerer, mm	167.5	182.5	202.5	242.5
Fork length	442.0			
Direct Fit	8.0	8.4	8.6	9.0
Direct Fit Angle	51.4	50.9	51.1	52.1
MM				
Rider Height	171	179	184	194
Small Rider Height	166	174	179	189
Large Rider Height	174	182	187	197
IN				
Rider Height	67	71	72	76
Small Rider Height	65	68	70	74
Large Rider Height	69	72	74	78

Adept Race

Our Price: $

Main tubes	Klein Gradient aluminum	
Stays	Aluminum/ OCLV carbon	
Fork	Manitou SX-R	80mm travel
Rear shock	Fox Float R	1.5"" stroke, 70mm rear wheel travel 6.5" eye to eye, .5 x 7/8, open eyes ends
Headset	SAS Aheadset, alloy	25.4/34.0/30.0, 27.0mm stack
Handlebars	Bontrager Super Stock	25.4mm clamp diameter
Stem	Bontrager Comp AHS	41.0mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager Ergo	
Shifters	Shimano Deore LX RapidFire+	
Front derailleur	Shimano Deore LX	Top pull, 34.9 mm/ 1 3/8", high clamp only
Rear derailleur	Shimano Deore XT SGS	
Front brake	Avid Single Digit 3	linear pull
Rear brake	Avid Single Digit 3	linear pull
Brake levers	Shimano Deore LX	Integrated brake/shift
Crankset	Bontrager Race 44/32/22	64/104 mm bolt hole circle
Bottom bracket	Shimano BB-UN52	73 x 113
Pedals	Shimano SPD M515, clipless	9/16" axle
Cassette	Shimano HG50 11-32	9spd
Chain	Shimano HG-72	108 length, 9 speed
Front wheel	Rolf Dolomite	538 E.R.D., Velox 19mm rim strip
Rear wheel	Rolf Dolomite	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip
Spokes	DT 14/15G butted stainless, Al nips	20 spoke Radial Front 250; 24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, folding	49/48
Rear tire	Bontrager Super-X, folding	49/48
Tubes	Presta valve, ultra light	
Saddle	Bontrager FS 2000, Gel, Cro-Moly/leather	
Seatpost	Bontrager Race	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	2 water bottle mounts, CCD	
Colors	Big Sky Blue / Cobalt Blue fork • White logo	

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

26.7 lb.
12.12 kg.

Frame sizes	S	M	L	XL
Handlebar width	580	580	580	580
Stem length	105	120	120	135
Stem angle	10	10	10	10
Crank length	175	175	175	175
Seatpost length	350	350	350	350
Front brake hose				
Rear brake hose				
Steerer, mm	179.0	194.0	214.0	254.0
Fork length	442.0			
Direct Fit	8.0	8.4	8.6	9.1
Direct Fit Angle	51.5	50.8	51.0	51.9
MM Rider Height	172	180	185	195
Small Rider Height	166	174	179	189
Large Rider Height	175	183	188	198
IN Rider Height	68	71	73	77
Small Rider Height	65	69	70	74
Large Rider Height	69	72	74	78

Adept Race Disc

Front brake	Hayes Disc, full hydraulic	6.3 in. rotor, 44mm bolt hole circle
Rear brake	Hayes Disc, full hydraulic	
Brake levers	Hydraulic, attached to brake	
Seatpost length	600 / 600 / 600 / 600	
Front brake hose	1160 / 1160 / 1160 / 1160	
Front wheel	Rolf Dolomite Disc	538 E.R.D., Velox 22mm rim strip
Rear wheel	Rolf Dolomite Disc	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip
Spokes	DT 14/15G butted stainless, Al nips	24 spoke 2x Front 261/263; 24 spoke 2x Rear 261/260 rear (D/ND)

27.7 lb.
12.58 kg.

Our Price: $

Adept Pro

Our Price: $

Main tubes	Klein Gradient aluminum	
Stays	Aluminum/ OCLV carbon	
Fork	Manitou Mars Super	80mm travel
Rear shock	Fox Float RC	1.5"" stroke, 70mm rear wheel travel 6.5" eye to eye, .5 x 7/8, open eyes ends
Headset	SAS Aheadset, alloy	25.4/34.0/30.0, 27.0mm stack
Handlebars	Bontrager Race Lite	25.4mm clamp diameter
Stem	Bontrager Race Lite AHS	39.5mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager Ergo	
Shifters	Shimano Deore XT RapidFire SL	
Front derailleur	Shimano Deore XT	Top pull, 34.9 mm/ 1 3/8", high clamp only
Rear derailleur	Shimano XTR SGS	
Front brake	Avid Single Digit Mag	linear pull
Rear brake	Avid Single Digit Mag	linear pull
Brake levers	Shimano Deore XT	Integrated brake/shift
Crankset	Shimano Deore XT 44/32/22	64/104 mm bolt hole circle
Bottom bracket	Shimano BB-ES70	73 x 113
Pedals	Bontrager RE-1, clipless	9/16" axle
Cassette	Shimano Deore XT 12-34	9spd
Chain	Shimano HG-72	108 length, 9 speed
Front wheel	Rolf Propel, tubeless compatible	538 E.R.D., tubeless rim strip
Rear wheel	Rolf Propel, tubeless compatible	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., tubeless rim strip
Spokes	DT 14/15G butted stainless, Al nips	20 spoke Radial Front 252; 24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, 127tpi, folding	49/48
Rear tire	Bontrager Super-X, 127tpi, folding	49/48
Tubes	Presta valve, ultra light (for display)	
Saddle	Bontrager Race	
Seatpost	Bontrager Race	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	2 water bottle mounts, CCD	
Colors	Plum Crazy/ Cobalt Blue fork • Silver logo	

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

25.0 lb.
11.35 kg.

Frame sizes	S	M	L	XL
Handlebar width	620	620	620	620
Stem length	105	120	120	135
Stem angle	7	7	7	7
Crank length	175	175	175	175
Seatpost length	350	350	350	350
Front brake hose				
Rear brake hose				
Steerer, mm	172.5	187.5	207.5	247.5
Fork length	442.0			
Direct Fit	8.0	8.3	8.5	9.0
Direct Fit Angle	50.7	50.1	50.3	51.2
MM				
Rider Height	171	179	183	193
Small Rider Height	166	174	178	188
Large Rider Height	174	182	186	196
IN				
Rider Height	67	70	72	76
Small Rider Height	65	68	70	74
Large Rider Height	68	72	73	77

Mantra Frame Specs

Frame sizes	S	M	L	X
Head angle	71.2	71.7	71.8	71.8
Seat angle	73.2	73.2	73.2	73.2
MILLIMETERS				
Standover	726	738	778	791
Seat tube	444	448	489	533
Head tube	105	105	125	165
Eff top tube	573	594	610	626
Chainstays	417	417	417	417
BB height	310	315	319	323
Offset	38	38	38	38
Trail	74	71	70	70
Wheelbase	1042	1062	1076	1095
INCHES				
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
Chainstays	16.4	16.4	16.4	16.4
BB height	12.2	12.4	12.6	12.7
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

Rider Profile

The Mantra is ideal as an adventure bike, and 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.

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.

So what's the difference between a Carbon Mantra customer and an Adept customer? The Adept is like a comfortable hardtail with full suspension traction, while the Mantra is a long travel suspension bike with incredible singletrack handling and climbing.

Klein Feature List:

- Spot-On™ Geometry
- Airheadset™
- Reinforced Head tube/Down tube Junction
- Gradient 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

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.

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

This 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.

Airheadset

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

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 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. 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 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. To achieve a flat saddle while riding, set the tilt slightly nose down so that the sag will level the saddle.

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. This sensitivity is an awesome tool in the hands of an experienced rider, but can surprise someone who isn't expecting it. Using the front brake with too much force can cause the suspension to extend and the front of the bike to dive. 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.

