Contents

Welcome to Klein® Bicycles, 2003.

This year's manual brings more technical information than ever before. You'll learn about the invention of the first oversized aluminum bike, a new alloy Klein invented called ZR9000, what's new this year, how to service older Klein bikes, and you'll hear from Klein 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 shopping for Klein's we have included detailed explanations of our new road bike geometries, our full suspension mountain bike design, and the host of new component technology used in 2002 including Tubeless Compatible wheels, more disc brakes, and more Bontrager wheel groups.

As a reminder, we have most of this information, and more, on our web site at *www.kleinbikes.com*.

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.

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.

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 Klein bicycles

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.

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 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 frames 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.

A new home

Klein uses some very high-tech manufacturing to make bicycles. To meet these demands, Klein moved the manufacture of the 2003 model line to a new facility in Waterloo, Wisconsin. This move will allow Klein to continue to lead the market in performance, while providing better availability and value to you.

Oversized aluminum: 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.

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, Klein 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!

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.

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.

Can you compare 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.

Don't aluminum bike frames break?

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 does Klein 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.

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 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.

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**

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.

Please remember that material comparisons are 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.

Aluminum Alloy Specifically for Bicycles

In 2002 model year, we introduced something new to the bicycle industry- a frame material designed specifically for the manufacture of bicycles. We call it ZR9000.

Like some of our competitors, we can wax eloquent about various laboratory tests of strength and stiffness. Often, a new material is used as a reason to substantially raise the price of a bike. But as we've said before, the ride of a bicycle is the sum of its design, manufacture, and material, in that order. In other words, its not the material, but what we do with it that makes a bike ride better.

A great frame material should allow the designer to make a better bike. If a frame isn't lighter, better riding, and at a better value to you, where is the benefit from this new wonder material?

So the proof is in the finished product. Our models using ZR9000 are up to 190 grams (almost 1/2 pound) lighter than last year. At the same time, they are stronger, and have a fatigue life up to 5 times that of the comparable 2001 models. And we can deliver these awesome new bikes at approximately the same cost to you.

For some, knowing you are buying a lighter, stronger, longer lasting bike at the same cost is enough. But we know some of you want to know more about this technology. To explain in more detail, we've asked the developer of ZR9000 to say a few words:

A material designed for bicycle frames

by Gary Klein

Advertising Claims

I'll bet you are thinking: "Just what we need, another new bike frame material! Isn't the field crowded and confusing enough as it is? Are all of the various frame materials really different? Do the differences really matter? How can every material be superior to every other one? Or are they just marketing hype?"

Which of the claims from which companies should you believe? Most of the advertised properties for different frame materials are the properties of a material in its highest temper state, made into little coupons and tested in laboratory machines; not the strength that the frame material is in after it has been made into frame tubes, and welded or brazed into a bicycle frame. The material may chemically be the same, but the advertised strength is not there.

In addition, and more to the point, the advertised strength is a bulk material property and does not reflect the engineering design of the bike, such as the diameters, wall thickness, and shapes of the tubing used. These have a huge influence on the overall strength of the finished frame, and at least as much influence on the way the bike rides. Please do not equate advertised material properties with frame durability, performance or low weight. If you want to compare the strength of one frame to another, you probably need to test them both. And if you want to compare the ride, instead of looking at charts you'll need to ride them!

Why Aluminum?

In the early 70's, when I lined up on my first starting line, the bikes around me weighed an average of about 22 pounds. My Fuji Finest was at least average in quality, yet the frame represented the heaviest part of the bicycle. Even so, I found that it was not stiff enough to keep the drive train in alignment during sprinting efforts.

At the time I was a student at MIT in Boston, Massachusetts. A professor, myself, and some other students started to look at what would make a better material for bicycle frames. The standard high-end bicycle frame was made of double-butted chrome molybdenum steel alloy tubing. Steel is easy to work with, but it is very dense, making even the thin tubes of my high-end steel racing bike into a heavy structure.

Our goal was to make the frame lighter, stronger and stiffer. To meet those goals, our first criteria was a material less dense than steel.

As lower density alternatives, we looked at Aluminum, Magnesium, Titanium, and Carbon fiber. While each of these looked like they might provide some benefits, we were also looking for an easy way to make a few bikes. We were hoping to find a material that we could obtain easily, and assemble into a strong and light frame.

Carbon fiber needs special molds for each size and geometry of frame to be produced. This would take time and cost a lot of money for prototypes.

Titanium was very expensive and the welding was difficult. The entire area being heated needed to be shielded from air. Even ignoring the cost, it was difficult to obtain in the tubing sizes we needed for bikes. Most available tubing was CP (Commercially Pure) titanium which did not provide much of a strength benefit.

Magnesium has the lowest density of the metals we looked at. Initially Magnesium looked good, with relatively high tensile strength per weight, but it does not have the ductility of aluminum, and does not weld as easily. Also the tubing sizes we needed were not readily available. Another problem was this was in the Boston area, where the streets are salted in the wintertime. We had seen what the salt does to a steel frame, and we knew that magnesium has an even lower resistance to corrosion. So it would need a real good protective coating.

After our research, we decided on aluminum as the material of choice. As we wanted the highest performance frame possible, we started looking at the highest strength aluminum alloys. Unfortunately, they were difficult to weld, to form, had corrosion problems, etc..

Materials that were strong, but not weldable, would create the need for special bonding lugs at each joint. These would have to be designed and machined individually for each frame design, a somewhat daunting task. So we looked for a material where we could create a high strength weld with normal welding methods.

Finally we settled on 6061 aluminum. It came the closest to meeting all of our frame material goals. 6061 was the workhorse of the structural aluminum alloys, and it had most everything we desired. It is easily welded, machines easily, is formable at room temperature, and resists corrosion pretty well (it is used extensively for marine applications). As a real plus, 6061 was used extensively in aircraft, so thin wall tubing was readily available in various diameters.

Aluminum

Pure aluminum is very soft. The molecules align and interconnect such that in pure aluminum, molecular slippage easily occurs in all three directions (slip planes). As a result, it is not strong enough to make a good bicycle frame.

By adding various alloying agents to the aluminum, different characteristics can be obtained. These alloys of aluminum have a number which describe the alloying elements. 6061 aluminum has small amounts of magnesium, silicon, copper, and chromium added to the pure aluminum. This alloy obtains its strength from microscopic precipitates (magnesium silicide crystals) that mechanically stop the slip planes in the aluminum crystals from sliding when force is applied. As an analogy, they work like putting sand in a sliding bearing.

Aluminum alloys can also be strengthened by mechanical working. Cold-drawing the tubing is an example of mechanical working. This causes microscopic defects and strains in the aluminum crystal, which make it more difficult for the slip planes to move.

Welding aluminum

When welding 6061, and aluminum alloys in general, several undesirable things happen.

With changes in temperature, aluminum changes dimension more than steel. When a weld puddle cools down, it shrinks and pulls on the adjacent material. With aluminum alloys this means a weld distorts the material more and leaves the material under high residual stress after the weld is complete. This residual stress adversely affects yield strength and fatigue life.

If the tube had any strengthening due to mechanical working, this cold-work induced strength would be lost near the weld where the material was heated to high temperatures. Welding removes the strengthening effects of the T6 heat treatment.

The optimum distribution and size of magnesium silicide crystals are created by the T6 process, which involves a high temperature solution-quench followed by lower temperature artificial age. Exposing the material to the high temperatures of welding dissolves some of these fine crystals and make others grow large, weakening the material near the weld.

Heat treatment of aluminum

6061 loses so much strength after welding that we decided there was no alternative but to heat treat the entire frame after welding in order to obtain a high strength, long life, lightweight frame. By heat treating the entire frame to a T6 condition, the material is brought back to full strength throughout the frame structure. At 1000 degrees in the oven, part of the solution quench process, the aluminum is close to its melting temperature. All of the precipitates present at room temperature dissolve into the aluminum. This makes it so soft that all of the residual weld stresses are relieved.

Of course we are not the only manufacturers to solution quench and artificially age the complete frame. Several other manufacturers of premium frames also typically do this on frames made of 6061 or other 6000 alloys.

Often the frames made from 7000 alloys are not heat treated after welding at all. In other cases they are only artificial aged after welding, which strengthens the material which was hot enough for long enough to dissolve the alloying elements, but does nothing for the rest of the frame material.

In these cases the alloy just got hot enough to partially dissolve the alloying elements, or just grow the strengthening crystals to a large size which weakens the material substantially. This is called over-aging. It is similar to what happens if you leave the material in the ageing oven for too long a time. Some of the crystals grow larger in size, while others shrink or disappear. The net result is that the weld is strengthened, but the tubing adjacent to the weld is weakened. So even though 7000 alloys claim a higher strength than 6061, it is probably less after welding.

Grain growth

In my opinion, the limiting factor for designing aluminum frames is the fatigue life. If we design a frame in 6061 T6 for the same fatigue strength as Chrome-Moly, the 6061 frame will have a much higher yield strength than the steel.

I wanted to make our frames even lighter, so in the early 80's I started looking for an aluminum alloy with a higher fatigue strength. There were a few alloys in the 6000 series that had slightly better test numbers.

The problem with the higher strength alloys is that the presence of the hardening elements causes the microscopic aluminum crystals (the grains) to grow when the alloy is at high temperatures or when it is under stress. Larger grains result in poor strength properties.

In making a Klein frame, we have multiple steps where we anneal the material with a high temperature oven cycle, in order to make it soft so we can perform some type of butting, swaging, forming or bending operation on it, after which we have to either solution quench and artificially age it to bring the strength back prior to the next operation, or we anneal it again to remove the work hardening effects of the last operation so we can perform further work to it.

I took a trip to the Alcoa Research center and talked to several of their material experts. They told me that I could not use the higher strength 6000 series alloys I was interested in because we would see uncontrolled grain growth in our process. 6061 uses a small amount of Chromium to help slow down this grain growth. That is what has made it work well for our early frames. So I did not find a good replacement for 6061 on the first try.

A recipe for a better aluminum alloy

I am not a metallurgist, so I have worked with several metallurgists during development, who have helped a great deal. However, I knew our processes and I knew what was needed to make a better bike. So I knew what I was looking for and researched other alloys and their use.