Our Price: $ ________

Mantra Carbon

Main tubes	Klein Hexcel carbon fiber composite		
Stays	Klein Gradient aluminum		
Fork	Manitou SX-R	80mm travel	
Rear shock	Fox Float, air/oil	2.5" stroke, 178 rear wheel travel 7.875" eye to eye, 7/8" ends	
Headset	Klein Airheadset w/shim to 1 1/8"	33.3/ 1.75-2" /39.7, 20.5mm stack	
Handlebars	Bontrager Crowbar Sport	25mm rise, 25.4mm clamp diameter	
Stem	Bontrager Sport AHS	41.0mm steerer clamp height	
Bar ends	- not supplied -		
Grips	Bontrager Ergo		
Shifters	Shimano Deore RapidFire+		
Front derailleur	Shimano Deore LX	Down pull, Plate style	
Rear derailleur	Shimano Deore XT SGS		
Front brake	Avid Single Digit 3	linear pull	
Rear brake	Avid Single Digit 3	linear pull	
Brake levers	Alloy, direct pull		
Crankset	Bontrager Comp 44/32/22	64/104 mm bolt hole circle	
Bottom bracket	Shimano BB-UN52E	73 x 113	
Pedals	Shimano SPD M515, clipless	9/16" axle	
Cassette	Shimano HG50 11-32	9spd	
Chain	Shimano HG-72	108 length, 9 speed	
Front wheel	Rolf Dolomite	538 E.R.D., Velox 19mm rim strip	
Rear wheel	Rolf Dolomite	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip	
Spokes	DT 14/15G butted stainless, Al nips	20 spoke Radial Front 250	24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, folding	49/48	
Rear tire	Bontrager Super-X, folding	49/48	
Tubes	Presta valve, ultra light		
Saddle	Bontrager FS 2000, Cro-Moly rails		
Seatpost	Bontrager Sport	31.6mm diameter	
Seat binder	Alloy w/integral bolt	39.85 clamp diameter	
Additionals	1 water bottle mount, CCD, replaceable derailleur hanger, shock pump		
Colors	Silver/Blue Linear / Red fork • Red logo		

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

27.1 lb.
12.30 kg.

Frame sizes	S	M	L	XL
Handlebar width	620	620	620	620
Stem length	105	120	135	135
Stem angle	15	15	15	15
Crank length	175	175	175	175
Seatpost length	350	350	350	350
Front brake hose				
Rear brake hose				
Steerer, mm	187.5	187.5	207.5	247.5
Fork length	442			
Direct Fit	8.2	8.5	8.8	9.1
Direct Fit Angle	53.5	51.7	51.4	52.5
MM				
Rider Height	176	182	189	196
Small Rider Height	170	176	183	190
Large Rider Height	179	185	192	199
IN				
Rider Height	69	72	74	77
Small Rider Height	67	69	72	75
Large Rider Height	70	73	76	78

Adroit Frame Specs

	Frame sizes	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
MILLIMETERS	Standover	669	703	735	772	814
	Seat tube	356	400	445	489	533
	Head tube	90	105	105	125	165
	Eff top tube	550	573	594	610	626
	Chainstays	417	417	417	417	417
	BB height	287	292	297	300	302
	Offset	35	35	35	35	35
	Trail	81	77	74	74	74
	Wheelbase	1014	1035	1053	1069	1087
INCHES	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
	Chainstays	16.4	16.4	16.4	16.4	16.4
	BB height	11.3	11.5	11.7	11.8	11.9
	Offset	1.4	1.4	1.4	1.4	1.4
	Trail	3.2	3.0	2.9	2.9	2.9
	Wheelbase	39.9	40.7	41.5	42.1	42.8

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 single-track 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:

- Airheadset™
- Internal Cable Routing
- Reinforced Head tube/Down tube 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

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

Adroits 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.

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.

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, and Airheadset™/MC3 Service.

New fork length

This 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. 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 Race

Our Price: $ ________

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	Manitou Mars Elite	80mm travel
Headset	Klein Airheadset	33.3/ 1.75-2" /39.7, 20.5mm stack
Handlebars	Bontrager Race Modified	25.4mm clamp diameter
Stem	Klein MC3	45.0mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager dual density	
Shifters	Shimano Deore XT RapidFire SL	
Front derailleur	Shimano Deore XT	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano XTR SGS	
Front brake	Avid Single Digit Mag	linear pull
Rear brake	Avid Single Digit Mag	linear pull
Brake levers	Shimano Deore XT	Integrated brake/shift
Crankset	Shimano Deore XT 44/32/22	58/104 mm bolt hole circle
Bottom bracket	Shimano BB-ES70	73 x 113
Pedals	Bontrager RE-1, clipless	9/16" axle
Cassette	Shimano Deore XT 12-34	9spd
Chain	Shimano HG-72	108 length, 9 speed
Front wheel	Rolf Propel, tubeless compatible	538 E.R.D., tubeless rim strip
Rear wheel	Rolf Propel, tubeless compatible	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., tubeless rim strip
Spokes	DT Revolution 14/17G, Al nips	20 spoke Radial Front 252; 24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, 127tpi, folding	49/48
Rear tire	Bontrager Super-X, 127tpi, folding	49/48
Tubes	Presta valve, ultra light (for display)	
Saddle	Bontrager Race	
Seatpost	Bontrager Race	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	3 water bottle mounts, CCD	
Colors	Plum Crazy/ Cobalt Blue fork • Silver logo	

	22	32	44
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
20	29	42	58
23	25	36	50
26	22	32	44
30	19	28	38
34	17	25	34

24.0 lb.
10.90 kg.

Frame sizes	XS	S	M	L	XL
Handlebar width	580	580	580	580	580
Stem length	90	105	120	120	135
Stem angle	6	6	6	6	6
Crank length	170	175	175	175	175
Seatpost length	350	350	350	350	350
Front brake hose					
Rear brake hose					
Steerer, mm	176.5	191.5	191.5	211.5	251.5
Fork length	442				
Direct Fit	7.7	8.1	8.3	8.5	9.0
Direct Fit Angle	53.9	52.6	50.7	50.8	51.6
MM Rider Height	166	174	179	183	193
Small Rider Height	160	168	173	178	187
Large Rider Height	169	177	182	186	196
IN Rider Height	65	68	71	72	76
Small Rider Height	63	66	68	70	74
Large Rider Height	66	70	72	73	77

Attitude Frame Specs

	Frame sizes	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
MILLIMETERS	Standover	669	703	735	772	815
	Seat tube	356	400	445	489	533
	Head tube	90	105	105	125	165
	Eff top tube	550	573	594	610	626
	Chainstays	417	417	417	417	417
	BB height	287	292	297	300	302
	Offset	38.1	38.1	38.1	38.1	38.1
	Trail	77	74	71	70	70
	Wheelbase	1014	1035	1053	1069	1087
INCHES	Standover	26.3	27.7	28.9	30.4	32.1
	Seat tube	14.0	15.7	17.5	19.2	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
	Chainstays	16.4	16.4	16.4	16.4	16.4
	BB height	11.3	11.5	11.7	11.8	11.9
	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	42.1	42.8

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:

Reinforced Head tube/Down tube Junction
Internal Cable Routing
Gradient 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

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 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

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.

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.

Fitting the Attitude

To best fit the Attitude frames, start with our recommendations for overall body height. 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 spacers, and adjust the saddle position.

Attitude

Our Price: $ ______

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	Manitou SX	80mm travel
Headset	STR Aheadset	25.4/34.0/30.0, 20.5mm stack
Handlebars	Bontrager Super Stock	25.4mm clamp diameter
Stem	Bontrager Sport AHS	41.0mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager Ergo	
Shifters	Shimano Deore RapidFire+	
Front derailleur	Shimano Deore	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano Deore LX SGS	
Front brake	Shimano M420	V type
Rear brake	Shimano M420	V type
Brake levers	Alloy	
Crankset	Bontrager Comp 44/32/22	64/104 mm bolt hole circle
Bottom bracket	Shimano BB-LP27	73 x 113
Pedals	Shimano SPD M515, clipless	9/16" axle
Cassette	SRAM 7.0 11-32	9spd
Chain	SRAM PC-59 Power	106 length, 9 speed
Front wheel	Rolf Satellite	542 E.R.D., Velox 19mm rim strip
Rear wheel	Rolf Satellite	HyperGlide cassette, 8/9spd, 135mm O.L.D., 542 E.R.D., Velox 22mm rim strip
Spokes	DT 14G stainless	20 spoke Radial Front; 24 spoke 2x Rear
		254; 265/263 rear (D/ND)
Front tire	Bontrager Super-X, folding	47/46
Rear tire	Bontrager Super-X, folding	47/46
Tubes	Presta valve, ultra light	
Saddle	Bontrager FS 2000, Cro-Moly	
Seatpost	Bontrager Sport	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	3 water bottle mounts (2 on XS), CCD	
Colors	Big Sky Blue / Cobalt Blue fork • White logo	

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

26.3 lb.
11.94 kg.

Frame sizes	XS	S	M	L	XL
Handlebar width	580	580	580	580	580
Stem length	90	105	120	120	135
Stem angle	15	15	15	15	15
Crank length	170	175	175	175	175
Seatpost length	300	350	350	350	350
Front brake hose					
Rear brake hose					
Steerer, mm	172.5	187.5	187.5	207.5	247.5
Fork length	442.0				
Direct Fit	7.8	8.1	8.4	8.6	9.1
Direct Fit Angle	54.7	53.5	51.8	51.8	52.6
MM					
Rider Height	166	174	180	185	194
Small Rider Height	161	168	174	179	188
Large Rider Height	170	177	183	188	197
IN					
Rider Height	66	69	71	73	77
Small Rider Height	63	66	69	70	74
Large Rider Height	67	70	72	74	78

Our Price: $ ________

Attitude Comp

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	Manitou SX-R	80mm travel
Headset	STR Aheadset	25.4/34.0/30.0, 20.5mm stack
Handlebars	Bontrager Super Stock	25.4mm clamp diameter
Stem	Bontrager Comp AHS	41.0mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager Ergo	
Shifters	Shimano Deore LX RapidFire+	
Front derailleur	Shimano Deore LX	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano Deore XT SGS	
Front brake	Avid Single Digit 3, linear pull	
Rear brake	Avid Single Digit 3, linear pull	
Brake levers	Shimano Deore LX	Integrated brake/shift
Crankset	Bontrager Race 44/32/22	64/104 mm bolt hole circle
Bottom bracket	Shimano BB-UN52	73 x 113
Pedals	Shimano SPD M515, clipless	9/16" axle
Cassette	Shimano HG50 11-32	9spd
Chain	Shimano HG72	108 length, 9 speed
Front wheel	Rolf Dolomite	538 E.R.D., Velox 19mm rim strip
Rear wheel	Rolf Dolomite	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip
Spokes	DT 14/15G butted stainless, Al nips	20 spoke Radial Front 250; 24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, folding	49/48
Rear tire	Bontrager Super-X, folding	49/48
Tubes	Presta valve, ultra light	
Saddle	Bontrager FS 2000, Cro-Moly	
Seatpost	Bontrager Sport	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	3 water bottle mounts (2 on XS), CCD	
Colors	Approaching Storm / Black fork • White logo	

	22	32	44
11	52	76	105
12	48	70	96
14	41	60	82
16	36	52	72
18	32	47	64
21	27	40	55
24	24	35	48
28	21	30	41
32	18	26	36

25.5 lb.
11.58 kg.

Frame sizes	XS	S	M	L	XL
Handlebar width	580	580	580	580	580
Stem length	90	105	120	120	135
Stem angle	5	10	10	10	10
Crank length	170	175	175	175	175
Seatpost length	300	350	350	350	350
Front brake hose					
Rear brake hose					
Steerer, mm	172.5	187.5	187.5	207.5	247.5
Fork length	442				
Direct Fit	7.7	8.1	8.4	8.6	9.0
Direct Fit Angle	53.6	52.9	51.1	51.2	51.9
MM Rider Height	165	174	180	184	194
Small Rider Height	160	168	174	178	188
Large Rider Height	168	177	183	187	196
IN Rider Height	65	69	71	72	76
Small Rider Height	63	66	68	70	74
Large Rider Height	66	70	72	74	77

Attitude Comp Disc

Front brake	Hayes Disc, full hydraulic		6.3 in. rotor, 44mm bolt hole circle			
Rear brake	Hayes Disc, full hydraulic					
Brake levers	Hydraulic, attached to brake					
Seatpost length	690	690	690	690	750	
Front brake hose	1280	1280	1280	1280	1350	
Front wheel	Rolf Dolomite Disc		538 E.R.D., Velox 22mm rim strip			
Rear wheel	Rolf Dolomite Disc		HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip			
Spokes	DT 14/15G butted stainless, Al nips		24 spoke 2x Front 261/263		24 spoke 2x Rear 261/260 rear (D/ND)	

26.5 lb.
12.03 kg.

Our Price: $ ________

Our Price: $ ________ Attitude Race

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	Manitou Mars	80mm travel
Headset	SAS Aheadset, alloy	25.4/34.0/30.0, 27.0mm stack
Handlebars	Bontrager Race Modified	25.4mm clamp diameter
Stem	Bontrager Comp AHS	41.0mm steerer clamp height
Bar ends	- not supplied -	
Grips	Bontrager Ergo	
Shifters	Shimano Deore XT RapidFire SL	
Front derailleur	Shimano Deore XT	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano XTR SGS	
Front brake	Avid Single Digit 5	linear pull
Rear brake	Avid Single Digit 5	linear pull
Brake levers	Shimano Deore XT	Integrated brake/shift
Crankset	Shimano Deore XT 44/32/22	58/104 mm bolt hole circle
Bottom bracket	Shimano BB-ES70	73 x 113
Pedals	Shimano SPD M515, clipless	9/16" axle
Cassette	Shimano Deore XT 11-34	9spd
Chain	Shimano HG72	108 length, 9 speed
Front wheel	Rolf Urraco	538 E.R.D., Velox 19mm rim strip
Rear wheel	Rolf Urraco	HyperGlide cassette, 8/9spd, 135mm O.L.D., 538 E.R.D., Velox 22mm rim strip
Spokes	DT 14/15G butted stainless, Al nips	20 spoke Radial Front 252; 24 spoke 2x Rear 261/260 rear (D/ND)
Front tire	Bontrager Super-X, 127tpi, folding	49/48
Rear tire	Bontrager Super-X, 127tpi, folding	49/48
Tubes	Presta valve, ultra light	
Saddle	Bontrager FS 2000, Cro-Moly	
Seatpost	Alloy micro-adjust	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	3 water bottle mounts (2 on XS), CCD	
Colors	Aztec Gold / Black fork • Black logo	

	22	32	44
11	52	76	105
13	44	65	89
15	38	56	77
17	34	49	68
20	29	42	58
23	25	36	50
26	22	32	44
30	19	28	38
34	17	25	34

24.5 lb.
11.12 kg.

Frame sizes	XS	S	M	L	XL
Handlebar width	580	580	580	580	580
Stem length	90	105	120	120	135
Stem angle	5	10	10	10	10
Crank length	170	175	175	175	175
Seatpost length	300	350	350	350	350
Front brake hose					
Rear brake hose					
Steerer, mm	179	194.0	194.0	214.0	254.0
Fork length	442				
Direct Fit	7.7	8.1	8.4	8.6	9.1
Direct Fit Angle	53.9	53.2	51.4	51.5	52.2
MM Rider Height	166	174	180	185	194
Small Rider Height	161	169	175	179	189
Large Rider Height	169	178	183	188	197
IN Rider Height	65	69	71	73	77
Small Rider Height	63	66	69	70	74
Large Rider Height	67	70	72	74	78

Quantum Pro Frame Specs

	Frame sizes	49	52	54	56	58	61
	Head angle	72.5	72.7	72.8	73.9	73.9	74.0
	Seat angle	74.0	74.0	74.0	74.0	74.0	74.0
MILLIMETERS	Standover	691	734	786	819	828	860
	Seat tube	444	496	560	580	600	630
	Head tube	83	100	125	142	164	198
	Eff top tube	524	542	555	567	579	598
	Chainstays	414	414	414	414	414	414
	BB height	260	263	265	267	269	272
	Offset	41.0	41.0	41.0	35.0	35.0	35.0
	Trail	64	63	62	62	62	61
	Wheelbase	964	983	996	993	1006	1025
INCHES	Standover	27.2	28.9	30.9	32.3	32.6	33.9
	Seat tube	17.5	19.5	22.1	22.8	23.6	24.8
	Head tube	3.2	3.9	4.9	5.6	6.4	7.8
	Eff top tube	20.6	21.3	21.9	22.3	22.8	23.5
	Chainstays	16.3	16.3	16.3	16.3	16.3	16.3
	BB height	10.2	10.4	10.4	10.5	10.6	10.7
	Offset	1.6	1.6	1.6	1.4	1.4	1.4
	Trail	2.5	2.5	2.4	2.4	2.4	2.4
	Wheelbase	38.0	38.7	39.2	39.1	39.6	40.4

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:

- Airheadset™
- Internal Cable Routing
- Reinforced Head tube/Down tube 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 2001:

- Command geometry
- Size specific fork offset

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	377mm
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
BB cable guide	963350
STI lever adjusters	972589
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 down tube 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.