Around 1990, I started looking at some Lithium Aluminum alloys. These are different than typical aluminum alloys in that they have significantly lower density, and increased modulus (that means higher stiffness). They are not perfect, and have some unique problems to overcome. The aircraft industry spent millions on their development, but these alloys have not seen a lot of use to date.

One of the interesting features of the particular lithium aluminum alloy I was working with was that it utilized Zirconium as the ingredient for grain control. From our testing, zirconium seemed like it was particularly effective. So when I decided to attempt to create an alloy specifically for making a bike frame, I decided to get rid of the Chromium used in 6061, and use Zirconium instead.

Since we use multiple heat treat cycles when we manufacture a frame, we needed a high response to the heat treatment. So I added more of the precipitation hardening ingredients Silicon and Magnesium.

I also increased the amount of Copper, as it has a strong strengthening effect, and the copper-based aluminum alloys show excellent fatigue properties. So I thought more Copper might help increase the fatigue strength of the alloy.

Another requirement we have is the ability to form the material substantially at room temperature when it is in the soft condition. The auto industry uses a couple of 6000 series alloys specifically designed for forming into complex auto body surfaces. These are 6009 and 6010, sheet forming alloys. The notable difference between these and other 6000 alloys is a significant Manganese addition. So I added a little Manganese to the alloy to improve the forming ability.

May I have a bit of alloy, please?

The barrier to testing a new "mix" is that you need a good foundry to make a batch for you. A single furnace load of material is 40,000 pounds, or 20 tons of aluminum. If the alloy does not work out well that could be a lot of scrap. So I made my best guess at what the percentages should be, and had the first batch poured.

Impressive results

ZR9000 has worked out extremely well. It machines cleaner and with less tearing than 6061 tubing can be mitered with higher accuracy, and press fits (like headset bearings) are more precise. In the annealed condition, it forms very well which helps us make our sophisticated chainstays. It welds very nicely, with high strength and good cosmetic appeal. It has an excellent response to heat treatment, which adds to our frame alignment. So compared to 6061, it allows us to make the frame without any additional trouble.

In a completed structure, ZR9000 tests out very well. In tensile tests of identical complete frames, the yield strength is about one third higher than 6061. On our fatigue testing machines, the ZR9000 frames endure 5 times the number of stress cycles (at the same loading) as the 6061 frames before failure.

These results are as good as I could have hoped for. We have been able to use the higher properties of the new material to remove weight in places where it is beneficial and increase the fatigue life and dent resistance of the frame tubing.

This is the first material that I am aware of that has been designed expressly for the process by which we make a high performance bicycle frame and thus to optimize the frame's performance.

The Name ZR9000 was chosen because the small amount of Zirconium addition for controlling the grain size is the key that allowed us to increase the amounts of the other strengthening additives. The 9000 is because new or experimental alloys which have not been assigned industry numbers are designated in the 9000 series. So this is our Zirconium grain refined, experimental alloy developed specifically for making state of the art bicycle frames.

Even though I have been working on aluminum bike frames for 28 years, the pace and amount of innovation has kept it really fun. I'm sure you will enjoy using our new products based on this material innovation

Geometry

The performance of a bike is determined by three things; its geometry, the frame material (including tubing dimensions, butting, and manufacturing quality), and the parts attached to the frame.

When they speak of bicycle geometry, most people are referring to what engineers call centerline drawings. These are stick figures of the bicycle frame showing some of the angles and lengths of the tubes. This information roughly indicates how a bike might fit or perform. However, unless you are very familiar with geometry information, like knowing exactly the geometry of the bike you currently ride, a geometry chart really isn't very helpful. More to the point, it should be easy to see that the rider does not touch the frame, so the parts on the bike can have as much to do with the fit as the frame does. Even if you are familiar with geometry, most charts leave out critical fit information, like head tube length.

In addition to defining the fit, bike design also effects performance. Performance can be roughly defined as how a bike rides. The geometry charts show some of these parameters such as bottom bracket height or head angle.

They do not show the engineer's choice of materials and tubing dimensions, which also effect the ride. As an example, some people believe that steep angles make a bike ride harshly. But if that bike is built from small diameter tubes of a flexible material, what happens? Imagine a bicycle made of rubber, and you can see that you have to look at the whole big picture to even begin to understand how a bike performs.

Geometry charts don't show how some of these factors work together, particularly in the important relationship to your 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. Still, we supply you with charts, so we feel the need to explain what the information means.

Head tube angle

This is the angle between the ground, and a line extending through the center of the head tube. To help you understand how this effects steering, let's look at the extremes. If that line were completely vertical (90 degrees), every movement of the handlebars would translate into an immediate change in direction. While this may sound great, such quick steering could mean that taking a hand off the bars to reach your waterbottle would cause you to run off the road.

At the opposite end of the spectrum, a completely horizontal head angle (0 degrees) means that turning the handlebars would not turn the wheel at all, but simply lay the front wheel over on its side.

Somewhere in between is the happy medium and it turns out, through the evolution of the bicycle, that most two wheeled vehicles have a head angle of somewhere between 65 and 75 degrees.

Seat tube angle

This is the angle between the ground and a line extending through the center of the seat tube. With some designs, an "effective seat angle" is determined by extending a line from the bottom bracket center through a selected spot in the centerline of the seatpost.

This angle determines the fore and aft position of the saddle relative to the bottom bracket, setting the parameters of possible saddle position. While this angle is important, it should be noted that most saddles have rails under them that allow for lots of fore and aft adjustment, and different seatposts offer fore and aft positioning as well. Some people attribute a slack angle (fewer degrees) to a more comfortable ride. However, the rear triangle of a bike is essentially a fully triangulated space frame, so without purposeful design to the contrary, the rear triangle of a bike is totally rigid in the vertical plane.

Effective top tube

This is the horizontal distance from the centerline of the head tube to the centerline of the seat tube. The elevation at which this is measured is important, since the two centerlines aren't always parallel. But the elevation isn't consistent; some bikes are measured from the top of the head tube, others from the junction of the centerlines of the head tube and top tube.

This measurement is supposed to accommodate different torso and arm lengths of riders. Other factors, including stem length, stem angle, handlebar reach, and handlebar design.

In addition, without knowing (and calculating) the seat angle, the top tube doesn't tell you much. The reason for this is simple; what you really want to know is the horizontal distance from the crankset to the rider's hands. If you don't figure in seat angle, knowing the top tube does not tell you where the crankset is.

In other words, a bike with a shorter top tube can have a longer reach. As an example, the reach to the bars on a bike with a 580 mm effective top tube and a 74 degree seat angle is actually longer than a bike with a 590 mm effective top tube and a 72 degree seat angle. (illustrate this)

Seat tube length

This is the distance from the center of the bottom bracket to some point on the seat tube. Some manufacturer's pick the top of the top tube (center-to-top), others the intersection of the centerlines of the top tube and seat tube (center-to-center). Arguments exist in support of either method.

More to the point, neither really means very much in modern bike design since the seat height is the most adjustable fit parameter of the bike. In other words, a "traditional" bike with a horizontal top tube can fit identically to a "compact" frame with a sloping top tube if the hand position is the same; the only difference is the amount of seatpost showing.

Rake, or offset

This is the perpendicular distance from the centerline of the head tube to the front axle. Some forks have a sweeping curve near the front axle, others have straight legs angling from the fork crown. You still measure from the centerline of the head tube.

Some people think that a fork with curves should be more comfortable than a straight fork. However, considering the variations in materials, diameters, and wall thickness, a good designer can make a fork as rigid or flexible as they desire. Also note that while more fork flex (or splay) can add comfort, it also can detract from steering precision.

Trail

This 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. 1). 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 your Center of Gravity.

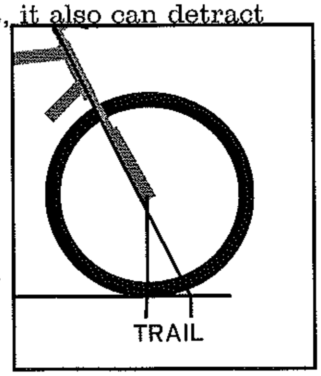

Fig. 1

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).

Your 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 put lots of weight on the bars (like adding front panniers to a touring bike), its steering may become truck-like. On the other hand, if you take a really sluggish bike with heavy steering and put all your 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, our 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 our bikes handle consistently through their size runs.

Bottom bracket height

This is the distance from the center of the bottom bracket to the ground. This effects your center of gravity. The higher your center of gravity, the less stable the bike is in a sudden deceleration. But the closer your 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 effect your ability to pedal through corners in a criterium. With full suspension mountain bikes, the suspension allows you to sit and pedal through terrain where you 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 you hit your pedals on those same rocks, you can't pedal anyway. With improper bottom bracket height, a bike loses one of the advantages of full suspension.

We use different bottom bracket heights according to the use of the bike, as well as size-specific bottom bracket heights where we intend to use differing crank lengths.

Chainstay length

This is the distance from the center of the bottom bracket to the center of the rear axle. With some dropout designs the axle can be moved, and in this case the measurement is to the intersection of the centerlines of the seat stays and chainstays.

The length of the chainstays determines, to some extent, the position of the rider's center of gravity in relation to the rear wheel contact patch. This effects traction and to some extent steering feel.

A new term is "effective chainstay length" used to describe the horizontal distance from the bottom bracket to the rear axle. This is to compensate for the longer distance created when the bottom bracket is at a very different vertical height from the rear axle, like with 29" mountain bike wheels.

On some bikes, chainstay length effects clearance between the rider's feet and panniers, or bags, or the rear rack (simply referred to as "heel clearance"). On race bikes, we use shorter chainstays to increase the rigidity of the rear triangle during hard pedaling. On touring or city bikes we use long chainstays for increased heel clearance.

Wheelbase

This is the distance from the rear axle to the front axle. Again, lets consider the extremes. A wheelbase of 0 (a unicycle) can turn very quickly. A school bus cannot. So wheelbase partially determines the "natural turning radius" of a bike, or in plain language: how fast it turns. Wheelbase also can effect comfort, through timing of impacts as the front and rear wheel individually contact a bump. Also a longer structure is more likely to flex vertically, so this can also effect comfort.

Handlebar height

If you add together head tube length + stem reach and rise + fork length + headset stack and spacers + handlebar style, you can calculate handlebar height, which is critical for your comfort. And since most bikes don't have a lot of adjustment (some special headset/ suspension systems don't have any!), it's critical that the head tube and other components be a length that places the handlebars at the right height.

Front center

This is the distance from the bottom bracket to the front wheel axle. Assuming that for your optimum fit you will always put the handlebars in a certain position relative to the bottom bracket, this dimension tells you how far the front wheel will be in front of you. The placement of the front wheel relative to your 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.

Since front center, along with chainstay length, is a component of wheelbase, it effects steering quickness. Road racing bikes usually need short front/ centers, such that the pedal can be quite close to the front tire in a turn. A mountain bikes usually has a longer front center to give it additional stability in sudden decelerations.

Weight distribution

This is how your weight is spread over the two wheels, and where your 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, moving your center of gravity will effect the steering. It also effects rear wheel traction when climbing. The closer your 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

These 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 you do not touch the frame. There are a lot of parts between you 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.

"Compact" versus "Traditional" design

Now that you know a little about bike design and terminology, and what the different aspects of design do to the way a bike fits and rides, consider the new "compact" designs. In its most basic concept, Compact geometry simply means a sloping top tube. If that is the only change from a traditional design, the difference can be considered to be mostly one of style. However, if you are a sensitive rider, it's possible that you might notice slightly more road comfort on a compact frame. The comfort would likely be the result of additional flexibility of an extended seatpost, or perhaps because as the top tube and down tube of a frame come closer to parallel, the frame will allow more vertical flex. There may also be a slight difference in overall bike weight. However, this will be very small since the lower frame weight of a Compact design must be compensated with a longer, heavier seatpost.

Some companies use the Compact design philosophy as a way to save them money by eliminating a whole bunch of frame sizes. To accomplish this, they expect you to use an unusual stem configuration to achieve your normal fit. If you're lucky, it works. If not, the weird stem length, coupled with a front center length that puts the front wheel in a poor position, can make for poor handling. Although saving money can be a good thing, offering just three road frame sizes certainly doesn't make sense for a performance oriented bicycle.

It's a package

To truly understand the way a bike performs, its important that you test ride the bike. Perform a series of exacting tests during the ride to highlight strengths and weaknesses in handling and comfort for your 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 select your perfect dream bike.

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 commercial grade tubes is checked for dimensional tolerance, with no regard for purity or strength. Using commercial grade 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 getting.

Contrast that with what we use at Klein. '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

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

Instead of focusing simply on weight or stiffness, Klein's design philosophy includes overall ride quality. Gradient tubing is one of the keys to Klein's success. In the twenty years since he built the first bike using oversized aluminum tubing at MIT, 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. 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. Other companies use butted tubes that have a short transition areas from one wall thickness to another, essentially just to reinforce the weld zone. 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.

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. Klein has spent 20 years tweaking these designs and processes so Klein bikes have an almost magical ride. So while Klein bikes are super light, 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.

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. Not everyone will notice, but Klein insists on perfecting every detail. Note that the large diameter seatpost results in a noticeable change in saddle feel. A 31.6 mm seatpost is almost twice as stiff as a 27.2 mm 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

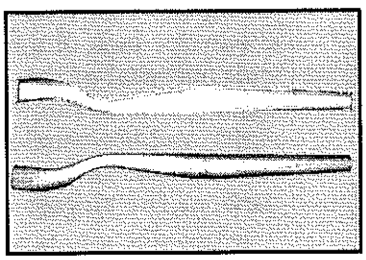

Fig. 2

Turn a Klein frame over and look at the sculpted chainstays (Fig. 2). While all the other Klein tubes get similar treatments for their specific purposes, 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. This box section adds durability and stiffness at a point where most chainstays are at their weakest. 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 dropouts.

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 that on a mountain bike, the tight, precisely placed bends make for gobs of mud clearance, even when using 2.35 tires.

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. To make these stays a reality, Klein had to custom design and hand build their own machines. 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.

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

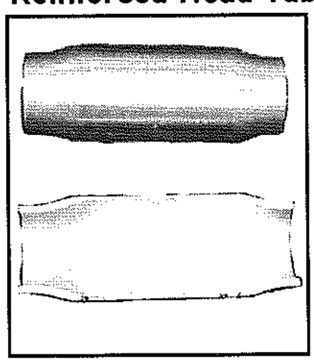

Fig. 3

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.

To add front end strength, Klein starts with a light-weight internally tapered head tube, which is heavily reinforced around the bearing races (Fig. 3). This extra material prevents bearing shock loads from ovalization of the tube.

Note the distinctive barrel-shaped profile of the standard Klein ATB head 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.

Internal Cable Routing

Klein bicycles 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 (Fig. 4). Klein used FEA (Finite Element Analysis, a very high-tech computer modeling program) 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.

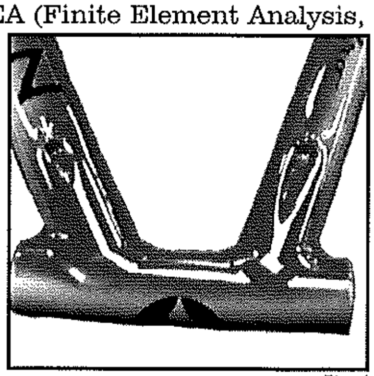

Fig. 4

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.

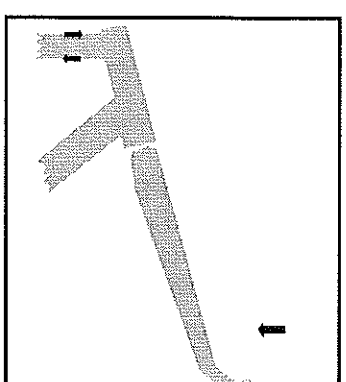

Fig. 5

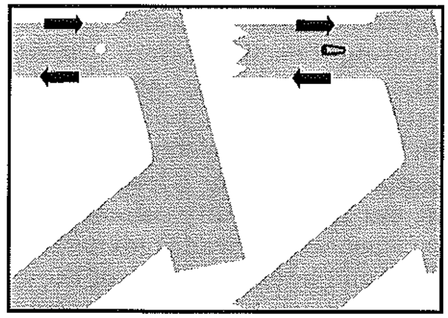

Fig. 6

The top tube and down tube are predominantly loaded by the front fork, in plane with the frame tubes (Fig. 5). 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. 6). 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.

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

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

By making the overall 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. Klein'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 85 mm. On a Klein road bike its about 45 mm (Fig. 7). 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.

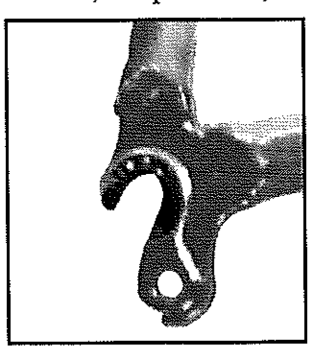

Fig. 7

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. 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. For more information on using MicroDrops, see "Installing a wheel with MicroDrops."

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 road bikes can have a lighter, tighter, more rigid chainstay assembly.

It's a 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.

Note: As of 2002, all Klein ATBs use a conventional style rear dropout design. This design is necessary to be compatible with international-style disc brakes. With international disc brakes, applying the brake creates a force in a rearward, downward direction. MicroDrops release the wheel in this direction, which some construe as placing too much reliance on a tight quick release.

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.

As a compliment to Klein's development of this process, you'll notice that other builders are trying to imitate this technique.

Klein Heat Treating

Before 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, Klein 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.

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

Through his research, Klein 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 0.1 mm (.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.

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.

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 the Klein factory 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.

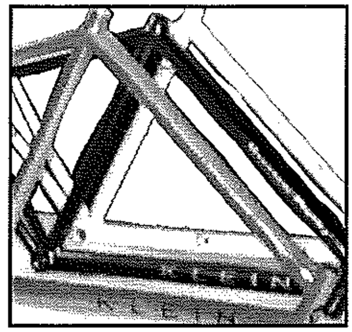

Fig. 8

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 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.

Updating a Classic- The new Q-Pro Carbon

Although it may seem to some Klein aficionados that the Quantum Pro has been around for decades, its actually received continuous improvements to the frame, and quite a few updates over the last few years. As an example, for 2001 we introduced Command geometry, a revision to the frame design that was denoted by a change in frame sizes. We kept the frame name, though, because it was really a tweak and not a wholesale change.

Geometry changes

Klein originally designed the Quantum Pro in the style of American criterium racers; a forward, aerodynamic position. However, the feedback we've gotten from racers is that they love the way the Quantum rides in long road stages, except that this style of riding demands a more rearward position. So for 2002, we have moved the seat cluster rearward to accommodate the position preferred by stage racers like the Pros on Team Gerolsteiner. We added some top tube and slackened the seat tube angle. But nothing else changed, so those who prefer a forward position need only slide their saddle slightly further ahead.

New Aeros high modulus carbon fork

Carbon fiber composite is used in a wide variety of applications, from jet airplane wings to car springs to prosthetic limbs. Of these, the bicycle frame is one of the most complicated shapes made. A jet fighter wing, although very large and under extremely high stress, is a simple shape. Most bicycle frame designs are of complicated shape with lots of surfaces joined by tight radius curves. This makes a bike frame, or fork, very hard to produce. The various surfaces must be in alignment and often have parts bonded to them, such as the dropouts, or fork tips.

The Klein Aeros fork has been on the Quantum Pro for quite a few years. It has proven itself to be quite robust, while extremely light weight. Starting in 2002, the Aeros is made with a new process, of an even lighter material called OCLV 110. The resulting fork is also used in the Trek model 5900 ridden by Lance Armstrong to his victory in the 2001 Tour de France.

Trek named their carbon composite manufacturing process according to engineering terms describing the resultant laminate quality. Compaction refers to how close the fibers are in the finished part. Ideal, or optimum, compaction of the fibers yields a blend of about 65% fiber and 35% matrix. Any more matrix, and the weight goes up while reducing the strength. Any less matrix and the fibers may not be fully wetted. OCLV has Optimum Compaction.