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.

Fitting the Quantum

To best fit the Quantum Pro frames, start with our recommendations for overall body height. 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 spacers, and adjust the saddle position.

Our Price: $ ________

Quantum Pro

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	Klein Aeros carbon composite	
Headset	Klein Airheadset	27.0/1.5-1.75"/33.4, 20.5mm stack
Handlebars	ICON Sterling, 7075, ergo bend	26.0mm clamp diameter
Stem	Klein MC3	39.5mm steerer clamp height
Grips	ICON Powercork	
Shifters	Shimano Dura-Ace STI	Flite Deck compatible
Front derailleur	Shimano Dura-Ace	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano Dura-Ace	
Front brake	Shimano Dura-Ace	
Rear brake	Shimano Dura-Ace	
Brake levers	Shimano Dura-Ace	Integrated brake/shift
Crankset	Shimano Dura-Ace 53/39	130 mm bolt hole circle
Bottom bracket	Shimano Ultegra	68 x 109.5
Pedals	-not supplied-	9/16" axle
Cassette	Shimano Dura-Ace 12-23	9spd
Chain	Shimano Dura-Ace	108 length, 9 speed
Front wheel	Rolf Sestriere	592 E.R.D., Velox 16mm rim strip
Rear wheel	Rolf Sestriere	HyperGlide cassette, 8/9spd, 130mm O.L.D., 592 E.R.D., Velox 16mm rim strip
Spokes	DT Revolution 14/17G, Al nips	20 spoke Radial Front 278; 24 spoke 2x Rear 288 rear (D/ND)
Front tire	Michelin Axial Pro K, folding	700 x 23c
Rear tire	Michelin Axial Pro K, folding	700 x 23c
Tubes	Presta valve, 48mm stem	
Saddle	Selle San Marco Era, Ti/leather	
Seatpost	Thomson Elite	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	2 water bottle mounts	
Colors	Plum Crazy • Silver logo	

	39	53
12	86	117
13	79	108
14	74	100
15	69	93
16	64	88
17	61	82
19	54	74
21	49	67
23	45	61

17.2 lb.
7.81 kg.

Frame sizes	49	52	54	56	58	61
Handlebar width	400	400	420	420	440	460
Stem length	70	70	90	100	110	110
Stem angle	6	6	6	0	0	0
Crank length	170	170	172.5	172.5	175	175
Seatpost length	287	287	287	287	287	287
Steerer, mm	172.5	189.5	208.5	225.0	248.5	280.0
Fork length	377					
Direct Fit	7.6	7.8	8.2	8.4	8.7	9.0
Direct Fit Angle	49.3	49.2	48.9	48.3	48.5	49.1
MM Rider Height	163	167	176	181	187	193
Small Rider Height	161	165	173	178	184	189
Large Rider Height	168	172	180	186	192	197
IN Rider Height	64	66	69	71	74	76
Small Rider Height	63	65	68	70	72	74
Large Rider Height	66	68	71	73	76	78

Quantum Frame Specs

		49	52	54	56	58	61
	Frame sizes	49	52	54	56	58	61
	Head angle	72.5	72.7	72.8	73.9	73.9	74.0
	Seat angle	74.0	74.0	74.0	74.0	74.0	74.0
MILLIMETERS	Standover	691	734	786	819	828	860
	Seat tube	444	496	560	580	600	630
	Head tube	80	97	118	135	157	190
	Eff top tube	524	542	555	567	579	598
	Chainstays	414	414	414	414	414	414
	BB height	260	263	265	267	269	272
	Offset	47	47	47	43	43	43
	Trail	58	56	56	53	53	53
	Wheelbase	971	989	1002	1001	1014	1033
INCHES	Standover	27.2	28.9	30.9	32.3	32.6	33.9
	Seat tube	17.5	19.5	22.1	22.8	23.6	24.8
	Head tube	3.1	3.8	4.6	5.3	6.2	7.5
	Eff top tube	20.6	21.3	21.9	22.3	22.8	23.5
	Chainstays	16.3	16.3	16.3	16.3	16.3	16.3
	BB height	10.2	10.4	10.4	10.5	10.6	10.7
	Offset	1.9	1.9	1.9	1.7	1.7	1.7
	Trail	2.3	2.2	2.2	2.1	2.1	2.1
	Wheelbase	38.2	38.9	39.5	39.4	39.9	40.7

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 drivetrain 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 a 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,

- Reinforced Head tube/Down tube 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 2001:

- Command geometry
- 1 1/8" headset size
- All Aheadset type headsets

Mechanic's Specs and Notes

Seatpost diameter	31.6mm
Seatclamp diameter	36.4mm
Headset size	25.4/34.0/30.0
Fork length	371mm
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
Down tube 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 down tube 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.

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 spacers, and adjust the saddle position.

Our Price: $ ______ Quantum

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	ICON Air Rail OD	
Headset	Cane Creek S-2 Aheadset	25.4/34.0/30.0, 26.5mm stack
Handlebars	ICON Onyx, ergo bend	26.0mm clamp diameter
Stem	ICON Graphite, direct connect	
Grips	ICON Powercork	
Shifters	Shimano 105 STI	Flite Deck compatible
Front derailleur	Shimano 105	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano 105	
Front brake	Shimano 105	
Rear brake	Shimano 105	
Brake levers	Shimano 105	Integrated brake/shift
Crankset	Shimano 105 53/39	130 mm bolt hole circle
Bottom bracket	Shimano 105	68 x 109.5
Pedals	-not supplied-	9/16" axle
Cassette	Shimano HG72 12-25	9spd
Chain	Shimano HG72	108 length, 9 speed
Front wheel	Rolf Vector Comp	575 E.R.D., Velox 16mm rim strip
Rear wheel	Rolf Vector Comp	HyperGlide cassette, 8/9spd, 130mm O.L.D., 575 E.R.D., Velox 16mm rim strip
Spokes	DT Aero 2.0/1.3, stainless	18 spoke Radial Front 270; 20 spoke 2x Rear 290/288 rear (D/ND)
Front tire	Michelin Axial Pro K, folding	700 x 23c
Rear tire	Michelin Axial Pro K, folding	700 x 23c
Tubes	Presta valve, 48mm stem	
Saddle	SSM New Millennium, CrMo/leather	
Seatpost	ICON Graphite, 2014	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	2 water bottle mounts	
Colors	Silver Cloud • Silver logo	

	39	53
12	86	117
13	79	108
14	74	100
15	69	93
17	61	82
19	54	74
21	49	67
23	45	61
25	41	56

18.8 lb.
8.54 kg.

Frame sizes	49	52	54	56	58	61
Handlebar width	400	400	420	420	440	460
Stem length	60	70	90	100	110	110
Stem angle	15	15	0	0	0	0
Steerer clamp ht.	44.5	44.5	39.5	39.5	39.5	39.5
Crank length	170	170	172.5	172.5	175	175
Seatpost length	270	270	270	270	270	270
Steerer, mm	177.0	193.5	210.0	227.0	249.0	282.0
Fork length	371					
Direct Fit	7.6	7.8	8.2	8.5	8.7	9.0
Direct Fit Angle	49.7	49.5	47.9	47.9	48.1	48.8
MM						
Rider Height	164	168	176	182	186	192
Small Rider Height	160	164	171	177	182	189
Large Rider Height	168	172	180	185	191	196
IN						
Rider Height	64	66	69	71	73	76
Small Rider Height	63	65	67	70	72	74
Large Rider Height	66	68	71	73	75	77

Quantum T

Front derailleur	Shimano 105 T		Down pull, 34.9 mm/ 1 3/8"			
Rear derailleur	Shimano 105 GS					
Crankset	Shimano 105 52/42/30		130 mm bolt hole circle			
Bottom bracket	Shimano 105		68 x 118			
Crank length	170	170	170	175	175	175

	30	42	52
12	66	93	115
13	61	85	106
14	57	79	98
15	53	74	92
17	47	65	81
19	42	58	72
21	38	53	65
23	35	48	60
25	32	44	55

Our Price: $ ______

19.3 lb.
8.76 kg.