If there are any air bubbles in the laminate, these create weak spots. These weak spots are called voids. Aircraft spec for carbon laminate is "low void", or under 2% voids. OCLV is typically even lower.

A square meter of OCLV 110 tow weighs just 110 grams. Since there is less carbon in this fork than many others, we use a higher strength, higher modulus carbon. The resulting fork is extremely light, even though it tests out stronger than almost all of the competition, regardless of weight. The drawback to high modulus carbon is greatly increased material costs. In plain English, the Klein Aeros fork is very expensive.

Carbon composite seatstays

While we were working on the front fork, we added carbon composite to the rear of the bike. With similar results, we were able to reduce the weight and smooth the ride. However, we kept the drivetrain rigidity of the Quantum Pro by maintaining the full Gradient aluminum main triangle and chainstays.

ZR9000 alloy

The new Q-Pro Carbon has a visible difference in the carbon stays. What you can't see is the incredible material revolution under the paint; Klein's proprietary ZR9000 alloy. This incredible material allows a 15% reduction in weight while creating a 15% increase in strength. And unlike many high-strength alloys, ZR9000 actually increases the fatigue life of the frame. By a factor of almost 5!

Klein feature list

The Q-Pro Carbon borrows from a long list of proprietary Klein features. We list these features here, but for a more detailed explanation please see "Klein Details".

- **Aerospace grade tubing**
- **MicroDrops**
- **Large diameter frame tubing**
- **Gradient tubing**
- **ZR9000 alloy**
- **Reinforced head tube/ down tube junction**
- **Internal cable routing**
- **Void-free welds**
- **Klein heat-treating**
- **The finest paint jobs**
- **Klein geometry**

For the last 30 years, Klein has been a leader in road bike performance. It may be rare that a single person can lead his field for this long, but Gary continues to ride, dream, and innovate. Klein's new Klein Q-Carbon is a great example of Klein staying ahead of the pack.

A new approach

Klein has been producing a variety of Quantum models for a long, long time. Of these, the Quantum Pro has been the flagship. It's an amazing bike, and the amount of work that goes into each one is extensive. Klein developed the Quantum Pro as his own personal dream bike, and has spared no detail. As such, the Quantum Pro has always been one of the most expensive bikes on the market.

The new Q-Carbon borrows both technology and style from the Quantum Pro, but at a much more attractive price. Challenged to maximize the performance per dollar equation, the real genius behind this Klein is its ride. It is so superior to other bikes in its price range, that we can only compare it to our own Quantum Pro.

Q-Carbon frame materials

Klein bicycles have always been renowned for their pedaling efficiency. After all, Klein was the inventor of bikes built from oversized aluminum tubing. Klein's design maximizes lateral frame rigidity to get the most from your every pedal stroke. On a Q-Carbon you'll get instant acceleration with no wasted energy, However, on a Klein you won't have to trade efficiency for ride comfort like on some bikes. Through clever design including a lengthy series of tubing manipulations, Klein bike are surprisingly comfortable. The key to this fabulous ride is the extensive work done to the tubing. We call the end result Gradient tubing, and no other bikes have anything quite like it...except the Quantum Pro.

For more specific information about the work that goes into every Klein, see "Frame Details". All the shaping, stretching, and butting that goes into Gradient tubing allows Klein to fine-tune the ride of the bike while reducing frame weight. Still, Klein wanted something lighter. Klein saw that to get a lighter bike, he needed a stronger material, but he found his the possible list of materials for his quest limited. He found some pretty cool materials but they simply would not stand up to his manufacturing processes. Not willing to compromise strength for weight, Klein invented his own aluminum alloy.

Designed just for building Klein bikes, we call this new material ZR9000. Klein's new alloy allows a 15% weight reduction of the frame, while at the same time increasing its strength by 15%. Most important, ZR9000 provides up to five times the fatigue strength.

The Quantum Pro has used a carbon fiber composite fork for many years. For 2002, we put carbon fiber composite seatstays on the Quantum Pro. The new Q-Carbon gets both these treatments. Changing from ZR9000 to carbon fiber doesn't change the weight as much as you might initially think, but you must remember that we're discussing one of the lightest aluminum frames on the planet. On the other hand, adding carbon fiber to the frame changes the feel a lot. Thanks to an ideal blending of these two great materials, the Q-Carbon is incredibly smooth on the road.

Frame details

The Quantum Pro uses a proprietary bearing design that does without standard headset cups. There are several benefits, including lower weight and a clean look. The Q-Carbon uses an integrated headset for the seam benefits.

The Quantum Pro uses a straight-bladed carbon composite fork that is both light and precise in its handling. There is a misconception that a straight fork will be so rigid as to be uncomfortable. Instead, one of the benefits of carbon fiber is the ability to 'tune' the flex for the ideal feel. Since Klein has been refining the basic Q-Pro fork design for almost 10 years, we've pretty much optimized our straight-blade carbon forks. The Q-Carbon also uses a straight-bladed carbon fork.

The Quantum Pro uses internal cable routing for a clean look. The amazing part of this story is that the "dimples" of the internal routing actually strengthen the frame, and add comfort to the ride. The Q-Carbon gets these same features.

Klein feature list

The Q-Carbon borrows from a long list of proprietary Klein features. We list these features here, but for a more detailed explanation please see "Klein Details".

- **Aerospace grade tubing**
- **MicroDrops**
- **Large diameter frame tubing**
- **Gradient tubing**

- **ZR9000 alloy**
- **Reinforced head tube/ down tube junction**
- **Internal cable routing**
- **Void-free welds**
- **Klein heat-treating**
- **The finest paint jobs**
- **Klein geometry**

Frame geometry

The Quantum Pro is a thoroughbred racing bike, raced in the European Professional circuit by Team Gerolsteiner. As such, this frame is designed for riders in a forward, aerodynamic position ideal for a world class athlete.

For those of us who want the ride but don't have that world class thing going on, the Q-Carbon is ideal. The position of the rider on the Q-Carbon is very slightly more upright, with the handlebars placed about 10 mm higher and 5-10 mm closer to the saddle. The bottom bracket is a few millimeters lower for a lower center of gravity and stable feel. The steering is slightly more relaxed for a more forgiving ride. In basic terms, the Q-Carbon makes a small sacrifice in steering agility for additional comfort.

One large visual difference between the Q-Pro and Q-Carbon is the "compact" frame design. The term "compact" means different things to different people, so we'd like to define our use here. In its most basic concept, Compact geometry simply means a sloping top tube. Since that is the major change from the Q-Pro, the difference can be considered to be mostly one of style. However, if you are a sensitive rider, it's possible that you might notice slightly more road comfort on this compact frame, possibly the result of additional flexibility of an extended seatpost, or perhaps because as the top tube and down tube of a frame come closer to parallel, the frame will allow more vertical flex. There may also be a slight difference in overall bike weight. However, this will be very small since the lower frame weight of a Compact design must be compensated with a longer, heavier seatpost.

Some companies use the Compact design philosophy as a way to save them money by eliminating a whole bunch of frame sizes. We designed these bikes so that the variation from one size to the next is no more than one stem size. In other words, if you increase the stem one size on a 55, and decrease the stem one size on a 58, they will have approximately the same handlebar position. Thanks to this thoughtful design, our five Q-Carbon frames effectively span a range of rider heights from about 5'2 to 6'4 (157-193 cm).

A New Attitude

Improving the best

The Klein Attitude has earned a reputation over the years. That reputation if one of razor-sharp handling, and the power to climb like a scared cat. The exceptional performance of the Attitude is the result of Klein's relentless pursuit of the perfect ride.

Gary rides in technical terrain that is quite mountainous, and often muddy. As a result, he designs his bikes to handle with agility, to be as light as possible, but still offering excellent frame rigidity and tons of tire clearance.

As you can probably see, these features are often at odds with one another. To be really light, you must use less material. Using less material usually means less frame rigidity. One way around that is to use shorter, straighter tubing, but that reduces tire clearance.

It's magic!

The key to achieving the ride of the Attitude is a complex story involving lots of miles, and a truly innovative approach to designing and making bikes. We have listed many of the individual features that go into a Klein in the section "Klein Details". What we didn't tell you there is that the combination of features found on a Klein Attitude cannot be found on any other bike frame. And that bit of magic is why no other bike rides like a Klein.

The tinkerers

The engineers at Klein just can't leave anything alone. In their minds, no bike will ever be satisfactory. Things can always be improved.

The Attitude has been around for a long time. During that time, there have been constant updates to its performance. Many of these have been "invisible". Often we haven't even told anyone we made the change. But it mattered to Klein, and he believes that it makes the bikes ride better.

The 2002 Attitude adjustment

For 2002, we made several changes to the Attitude that you can see. The obvious one is a larger diameter top tube. This larger tubing makes the frame stiffer, while at the same time slightly lighter, but without sacrificing any strength. The change wasn't really necessary since the 2001 Attitude was plenty stiff. But Klein saw the new wave of longer-travel suspension forks as a stepping stone to a higher level of frame performance, and started tinkering again.

While he was at it, Klein changed the Attitude's cable routing. Instead of running the cables under the bottom bracket, the new model uses top-routed cables. This is a reflection of Shimano derailleur design, and an effort to keep shop mechanics happy through the use of similar parts on all Klein bicycles.

Not satisfied with any particular cable orientation on the outside of the top tube, Klein instead chose to use internal cable routing. The procedure used by Klein to put the cables inside the top tube is an expensive one. This isn't simply a set of holes drilled in the tube. It involves several different procedures to create the dimples. And each of these procedures individually requires annealing and heat treating the tubing to achieve the mechanical properties necessary to form the aluminum.

But Klein likes the clean look of internal cables, and loves the fact that he's not snagging his shorts when he jumps off the saddle, nor is he gouging his shoulder when he has to carry his bike. Some would say that Klein's expectations of perfection show him as a little bit spoiled. Klein would say that when you've been able to ride the best bikes on the planet for over 25 years, you are definitely spoiled.