Our Price: $ ________

Quantum Race

Main tubes	Klein Gradient aluminum	
Stays	Klein Gradient aluminum	
Fork	ICON Air Rail OD	
Headset	Cane Creek S-2 Aheadset	25.4/34.0/30.0, 26.5mm stack
Handlebars	ICON Graphite, 7075, ergo bend	26.0mm clamp diameter
Stem	ICON Graphite, direct connect	
Grips	ICON Powercork	
Shifters	Shimano Ultegra STI	Flite Deck compatible
Front derailleur	Shimano Ultegra	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano Ultegra	
Front brake	Shimano Ultegra	
Rear brake	Shimano Ultegra	
Brake levers	Integrated brake/shift	
Crankset	Shimano Ultegra 53/39	130 mm bolt hole circle
Bottom bracket	Shimano Ultegra	68 x 109.5
Pedals	-not supplied-	9/16" axle
Cassette	Shimano Ultegra 12-25	9spd
Chain	Shimano HG92	108 length, 9 speed
Front wheel	Rolf Vector Pro	575 E.R.D., Velox 16mm rim strip
Rear wheel	Rolf Vector Pro	HyperGlide cassette, 8/9spd, 130mm O.L.D., 575 E.R.D., Velox 16mm rim strip
Spokes	DT Blade 2.2/1.0, locking Al nips	14 spoke Radial Front 280; 16 spoke 1x Rear 286/284 rear (D/ND)
Front tire	Michelin Axial Pro K, folding	700 x 23c
Rear tire	Michelin Axial Pro K, folding	700 x 23c
Tubes	Presta valve, 48mm stem	
Saddle	SSM Era, CrMo/leather	
Seatpost	ICON Graphite, 2014	31.6mm diameter
Seat binder	Alloy w/integral bolt	36.4 clamp diameter
Additionals	2 water bottle mounts	
Colors	Big Sky Blue • White logo	

	39	53
12	86	117
13	79	108
14	74	100
15	69	93
17	61	82
19	54	74
21	49	67
23	45	61
25	41	56

17.9 lb.
8.13 kg.

Frame sizes	49	52	54	56	58	61
Handlebar width	400	400	420	440	440	460
Stem length	60	70	90	100	110	110
Stem angle	15	15	0	0	0	0
Steerer clamp ht.	44.5	44.5	39.5	39.5	39.5	39.5
Crank length	170	170	172.5	172.5	175	175
Seatpost length	270	270	270	270	270	270
Steerer, mm	177.0	193.5	210.0	227.0	249.0	282.0
Fork length	371					
Direct Fit	7.6	7.8	8.2	8.5	8.7	9.0
Direct Fit Angle	49.7	49.5	47.9	47.9	48.1	48.8
Rider Height	164	168	176	182	186	192
Small Rider Height	160	164	171	177	182	189
Large Rider Height	168	172	180	185	191	196
Rider Height	64	66	69	71	73	76
Small Rider Height	63	65	67	70	72	74
Large Rider Height	66	68	71	73	75	77

Quantum Race T

Front derailleur	Shimano Ultegra T	Down pull, 34.9 mm/ 1 3/8"
Rear derailleur	Shimano Ultegra GS	
Crankset	Shimano Ultegra 52/42/30	130 mm bolt hole circle
Bottom bracket	Shimano Ultegra	68 x 118

	30	42	52
12	66	93	115
13	61	85	106
14	57	79	98
15	53	74	92
17	47	65	81
19	42	58	72
21	38	53	65
23	35	48	60
25	32	44	55

Our Price: $ ________

18.4 lb.
8.35 kg.

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		
5mm allen wrench	100-120	11.3-13.6
Double clamp bolts, 4mm allen	45-60	5-6.8
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
Adept		
Shock mount bolts	61-75	6.9-8.5
Pivot bolts	100-110	11.3-12.4
Linkage bolts	50-75	5.7-8.5
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	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.

Airheadset™ / MC2 Service

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. Starting in 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. Bar-ends 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.

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

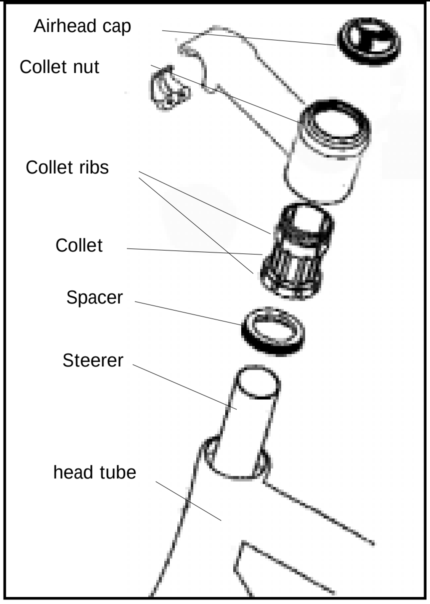


Fig. 28

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. 28).

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 head tube.

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 for MC3 bearing installation in aluminum headtubes.

Airheadset™ / MC3 Service

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.**

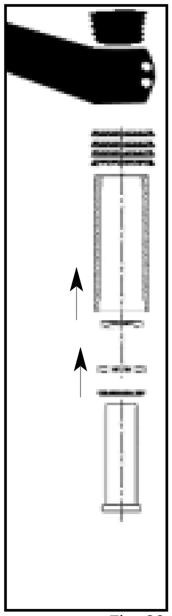


Fig. 29

Adroit Pro ATB Airheadset™

The Adroit Pro Airheadset™(Fig. 29), is similar to earlier Airheadsets where both the upper and lower bearings are installed from the bottom of the head tube. The upper bearing is pressed into the head tube, while the lower is pressed onto the fork crown. Then the fork is inserted from below the head tube and both bearings, the head tube 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 head tube.

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

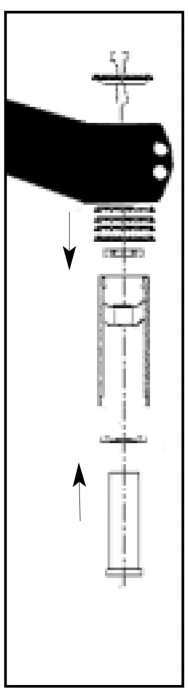


Fig. 30

Carbon Mantra Airheadset™

With the carbon Mantra (Fig. 30), the upper bearing is pressed in from top of the head tube, 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

Airheadset™ Tools

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

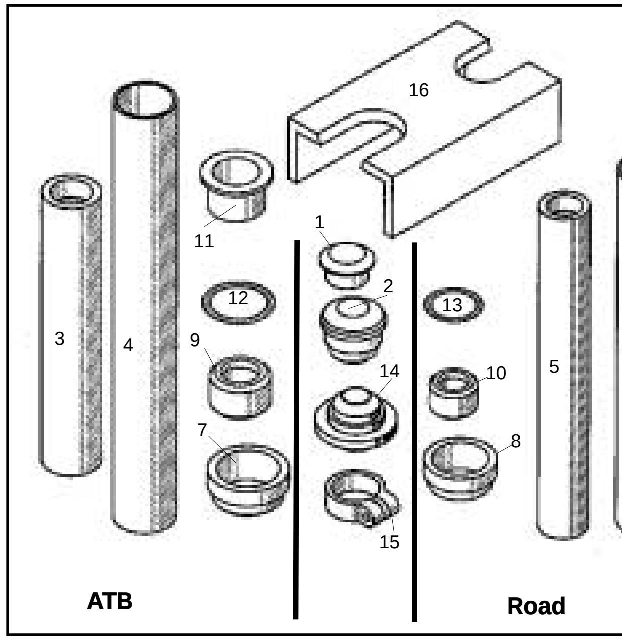


Fig. 31

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 head tube ATB Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the head tube 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. 32).

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).

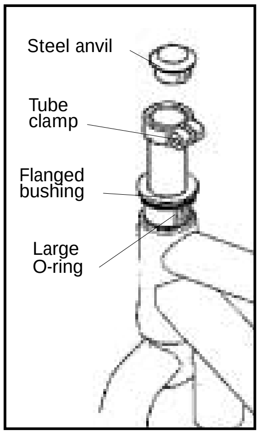


Fig. 32

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

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.

7. Continue hammering until the upper bearing drops into the head tube.

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

9.With the fork resting in the head tube, slide the thin-walled end of the **ATB bearing remover** over the steerer (Fig. 33).

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 head tube. Support both the fork and the head tube.

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

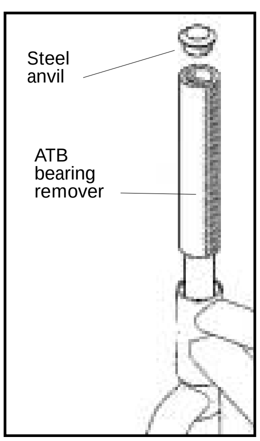


Fig. 33

Remove the Head tube 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. 34).

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

The bearing is in the head tube. 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 head tube 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**.

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

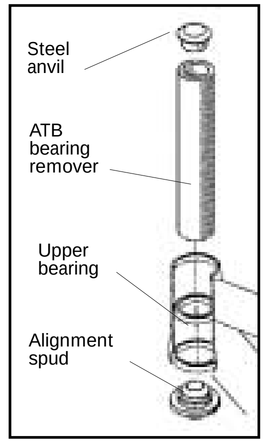


Fig. 34

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. 35).

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.

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.

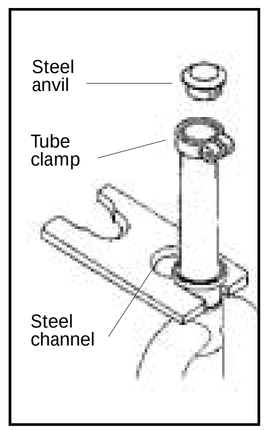


Fig. 35

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. 36).

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

head tube, 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.

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

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.

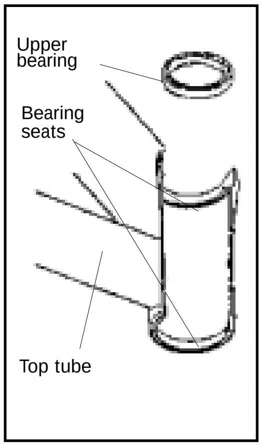


Fig. 36

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

8. Insert the **large knurled bushing** into the head tube (Fig. 37).

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.

12. Remove all tools from the head tube 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.

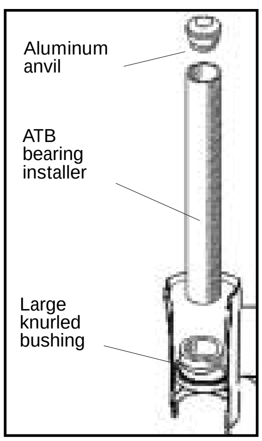


Fig. 37

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. 38)

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.

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 head tube and upper bearing (Fig. 39).

By supporting the head tube, 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.

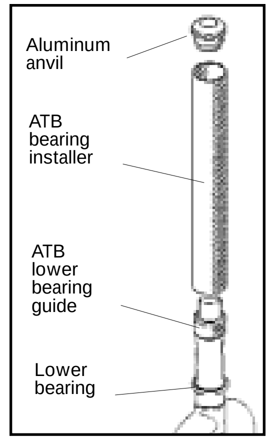


Fig. 38

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 head tube with a blunt screwdriver or putty knife.

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

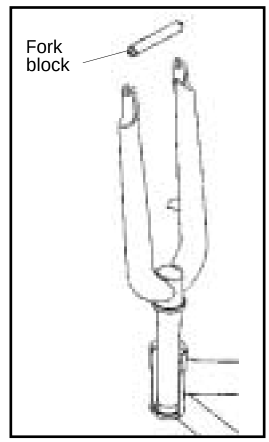


Fig. 39

Road Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the head tube 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. 40).

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

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

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 head tube.

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

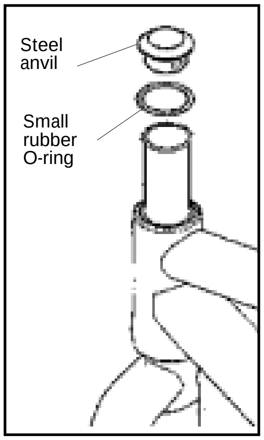


Fig. 40

If the top bearing is still seated on the fork and the lower bearing is still in the head tube, 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 Head tube Bearings".
If both bearings are on the fork, go to "Remove the Fork Bearings".

6. With the fork resting in the head tube, slide the thick-walled end of the **road bearing remover** over the steerer (Fig. 41).

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 head tube. Support both the fork and the head tube.

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

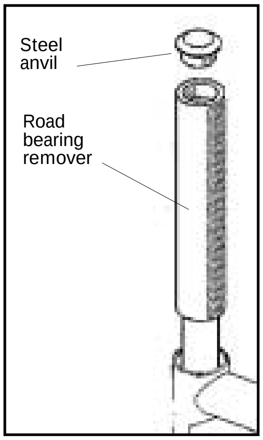


Fig. 41

Remove the Head tube Bearings

1. Insert the **steel anvil** into the thin-walled end of the **road bearing remover** (Fig. 42).

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 head tube. 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 head tube 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**.

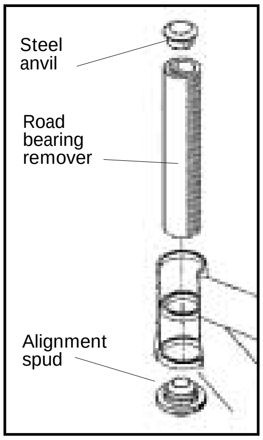


Fig. 42

5. Support the head tube while hammering both bearings from the head tube.

Remove the Fork Bearings

1. Clamp or bolt the **steel channel** (Fig. 43) 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.

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

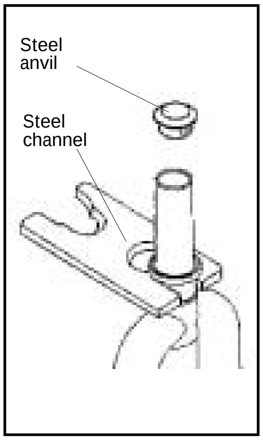


Fig. 43

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. 44).

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 head tube, 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.

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

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

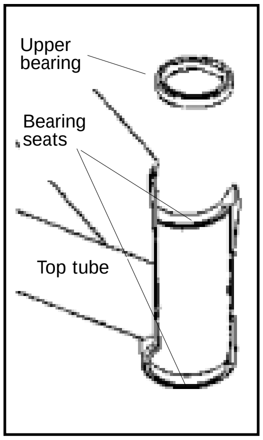


Fig. 44

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 head tube so that the notched seal will face the other bearing when installed.

8. Insert the **small knurled bushing** into the head tube (Fig. 45).

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 head tube 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.

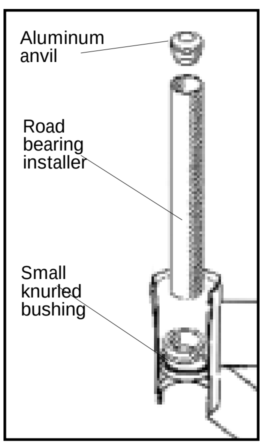


Fig. 45

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. 46).

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.

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 head tube and upper bearing (Fig. 47).