So spoil yourself- ride a new Attitude.

Klein feature list

The Attitude borrows from a long list of proprietary Klein features. We list these features here, but for a more detailed explanation please see "Klein Details".

- **Aerospace grade tubing**
- **Large diameter frame tubing**
- **Gradient tubing**
- **ZR9000 alloy**
- **Reinforced head tube/ down tube junction**
- **Internal cable routing**
- **Void-free welds**
- **Klein heat-treating**
- **The finest paint jobs**
- **Klein geometry**

Palomino

What do you get when you cross the world's foremost bicycle suspension designer with the father of modern aluminum bicycle frames? Either a long boring discussion about springs and damping, or one heck of a full suspension mountain bike. Luckily, we got the bike.

Introducing the new Klein Palomino-

Paul Turner, the head behind the original RockShox suspension fork, started a new company recently. Tasking himself with taking a fresh look at rear suspension, Paul came up a radical new rear suspension design he dubbed the Monolink, and built bicycles under the maverick label using this design. Not wanting to be burdened with becoming solely a manufacturing concern, Paul shopped his new design around a bit until he met someone who really loved the Monolink concepts. That was the father of aluminum bicycle frames, Gary Klein.

Klein immediately recognized some features in this design which are the hallmarks of every Klein bike. Klein has always believed in offering a lot of travel as the best method of dispersing large shock loads. This design allows a big 4 inches (100mm) of rear wheel travel. Klein could see that there are only two pivots, eliminating weight while at the same time limiting wear. A lightweight bike is more fun to ride. And no one wants to spend his or her free time doing pivot maintenance. As a bonus, both pivots are generously wide, increasing lateral rigidity of the structure. A rigid structure steers better and minimizes power-robbing frame flex.

In typical fashion Klein immediately saw ways to put a Klein spin on Paul Turner's ideas. Simply put, whittle away some rear triangle weight through standard Klein tricks, and then hook this slimmed-down rear end to a Klein front end. Presto- the Palomino was born.

Klein feature list

The Palomino borrows from a long list of proprietary Klein features. We list these features here, but for a more detailed explanation please see "Klein Details".

- **Aerospace grade tubing**
- **Large diameter frame tubing**
- **Gradient tubing**
- **ZR9000 alloy**
- **Reinforced head tube/ down tube junction**
- **Internal cable routing**
- **Void-free welds**
- **Klein heat-treating**
- **The finest paint jobs**
- **Klein geometry**

Mono-link benefits explained

The Monolink suspension is totally unique in the bicycle industry, using what some have called a "3-bar linkage". The three bars are the seat tube of the main triangle, the monolink that includes the bottom bracket, and the rear shock. The rear triangle is connected to the rear shock as single unit. Two large pivots keep the rear triangle and monolink in alignment with the front end.

The precision arrangement of link and pivots allows an upwardly rearward axle path that roughly parallels the movement of the front wheel. This axle path allows the wheel to move over obstacles with more efficiency than vertical-up or up-and-forward arced axle paths found on virtually every other design. The basic concept here is that when you hit a bump, the force is not straight up (unless you're landing a vertical jump with no forward motion involved). Instead, the bump contacts the leading edge of the tire, so the resultant force is up and also back. To get out of the way of the bump, the best direction for the wheel to move is up and back.

The bottom bracket is placed on the monolink, isolating the pedals from the suspension action while at the same time eliminating pedal kickback. Chain tension reverses the direction of the suspension axle path. This extends the rear shock, canceling out pedal bob so your pedal stroke is not disturbed.

Good things about the design

In addition to a superior frame and outstanding suspension action, the new Palomino has a host of additional benefits that will appeal to the cycling connoisseur.

The Palomino offers a generous 4" (100mm) of rear wheel travel. In today's market, this borders on "long travel". Even so, the Palomino has the climbing and pedaling efficiency to make it a great cross-country race bike. This versatility makes the Palomino the "one bike does-it-all" machine you've always dreamed of.

The Palomino is a really great looking bike. There are no big herky links, and the shock blends into the frame's lines creating the look of a classic hardtail.

The Palomino is very light for a full suspension bike. And what little extra weight there is has been placed very low on the frame for a low center of gravity. This makes the Palomino handle really well, especially when being tossed through the S-bends of a tight singletrack.

The Palomino not only looks like a classic bike, it maintains some of those features as well. You can put it over your shoulder for portages. And you can carry two waterbottles; a real advantage for those of us who drink water when we ride, or for holding bottle-shaped batteries at those 24-hour races.

With large, self-lubricating pivots, there is virtually no maintenance. Klein has used similar pivot designs and materials since the mid-90s, and these are virtually maintenance free. All you have to do is keep the pivot area clean and check the bolts occasionally. Less down time means more ride time.

The Palomino is suspension set-up tolerant. In other words, it will ride really well over a broad spectrum of suspension adjustment. That means that you don't have to have an advanced engineering degree to get a good ride. It also means that with a single adjustment, you'll get great performance over a wide variety of trail conditions. No need to tweak the springs as the trail angles up or downhill, or as the sandy road turns into a rocky singletrack.

Custom rear shock

The Palomino design incorporates the rear shock as a frame member. If the shock were removed, the frame would require a piece of metal in the same position. By clever design, the normal weight penalty of full suspension is minimized.

The Palomino's rear shock is designed by Paul Turner and manufactured by Fox. This shock uses an air-assist coil spring, which results in really plush suspension action. The shock uses three springs in a linear arrangement; an air spring for preload to adjust the shock sag, a coil spring for plush, deep feel to the suspension motion, and a nitrogen charge to back up the coil and prevent bottoming of the shock.

In addition to this sophisticated spring design, the Palomino's custom shock also has speed sensitive damping with adjustable rebound damping. Speed sensitive damping means that the damping rate changes according to the speed of the shock. This allows the bike to be really plush over smaller hits, yet really scrub off impact on a hard hit. With the adjustable rebound damping the feel can be dialed in just six clicks; from a slow setting of 6 to a very lively setting of 1.

Suspension setup

To get the most from your new Palomino, we recommend setting the forks for about 15% sag (12mm), and the rear shock at about 10% sag (10mm). This will provide a good, all-round ride. If your riding is slower or more technical, you may want a softer setup. If you ride really fast, or on smoother terrain, you may like the Palomino set up a bit firmer. Find out what the correct pressures for the starting sag are, and then try changing by increments of 5 to 10 psi.

As an alternative method to set up a Palomino, you can use body weight. However, be aware that the distribution of your body weight, both on your body and on the bike, may not balance out at the previous sag recommendations. As an example, if you like your saddle pushed way back, you will apply more force to the rear shock, increasing the sag. That said, try using a setting in the rear shock of 1/2 your body weight in pounds. If the shock has damping adjustment, set it at 2 clicks in from full fast.

Body Weight LBS	Preload PSI
100	50
110	55
120	60
130	65
140	70
150	75
160	80
170	85
180	90
190	95
200	100
210	105
220	110
230	115
240	120

Body Weight KG	Preload ATM
45	3.4
50	3.8
55	4.2
60	4.5
65	4.9
70	5.3
75	5.7
80	6.1
85	6.4
90	6.8
95	7.2
100	7.6
105	8.0
110	8.3

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.

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.

Is a Klein Really Better?

You know all bikes are not created equal

Would you buy a Box-Mart bike if it could save you one or two hundred dollars over a Pro shop bike with similar derailleurs? Most people know the Box-Mart bikes just don't measure up in quality to those sold in a professional bike shop. It's generally conceded they suffer from a combination of a lack of design experience, bargain-basement frame materials, and developing-nation craftsmanship.

A similar quality difference exists between bikes sold within that Pro shop. A Klein frame costs more than many of its competitors, and we think there is a difference in how our bikes ride. We truly believe that all our "extra" work isn't extra; its just what it takes to create the best riding bikes on the planet. Our attention to detail, and willingness to do what it takes to make those details a reality, is the reason why "Nothing else ride like a Klein".

Great frames start with great material

We almost wrote "tubes" instead of material. Most manufacturers start by buying tubesets from a tubing company. At Klein, we often design our own materials. We actually specify the material that is used to make our tubes. Examples include our new ZR9000 aluminum alloy, or the OCLV 110 used in the Aeros fork.

When we use "off the shelf" materials, we use certified Aerospace Grade material. This certification means that each batch of alloy has been inspected for chemical purity and conformance to the required alloying standards. It exactly matches the mechanical properties. Every Klein uses our Gradient tubing, which requires very extreme tubing manipulations . We've found that lower grades of alloy simply won't stand up to the processes required to get these complicated Gradient shapes and wall tapers.

Quality control from understanding processes

Drawing is the process where a cylindrical tube of constant wall thickness is tapered or butted. At one time, we used to draw our own tubes. This taught us volumes about the process, so that we've been able to identify the best companies to perform these duties for us. We're happy to say that at this point, the company drawing our tubesets does as good a job as we could do ourselves.

However, these tubes are not yet ready for the Gradient label. The torture has just begun!

Proprietary processes

Once we have received the drawn tubes into the plant and inspected them for adherence to our strict quality standards, its time for us to roll up our sleeves and begin really manipulating some tubes.

The best example is our famous chainstays. These start at the bottom bracket as a large diameter, round section. The large diameter yields more weld cross-section for increased strength and stiffness. They quickly taper to a compact, square section which fits in the tight space between the tire and the chainrings. As we move just a short distance rearward, the chainstays flare back to a large round section, then ovalize slightly for increased heel clearance. Finally, they gradually taper to their connection with the dropout. Through all these shapes and diameters, the wall thickness remains constant, sort of the opposite of butting and even harder to achieve. The constant wall makes the chainstay extremely strong, with no weak or thin spots.

Not only do we have extra expense in all these shapes, but the aluminum has to be annealed (softened) prior to each manipulation. This means we also have to run several extra heat treatment cycles. As you can imagine, all this handling adds cost, as does the time required to perform them.

If you look closely at a Klein, you'll notice that it has more tire clearance than just about any bike on the market, while you also get one of the stiffest rear triangles made. To save money, our competitors compromise tire clearance for frame stiffness, hoping you won't notice until you get bogged down in the mud, at which time you already own the bike. With a Klein, there is no performance compromise, it just costs more. Sorry, but we think it's worth it.

Another example of our attention to detail is our frame "dimples". We take a Gradient tube, which is already shaped on the outside and with tapered and varied wall thickness, and anneal it. Then we add the dimples, drill the cable holes, and re-heat-treat. While its easy to appreciate the clean look of hidden cables, our dimples actually make the frame stronger with a more comfortable ride. You may ask "Is it worth the expense?". Our answer is "It is if you want a stronger, lighter, better riding bike".

Other "extras" that add cost include our void free welds. With the long, fillet-looking welds, we get better stress distribution near the critical frame joints. So we can use lighter tubing. We even developed expensive machines that tap and/or face both ends of the bottom bracket or head tube simultaneously, so that we maintain exact concentricity.

A better paint job isn't faster, but.....

Although it may not effect the ride, our special paint techniques are the icing on the cake. We could use decals like almost all other bikes. But with the pride of creating the best riding bike comes a need to make a statement. We want our bikes to LOOK as good as they RIDE. So again, we go to extra effort, using a process called debossing.

Here's how we do it. A frame is painted with a base coat. Most bikes get a color coat right away to save time, but ours are allowed to completely dry. After the base coat dries, we add decals, and put a color coat over both. Then with careful timing we hand-peel the decals, exposing the base paint. If the color coat is wet, or too dry, debossing won't work. Then a clear coat is applied over the whole frame to give it that deep, lustrous color that lets everyone know you're riding the best bike in the world; Klein.

Bontrager Wheelworks wheels set a new standard in wheel performance. Bontrager Wheelworks wheels are light, fast, and rock solid, with a unique set of application-specific features.

Since different types of riding place different demands on wheels, Bontrager Wheelworks applies the features to each wheelset which will optimize its performance for that use. In other words, each wheelset draws on the best specific set of the following possible features: paired spoking, OSB (Offset Spoke Bed), front-or-rear specific rims, disc-specific rims, top quality spokes (aero in some applications), and special hub designs.

Engineered wheels

Bontrager Wheelworks wheels are highly engineered; every aspect of wheel performance has been considered, and redesigned when necessary. An extensive battery of tests has proven these to be truly outstanding products in aerodynamics, low moment of inertia, and durability. Since we proudly list the weights, it's easy to see the Bontrager advantage in this parameter. But with Keith Bontrager, durability is always a characteristic of paramount importance. These wheels are no exception. The battery of tests which every Bontrager wheel design must pass is truly astonishing.

As an example, one torture test involves placing a load on a wheel simulating a 300 pound rider on their bike, and rolling the wheel over fixed cleats at 30 MPH. Don't try this at home! While all Bontrager Wheelworks wheel designs must pass this test, it regularly destroys many of the wheels of our competitors.

The key to durable wheels

The most important aspect of wheel building is achieving even spoke tension, within a range of acceptable tension. Certainly some of the responsibility here lies on the careful hand-finishing applied to all Bontrager Wheelworks wheels. But even the best trained hands won't achieve consistent, even spoke tension if the wheel isn't designed properly.

Design review

When engineering wheels, every aspect of the wheel and its components must be considered as a group. Rim design effects lateral and radial stiffness, spoke bed strength, and in extreme cases impact resistance. Spokes must be selected with the right strength and elasticity. Hub design must provide support for the spoke head, and flange width effects lateral stability. All the features must match up exactly to optimize the design's strength-to-weight ratio. The wheel is only as strong as its weakest link.

The missing factor

On any bike, the rear wheel sees more stress than the front wheel. The rear wheel supports a greater percentage of the rider's weight. The rear wheel must accommodate the freewheel or cassette, yet center the rim over the axle ends. The rear wheel is trapped between the rigid chainstays, while some of the force that might otherwise load the front wheel is absorbed by the natural flex of the fork and its ability to pivot about the steering axis. Comparing the forces that occur in riding between the front and rear wheels, the rear wheel can see greatly increased radial and side loading.

Over the years, many approaches have been taken to increase rear wheel strength. Rather than attempt to review all those here, we'll simply present the goal of the Bontrager rear wheel; create the best possible balance of spoke tension from the drive side to the non-drive side of the rear wheel. Bontrager engineers closely studied the effects of various bracing angles and carefully maximized the distribution of the pulling load over more spokes to reduce variation in spoke tension. As we have said before, the greatest source of wheel failure is uneven spoke tensions. Since the inherent design of a multi-speed rear wheel creates a large difference in tension between left and right sides of the wheel, the best way to create a durable structure is to minimize this difference. If a spoke is at lower tension than its neighbors and the rim is further loaded, the spoke is in danger of reaching zero tension. At zero tension, a spoke can't effectively support the rim.

Bontrager Wheelworks rear wheels employ OSB (Offset Spoke Bed) rims and special hub designs with a more inboard left flange spacing. These features allow an increase in the left-side spoke tension. The higher left side tension allows the left spokes to transfer torque between the hub and rim. The more highly tensioned spokes also provide increased strength through increased radial and lateral load capacity. In other words, Bontrager Wheelworks wheels are stronger and more efficient.

Bontrager wheels create a structure with more even tension, and thereby reduce the overall stress on the individual components. The result is that Bontrager Wheelworks wheels offer unmatched strength and durability.

Bontrager wheels stay true longer

As your bike rolls down the road, the wheels are loaded with your body weight. The road resists the force of your body weight, slightly deflecting the rim at the point of road contact. As the wheels turn, the point of contact moves. This moving force creates a change in spoke tension such that every spoke on the wheel is seeing a loose-tight-loose-tight-loose-tight cycle.

The greater the difference in spoke tension within the wheel, the greater the chance that the loosest spoke will become slack. If a spoke becomes slack, additional fatigue is shifted onto other components in the wheel. This cycle creates fatigue in the spokes, which will eventually fail. In the same way, fatigue can even cause a rim to fail.

Long before fatigue causes parts to fail, the wheel may come out of true. As the tension is removed from a spoke, the nipple can more easily turn on its threads. This results in the wheel coming out of true. With Bontrager Wheelworks wheels, the design creates more even tensioning. Maintenance is therefore at a minimum.

The keys to a perfect road wheel

All wheels benefit from low weight, durability, and low maintenance. Bontrager Wheelworks road wheels employ a specific set of features to achieve their high level of performance.

Due to the higher average speeds seen on pavement, the aerodynamics properties of a road wheel are very important. One of the major influences on wheel aerodynamics is spokes. Many Bontrager road wheels use aero, or bladed, spokes to reduce wind drag. These wheels also use reduced spoke counts, relying on PST (Paired Spoke Technology) to maintain high wheel strength with fewer spokes.

Front and rear road wheels have different needs. On a bike, the front wheel sees the most wind resistance because it is the leading edge of the bike. The rear wheel is "drafting the seat tube", and is in much more turbulent air. For this reason, some models of Bontrager road front wheels use a deeper, more aerodynamic rim than the rear wheel.

Mountain bike wheels have different needs

Compared to road wheels, mountain bike wheels place a greater need on wheel durability and rigidity. They also sometimes require special configurations, like the ability to accept a disc brake rotor. Again, Bontrager Wheelworks mountain bike wheels select those features which will best create the ultimate structure.

With disc-specific wheels, there is no need for a flat rim sidewall. This allows optimization of the rim shape to reduce weight. Placing a rotor on the front wheel creates an asymmetric spoke configuration that can be enhanced using a rim with OSB (Offset Spoke Bed), thereby reducing the required dishing and providing more balanced spoke tension from left to right side of the wheel. Also, Bontrager disc wheels use crossed spokes to efficiently transfer disc brake forces between the hub and rim with less stress on the wheel.

With rim brakes, Bontrager Wheelworks incorporate tall sidewalls so that brake adjustment is easier, and pad wear has less effect on proper adjustment; taller sidewalls provide increased surface for the brake pad to mate to.

Bontrager rear mountain wheels focus on balancing spoke tensions on the drive and non-drive side of the wheel. To do this, they employ OSB (Offset Spoke Bed) rims and special hub designs with modified flange spacing. These features greatly reduce the tension differentials from side to side, creating a stronger, more durable structure. The higher left side tensions allow more torque transfer to the left side drive spokes. In other words, Bontrager Wheelworks mountain wheels are stronger.

Truing Bontrager Wheelworks wheels

Most Bontrager wheels employ standard, externally adjustable spoke nipples. The only exceptions are the Bontrager Race X Lite Carbon Road wheels, and the Bontrager Race X Lite Aero road wheels where a small aerodynamic benefit can make the difference between winning and losing a race.

Bontrager Road wheels use PST (Paired Spoke Technology) which require a slightly different technique to true. In many respects, truing Bontrager Wheelworks wheels with PST 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 Bontrager wheel with PST, 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 effects the tension, and thus the spatial position, of the two partners. This in turn effects the next outward pair, and so on.

When truing Bontrager Wheelworks road wheels, PST sometimes 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.

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 Villum, a highly sensitive truing stand that uses dial indicators driven by precision-bearing sensors rolling on the rim edges. When 0.5mm passes by the indicators on the Villum, the needles move about an inch. What looks like a mountain on the Villum 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, it's very visible to the naked eye.

With Bontrager Wheelworks, 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.

A note about the "little marks" on the rims

On 2002 and later Bontrager rims there is a small spherical indentation in the braking surface of the rim. This isn't a blemish, it's a wear indicator. If the braking surface has worn so that the indicator is no longer visible, have your dealer replace the rim.

Technical Specifications

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

Tubeless Compatible Technology

Snakebite

You are probably familiar with this scenario. With your tire pressure set on the soft side to enhance traction, you run 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.

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 a 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 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 are 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 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 4 PSI (1/4 ATM) per day.

For display purposes, 2003 complete bikes with tubeless tires include an installed inner tube. Since inner tubes have a slower bleed rate, the dealer won't have lots of bikes sitting on the sales floor with soft tires.

What if a tubeless tire runs over a nail?

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, it 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.

Anything 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 than does a conventional tire. This makes a tubeless tire 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.

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

Looking for something more exclusive?