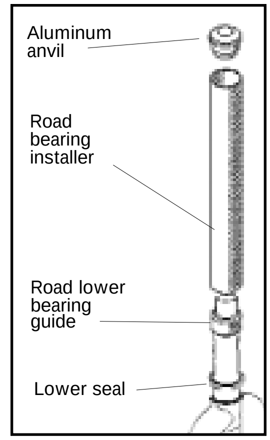


Fig. 46

By supporting the head tube, 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.

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

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

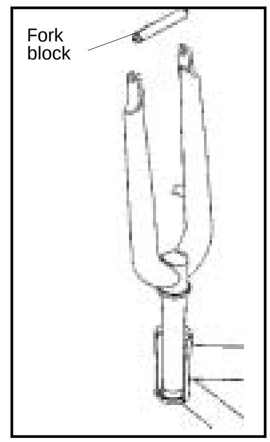


Fig. 47

Carbon head tube ATB Airheadset™ bearing replacement

Prepare the bike

1. Clamp the frame upright in a workstand by its seatpost with the head tube 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. 48).

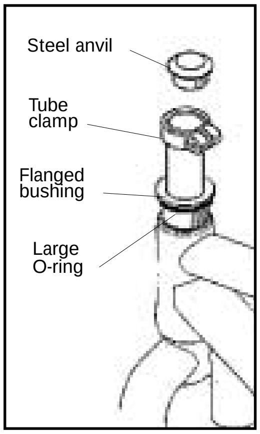


Fig. 48

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 head tube with another. Hammer the **steel anvil** driving the steerer from the head tube.

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 Head tube Bearings".
If the lower bearing is on the fork, go to "Remove the Fork Bearings".

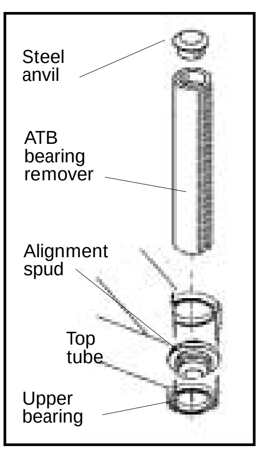


Fig. 49

Remove the Head tube 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. 49).

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 head tube while using the hammer to drive the upper bearing from the head tube.

6. Turn the frame back to its upright position.

7. Insert the large end of the **alignment spud** into the lower bearing (Fig. 50).

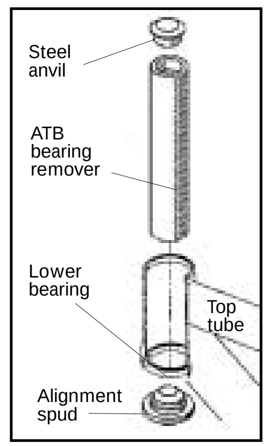


Fig. 50

8. From the top of the head tube 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 head tube while using the hammer to drive the lower bearing from the head tube.

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. 51).

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

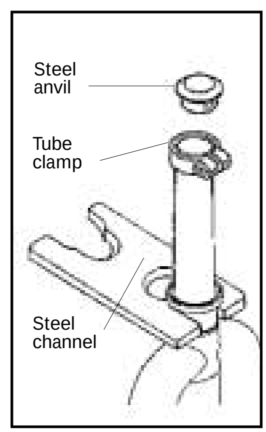


Fig. 51

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.

Install the Bearings

1. Use a sharp knife to scrape off any residual adhesive from the bearing seat surfaces (Fig. 52).

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

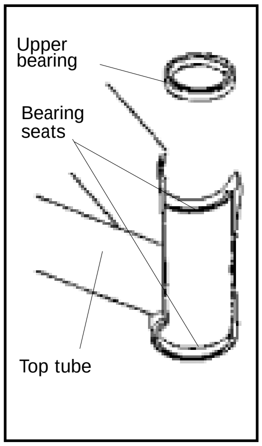


Fig. 52

2. Use a fast drying solvent to clean the inside of the head tube, 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 Loktite 680RC on the upper bearing seat of the head tube and the outer surface of the upper bearing.

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

7. Insert the **large knurled bushing** into the upper bearing (Fig. 53).

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.

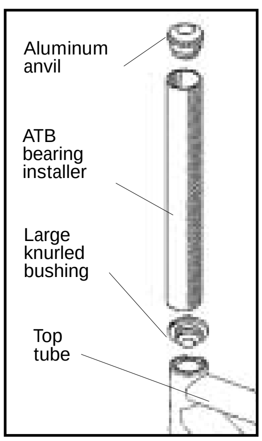


Fig. 53

11. Remove all tools from the head tube and wipe off any excess LokTite.

12. Install a starfangled nut into the steerer.

13.Apply a thin layer of LokTite 680RC 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.

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. 54)

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 LokTite 680RC 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 head tube and upper bearing (Fig. 55).

By supporting the head tube, 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.

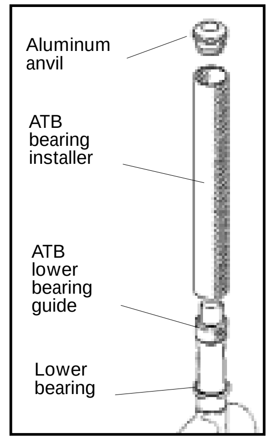


Fig. 54

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.

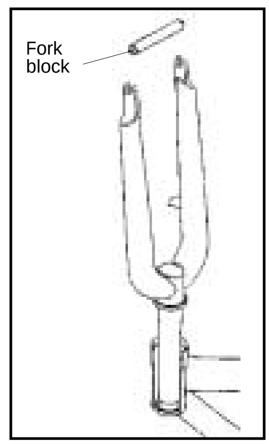


Fig. 55

Adept Pivot Service

Prepare the bike

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

2. Remove the rear wheel and right crankarm. Disconnect the rear brake and rear derailleur cable.

3. If possible, open the front derailleur cage and remove the chain. Otherwise, remove the rear derailleur..

Remove the rear swingarm

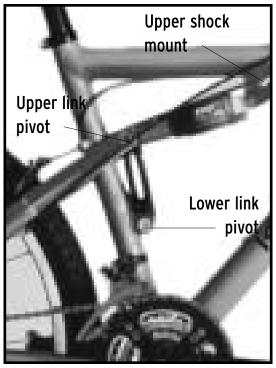


Fig. 56

1. Remove the upper link bolt and axle (Fig. 56). Be careful not to let the shock swing down and hit a frame tube.

2. Remove the lower link bolt and axle.

3. Remove the front shock mount bolt.

4. Remove the main pivot bolt (Fig. 57).

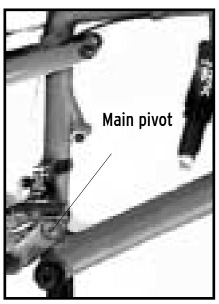


Fig. 57

Separate the parts

1. Remove the main pivot bushing from the frame. This part is held in place with Loktite, so you will probably need to lightly tap it with a hammer to drive it out of the frame (Fig. 58). A socket on an extension makes a good drift. The socket should contact the metal portion of the bushing, barely fitting inside the swingarm and pivot lug.


Fig. 58

Do not use heat to loosen the Loktite, as may damage the frame or paint.

2. Remove the main pivot bushing “top hats” from the swingarm. These are also installed with Loktite, so again tap them out with hammer using a properly sized socket. Avoid damage to the swingarm by properly supporting it as you drive out the bushings.

3. Inspect the bushings from the shock and both linkage axles. If they are in good shape, you can probably leave them. If not, remove them.

These bushings are installed dry, so you should be able to simply push them out. Do not use a screwdriver or other sharp tool, instead try something blunt like an allen wrench. If you use a sharp tool, you may cut or gouge the bearing surface, and this damage would require replacement of the bushing.

Inspect the parts

1. With a clean rag, wipe off all the surfaces. If any part is worn, it should be replaced. Signs of wear on the pivot and link axles are discoloration or a high degree of polish.

Some dark deposits may be left as the bushings and axle ‘seat in’ to each other. When this happens, some of the bearing material is sort of plated onto the axle. Its normal, and actually makes the pivot run smoother.

The bushings are harder to inspect; some discoloration is normal as the bushings and axle ‘seat in’ to each other. If wear looks uneven or non-concentric, its best to replace them.

Note: When in doubt, throw out old parts. Its relatively cheap to replace the parts, and time consuming to perform a rebuild. You do the customer a favor by only tearing their bike apart once.