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

What makes a mass-produced Klein unique?

If its a look you want, the Klein Custom program lets you pick from 25 different color and graphics packages, including 'glow in the dark' paint..

'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 25 colors, which include all stock 2002 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 Klein'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 Klein 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, Klein spent a lot of time doing just that; designing custom frames for people who either weren't satisfied with "off the shelf" or couldn't get comfortably fit. Klein 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 frame.

Which bikes are in the custom program?

Q-Pro Carbon Team
frame and fork

Q-Carbon Team
frame and fork

Attitude Comp
frame only

Palomino
frame, with Fox custom rear shock

How long does it take?

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!

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 dealer, or cybersurf to *www.kleinbikes.com* to get the latest.

Palomino Frame Specs

Frame sizes	16	17.5	19	21
Head angle	71.0	71.0	71.0	71.0
Seat angle	73.3	73.0	72.3	71.3
Standover	746	755	773	795
Seat tube	407	445	483	533
Head tube	90	105	125	165
Eff top tube	588	600	615	630
Chainstays	380	380	380	380
BB height	310	310	310	310
Offset	38.0	38.0	38.0	38.0
Trail	75	75	75	75
Wheelbase	1088	1099	1108	1118
Standover	29.4	29.7	30.4	31.3
Seat tube	16.0	17.5	19.0	21.0
Head tube	3.5	4.1	4.9	6.5
Eff top tube	23.1	23.6	24.2	24.8
Chainstays	15.0	15.0	15.0	15.0
BB height	12.2	12.2	12.2	12.2
Offset	1.5	1.5	1.5	1.5
Trail	3.0	3.0	3.0	3.0
Wheelbase	42.8	43.3	43.6	44.0

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 Palomino 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 Attitude doesn't hurt.

New for 2003

Completely new frame platform

Mechanic's Specs and Notes

Seatpost diameter	31.6 mm
Seatclamp diameter	38.3 mm
Headset size	25.4/34.0/30.0
Fork length	451 mm
Front derailleur	Plate style (only) Down pull
Bottom bracket	73 mm
Rear wheel travel	100 mm
Rear hub OLD	135 mm
Cable stops	3 cables, 2 internal (rear brake housing is fully closed, and stops are adaptable to disc brake hydraulic hose)
Disc brake mount	International type Adapter required
Bottle mounts	2, on frame
Rack mounts	No

Seatposts

Palominos 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 Palomino frame will only fit a plate style (fitted to the bottom bracket), down pull front derailleur. There is no seat tube to provide an attachment point for a seat tube clamp.

International disc brake mount

Klein mountain bikes do 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 of 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 the extra length and stiffness. For this reason, triple clamp forks should not be put on any Klein frames.

Fitting the Palomino

To best fit the Palomino bikes, start with our recommendations for overall body height, titled "Rider height". This can be found in the Fit section at the bottom of each model spec page.

"Rider height" is our calculation of the height of rider, on average, who fits this bike with the stock stem and handlebars in their highest position.

If you are not average, these calculations may not apply directly to you. In particular, fitness, flexibility, and body mass distribution will effect the calculations.

Changing to a longer stem makes the bike fit a taller person. Lowering the stem, or changing to a shorter stem, makes the bike fit a shorter person.

If you are in-between sizes, we point out that with a larger frame it is easy to move the stem down (making the bike fit smaller), and we have provided lots of spacers to allow this adjustment. However, if the handlebars are too low, it can be difficult to raise them.

Once you've found the bike size which most closely gives the desired fit, check that the standover is at least one inch, with more clearance preferable on a mountain bike. Then adjust the saddle position to suit.

Palomino suspension setup

Proper suspension set-up is critical to getting the performance advantage offered by the Palomino. The best way to measure the set-up is through shock sag, but a quick alternative that will get you close is to simply use body weight as a guide.

The correct sag, measured at the shock shaft, is about 5-8 mm of compression when the rider sits quietly in the saddle. This can be measured by using the O-ring on the shock as a marker. With the rider on the bike in a normal position, move the O-ring against the shock body. Then have the rider ease themselves off the bike (without activating the suspension). Measure the gap between the shock body and O-ring.

The alternate method, and usually pretty close, is by body weight. Simply follow the chart below and inflate the shock. Remember that this is for the stock shock. A different shock, due to varying design, may require different pressures to achieve a similar effect. Also remember that with the negative spring in a Fox shock, compressing the shock allows some of the main air chamber to equalize with the negative spring. If you change the preload by more than about 20 PSI (1.25 ATM) you should do it in two stages. First, set the preload. Then, get on the bike and compress the shock a few times. Then reset the preload.

Body Weight LBS	Preload PSI	Body Weight KG	Preload ATM
100	75	45	5.2
110	83	50	5.7
120	90	55	6.2
130	98	60	6.7
140	105	65	7.3
150	113	70	8.2
160	120	75	8.7
170	128	80	9.2
180	135	85	9.8
190	143	90	10.3
200	150	95	10.9
210	158	100	11.4
220	165	105	11.9
230	173	110	12.4
240	180		

Palomino Team

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS ZR9000
5.7 lb. (2.60 kg.) — Frame weight (estimated)
FORK . . . . Fox Float F80X
80 — Travel, mm
451.0 — Axle-crown length, mm
REAR SHOCK . . . . Fox Palomino custom, Air assist
2.36/60 — Stroke, inches/mm
HEADSET . . . . Cane Creek S-6 Aheadset, alloy
25.4/34.0/30.0 — Size
27.1 — Stack height, mm

CONTROLS

HANDLEBAR . . . . . Bontrager Race Lite
25.4 — Clamp diameter, mm
STEM . . . . Bontrager Race Lite
40.0 — Steerer clamp height, mm
SHIFT LEVERS . . . Shimano XTR, Dual Control
BRAKE LEVERS . . Integrated brake/shift
GRIPS . . . . Klein Instinct

DRIVETRAIN

FT DERAILLEUR . . Shimano Deore XT
Down pull — Cable routing
Plate style — Attachment
RR DERAILLEUR . Shimano XTR Rapid Rise
CRANKSET . . . . . . Shimano XTR 44/32/22
146/102/64 — Bolt hole circle, mm
BB . . . . Shimano XTR, integral axle
73 x 135.5, Integral to crank — Shell x axle, mm
CHAIN . . . . Shimano Dura-Ace
9 speed — Chain type
108 — Chain length (links)
CASSETTE . . . . Shimano XTR 11-34, 9spd

WHEELSET

FRONT WHEEL . . . Bontrager Race X Lite Tubeless ATB, 24°
539 — E.R.D., mm
Tubeless — Rim strip
FRONT TIRE . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — Tire size
REAR WHEEL . . . . Bontrager Race X Lite Tubeless ATB, 28°
542 — E.R.D., mm
Tubeless, assymetric — Rim strip
REAR TIRE . . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.1 — Tire size
SPOKES . . . . DT Revolution 14/17G (Special Revolution 14/16G rear drive), ProLock alloy nipples
250, Radialx — Front, mm
265/268, 3x — Rear, mm
INNER TUBES . . . . Presta valve

OTHER

SEATPOST . . . . Thomson Elite
31.6 — Outer diameter, mm
SADDLE . . . . Bontrager Race Lite, Ti/leather
BRAKES . . . . Avid SD Ultimate, linear pull
PEDALS . . . . -not supplied-
9/16" — Axle diameter
SEAT BINDER . . . . Alloy w/integral bolt
38.3 — Inner diameter, mm
ADDITIONALS . . . . 2 water bottle mounts, Wrench Force shock pump

COLORS

Great Barrier Reef Blue • Tone on Tone Blue • Matte Silver fork

FIT

Frame	Size	16	17.5	19	21
Rider height	Inches	67	69	70	73
	Cm	170	175	178	187
Handlebar	Width,mm	600	600	600	600
Stem	Length,mm	105	120	120	135
	Angle	7	7	7	7
Crank	Length,mm	175	175	175	175
Seatpost	Length,mm	410	410	410	410
Steerer	Length,mm	182.6	198.1	218.1	257.6

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Maverick rear suspension- no bob, plush, light, and laterally rigid rear suspension
Fox rear shock- air sprung for low weight and easy adjustment, oil damped with adjustable rebound for control Fork has large diameter stanchions and beefy crown to increase steering precision and durability. External rebound damping adjustment allows tuning of suspension 'feel', adding control. Lockout stops suspension motion for more powerful climbing, especially out of the saddle.

COMPONENTS HIGHLIGHTS

Shimano XTR shifting- the choice of Pro racers
Bontrager bars, stem- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance. Butted spokes, alloy nipples, ultralight tubes, and folding-bead tires- low weight. Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight. More threads per inch (tpi) means lower weight with higher strength.

GEARING

	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

BIKE WEIGHT (est.)

25.2 lb.
11.44 kg.