Prepare the parts for reassembly

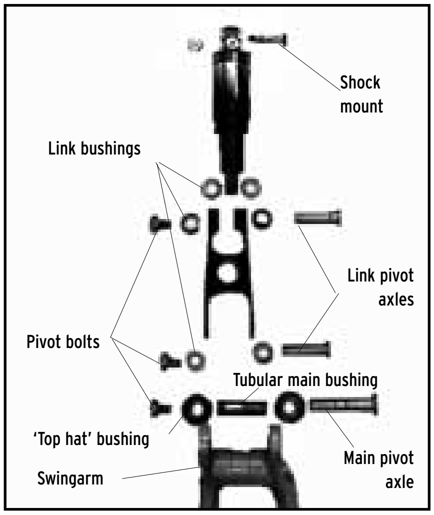


Fig. 59

1. Clean the bonding surfaces of the bushings and frame. These surfaces include the outside of the tubular main pivot bushing, the seating surfaces of the main pivot ‘top hat’ bushings that go into the swingarm, and the parts of the frame and swingarm that the bushings contact. These surfaces should be cleaned with Loktite Kleen ‘n Prime.

Be careful no to get Kleen n Prime on the paint or bushing material. It will remove paint, and also remove the lubrication in the bushings.

2. With the other bushings, simply wipe clean of dust or other debris.

3. Do not lubricate any bushings.

4. Clean the pivot and link bolts with Kleen n Prime.

Install the main pivot bushings

1. Check the fit of the bushings in the frame and swingarm by dry-assembling them (practice installation, but without Loktite). Normally the bushings are a light press fit, meaning they are snug but easily go into place with hand pressure. If the parts fit correctly, go to Step 2. If they seem very loose, go to Step 3.

2. If the parts fit correctly, apply Loktite 290 to all contact

surfaces between the bushings and the frame or swingarm, and install the bushings.

3. If the parts seem very loose, Loktite RC680 is required. 290 is a thread locker, and it works best where parts are in tight contact. RC 680 is a filler, so it has the ability to fill larger gaps and securely bond parts that do not fit tightly together.

4. After installing the bushings, wipe off any excess Loktite, particularly removing any Loktite that contacts the bearing surface.

Install the main pivot axle.

1. Carefully align the swingarm with the main pivot of the frame. The fit is tight. Avoid contact between the bushings and any residual Loktite.

2. Align the swingarm and install the main pivot axle (the long one) from the right side of the bike. Slide it all the way through the frame and swingarm eyes.

3. Apply Loktite 290 to the threads of the pivot bolt, and install the bolt from the left side of the bike. Tighten to 61-75 lb•in (6.9-8.5Nm).

Install the link bushings

1. The bushings supporting the link, the swingarm link pivot, and rear shock are all installed dry. Simply press them into place, being careful to keep them aligned during insertion.

Install the lower link pivot axle.

1. This axle goes through the link and the frame. Make sure the link is oriented in the way you'd like it (note printing on the side, etc.). Insert the lower link axle from the left side of the bike.

2. Apply Loktite 290 to the threads of the pivot bolt, and install the bolt from the right side of the bike. Tighten to 50-75 lb•in (5.7-8.5 Nm).

Install the upper link pivot axle.

1. This axle goes through the swingarm, link, and rear shock. Make sure the shock orientation is how you would like it. Insert the upper link axle from the right side of the bike.

2. Apply Loktite 290 to the threads of the pivot bolt, and install the bolt from the left side of the bike. Tighten to 15-20 lb•in (1.7-2.2 Nm).

Install the shock mount bolt.

1. Insert the shock mount bolt.

2. Apply Loktite 290 to the threads of the pivot bolt, and install the bolt from the right side of the bike. Tighten to 61-75 lb•in (6.9-8.5Nm).

Allow to Dry

Loktite normally requires 24 hours to full set. During this time, the bike should not be ridden. Do not compress the suspension or in other ways disturb the Loktite until is has fully set.

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.

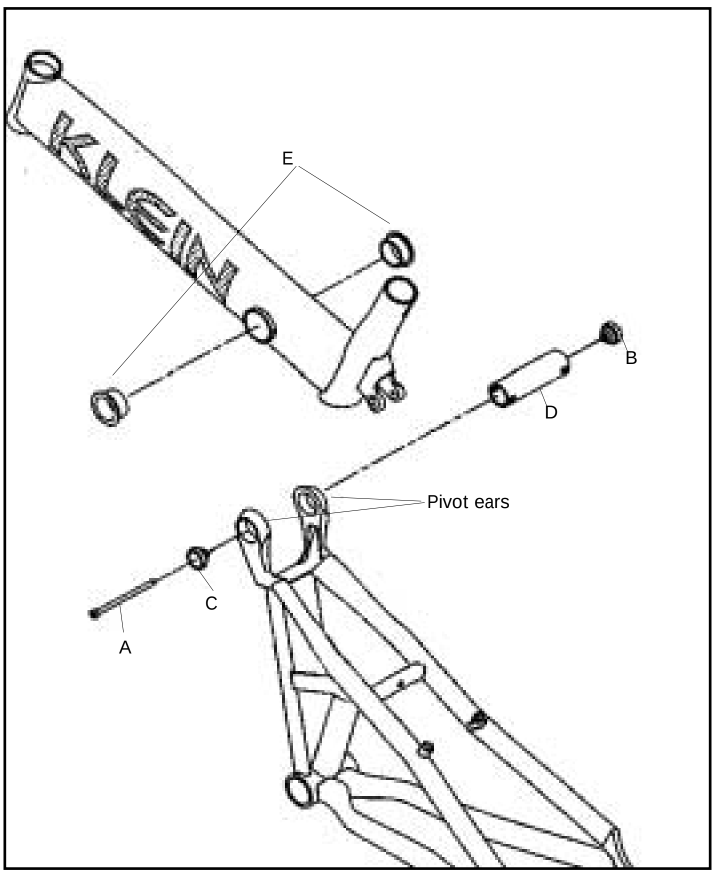


Fig. 60

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.

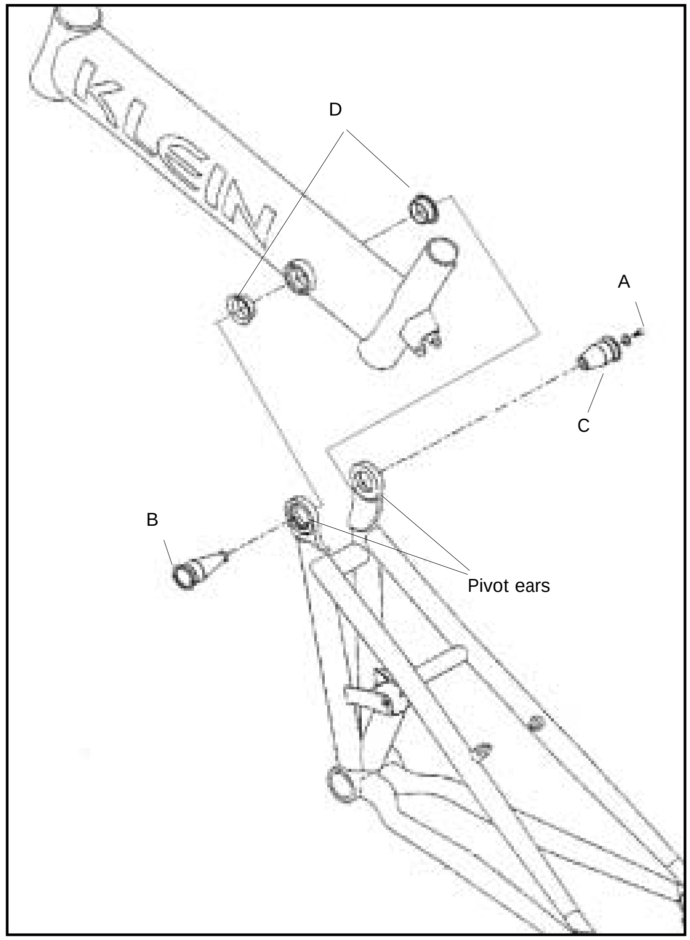


Fig. 61