Palomino Race

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS ZR9000
5.7 lb. (2.60 kg.) — *Frame weight (estimated)*
FORK . . . . Fox Float RL
100 — *Travel, mm*
471.0 — *Axle-crown length, mm*
REAR SHOCK . . . . Fox Palomino custom, Air assist
2.36/60 — *Stroke, inches/mm*
HEADSET . . . . SAS Aheadset, alloy
25.4/34.0/30.0 — *Size*
27.0 — *Stack height, mm*

CONTROLS

HANDLEBAR . . . . . Bontrager Race
25.4 — *Clamp diameter, mm*
STEM . . . . Bontrager Race
41.0 — *Steerer clamp height, mm*
SHIFT LEVERS . . . Shimano Deore XT RapidFire SL
BRAKE LEVERS . . Avid SD-5, long pull
GRIPS . . . . Klein Instinct

DRIVETRAIN

FT DERAILLEUR . . Shimano Deore XT
Down pull — *Cable routing*
Plate style — *Attachment*
RR DERAILLEUR . Shimano XTR SGS
CRANKSET . . . . . . Shimano Deore XT 44/32/22
64/104 — *Bolt hole circle, mm*
BB . . . . Shimano BB-ES51 E-type
73 x 118, Splined, Shimano — *Shell x axle, mm*
CHAIN . . . . Shimano HG-72
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE . . . . Shimano HG70 11-34, 9spd

WHEELSET

FRONT WHEEL . . . Bontrager Race ATB, tubeless compatible, 24°
539 — *E.R.D., mm*
Tubeless — *Rim strip*
FRONT TIRE . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — *Tire size*
REAR WHEEL . . . . Bontrager Race ATB, tubeless compatible, 28°
542 — *E.R.D., mm*
Tubeless, assymetric — *Rim strip*
REAR TIRE . . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — *Tire size*
SPOKES . . . . DT 14/15G butted SS, ProLock alloy nips
250, Radialx — *Front, mm*
265/268, 3x — *Rear, mm*
INNER TUBES . . . . Presta valve, ultra light

OTHER

SEATPOST . . . . Thomson Elite
31.6 — *Outer diameter, mm*
SADDLE . . . . Bontrager Race Lite, CrMo/leather
BRAKES . . . . Avid Single Digit 3, linear pull
PEDALS . . . . Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER . . . . Alloy w/integral bolt
38.3 — *Inner diameter, mm*
ADDITIONALS . . . . 2 bottle mounts, shock pump

COLORS

Kalahari Blood Red • Tone on Tone Red deboss • Matte Silver fork

FIT

Frame	Size	16	17.5	19	21
Rider height	Inches	69	70	72	74
	Cm	174	178	182	188
Handlebar	Width,mm	600	600	600	600
Stem	Length,mm	110	120	120	130
	Angle	10	10	10	10
Crank	Length,mm	175	175	175	175
Seatpost	Length,mm	350	350	350	350
Steerer	Length,mm	184.0	199.0	219.0	259.0

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Maverick rear suspension- no bob, plush, light, and laterally rigid rear suspension
Fox rear shock- air sprung for low weight and easy adjustment, oil damped with adjustable rebound for control Fork has large diameter stanchions and beefy crown to increase steering precision and durability. External rebound damping adjustment allows tuning of suspension 'feel', adding control. Lockout stops suspension motion for more powerful climbing, especially out of the saddle.

COMPONENTS HIGHLIGHTS

Shimano XTR and XT shifting- precise and long lasting
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Butted spokes, alloy nipples, ultralight tubes, and folding-bead tires- low weight
Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight. More threads per inch (tpi) means lower weight with higher strength.

GEARING

	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

BIKE WEIGHT (est.)

27.4 lb.
12.44 kg.

Palomino Race Disc

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS ZR9000
5.7 lb. (2.60 kg.) — Frame weight (estimated)
FORK . . . . Fox Float RL
100 — Travel, mm
471.0 — Axle-crown length, mm
REAR SHOCK . . . . Fox Palomino custom, Air assist
2.36/60 — Stroke, inches/mm
HEADSET . . . . SAS Aheadset, alloy
25.4/34.0/30.0 — Size
27.0 — Stack height, mm

CONTROLS

HANDLEBAR . . . . . Bontrager Race
25.4 — Clamp diameter, mm
STEM . . . . Bontrager Race
41.0 — Steerer clamp height, mm
SHIFT LEVERS . . . Shimano Deore XT RapidFire SL
BRAKE LEVERS . . Hydraulic, attached to brake
GRIPS . . . . Klein Instinct

DRIVETRAIN

FT DERAILLEUR . . Shimano Deore XT
Down pull — Cable routing
Plate style — Attachment
RR DERAILLEUR . Shimano XTR SGS
CRANKSET . . . . . . Shimano Deore XT 44/32/22
64/104 — Bolt hole circle, mm
BB . . . . Shimano BB-ES51 E-type
73 x 118, Splined, Shimano — Shell x axle, mm
CHAIN . . . . Shimano HG-72
9 speed — Chain type
108 — Chain length (links)
CASSETTE . . . . Shimano HG70 11-34, 9spd

WHEELSET

FRONT WHEEL . . . Btgr Race ATB Disc, tubeless compatible, 28°
537 — E.R.D., mm
Tubeless, assymetric — Rim strip
FRONT TIRE . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — Tire size
REAR WHEEL . . . . Btgr Race ATB Disc, tubeless compatible, 28°
537 — E.R.D., mm
Tubeless, assymetric — Rim strip
REAR TIRE . . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — Tire size
SPOKES . . . . DT 14/15G butted SS, ProLock alloy nips
266/264, 3x — Front, mm
264/265, 3x — Rear, mm
INNER TUBES . . . . Presta valve, ultra light

OTHER

SEATPOST . . . . Thomson Elite
31.6 — Outer diameter, mm
SADDLE . . . . Bontrager Race Lite, CrMo/leather
BRAKES . . . . Hayes HFX-Mag, hydraulic disc
PEDALS . . . . Shimano SPD M515, clipless
9/16" — Axle diameter
SEAT BINDER . . . . Alloy w/integral bolt
38.3 — Inner diameter, mm
ADDITIONALS . . . . 2 water bottle mounts, shock pump

COLORS

Kalahari Blood Red • Tone on Tone Red deboss • Matte Silver fork

FIT

Frame	Size	16	17.5	19	21
Rider height	Inches	69	70	72	74
	Cm	174	178	182	188
Handlebar	Width,mm	600	600	600	600
Stem	Length,mm	110	120	120	130
	Angle	10	10	10	10
Crank	Length,mm	175	175	175	175
Seatpost	Length,mm	350	350	350	350
Steerer	Length,mm	184.0	199.0	219.0	259.0

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Maverick rear suspension- no bob, plush, light, and laterally rigid rear suspension
Fox rear shock- air sprung for low weight and easy adjustment, oil damped with adjustable rebound for control Fork has large diameter stanchions and beefy crown to increase steering precision and durability. External rebound damping adjustment allows tuning of suspension 'feel', adding control. Lookout stops suspension motion for more powerful climbing, especially out of the saddle.

COMPONENTS HIGHLIGHTS

Shimano XTR and XT shifting- precise and long lasting
Bontrager bars, stem, and seatpost- designed for durability, light enough to race
Hayes hydraulic disc brakes are super powerful, offer excellent modulation for control

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Butted spokes, alloy nipples, ultralight tubes, and folding-bead tires- low weight
Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight. More threads per inch (tpi) means lower weight with higher strength.

GEARING

	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

BIKE WEIGHT (est.)

28.1 lb.
12.76 kg.

Palomino

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS ZR9000
5.7 lb. (2.60 kg.) — *Frame weight (estimated)*
FORK . . . . RockShox Duke SL
100 — *Travel, mm*
471.0 — *Axle-crown length, mm*
REAR SHOCK . . . . Fox Palomino custom, Air assist
2.36/60 — *Stroke, inches/mm*
HEADSET . . . . Alloy aheadset, semi-cartridge
25.4/34.0/30.0 — *Size*
27.0 — *Stack height, mm*

CONTROLS

HANDLEBAR . . . . . Bontrager Select
25.4 — *Clamp diameter, mm*
STEM . . . . Bontrager Select
41.0 — *Steerer clamp height, mm*
SHIFT LEVERS . . . Shimano Deore RapidFire+
BRAKE LEVERS . . Avid AD 3L, long pull
GRIPS . . . . Klein Instinct

DRIVETRAIN

FT DERAILLEUR . . Shimano Deore LX
Down pull — *Cable routing*
Plate style — *Attachment*
RR DERAILLEUR . Shimano Deore XT SGS
CRANKSET . . . . . . Shimano Deore LX 44/32/22
64/104 — *Bolt hole circle, mm*
BB . . . . Shimano BB-ES51 E-type
73 x 118, Splined, Shimano — *Shell x axle, mm*
CHAIN . . . . Shimano HG-72
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE . . . . SRAM 7.0 11-34, 9spd

WHEELSET

FRONT WHEEL . . . Bontrager Select Disc Compatible ATB, 28°
541 — *E.R.D., mm*
Velox 22mm — *Rim strip*
FRONT TIRE . . . . . Klein Deathgrip, folding
26 x 2.35 — *Tire size*
REAR WHEEL . . . . Bontrager Select Disc Compatible ATB, 28°
541 — *E.R.D., mm*
Velox 22mm — *Rim strip*
REAR TIRE . . . . . . Klein Deathgrip, folding
26 x 2.35 — *Tire size*
SPOKES . . . . DT 14/15G butted SS, ProLock alloy nips
268/268, 3x — *Front, mm*
267/268, 3x — *Rear, mm*
INNER TUBES . . . . Presta valve, ultra light

OTHER

SEATPOST . . . . Palomino, alloy
31.6 — *Outer diameter, mm*
SADDLE . . . . Bontrager FS 2000
BRAKES . . . . Avid Single Digit 3, linear pull
PEDALS . . . . Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER . . . . Alloy w/integral bolt
38.3 — *Inner diameter, mm*
ADDITIONALS . . . . 2 water bottle mounts, shock pump

COLORS

Black Sudbury • Tone on Tone Black deboss • Silver fork

FIT

Frame	Size	16	17.5	19	21
Rider height	Inches	68	70	72	74
	Cm	173	178	182	189
Handlebar	Width,mm	600	600	600	600
Stem	Length,mm	105	120	120	135
	Angle	10	10	10	10
Crank	Length,mm	175	175	175	175
Seatpost	Length,mm	350	350	350	350
Steerer	Length,mm	184.0	199.0	219.0	259.0

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Maverick rear suspension- no bob, plush, light, and laterally rigid rear suspension
Fox rear shock- air sprung for low weight and easy adjustment, oil damped with adjustable rebound for control Fork has Hydra Air springs for low weight, excellent small bump sensitivity. 30mm stanchions add steering control. Accepts tires to 2.4".

COMPONENTS HIGHLIGHTS

Deore, LX and XT shifting- precise and long lasting
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Low maintenance, high performance - Engineered and tested
Low weight- Butted spokes, alloy nipples, ultralight tubes, and folding-bead tires
Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight.

GEARING

	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

BIKE WEIGHT (est.)

28.2 lb.
12.80 kg.

Attitude Frame Specs

Frame sizes	14	16	17.5	19	21
Head angle	70.2	70.8	71.3	71.4	71.4
Seat angle	72.8	72.8	72.8	72.8	72.8
Standover	673	707	739	775	818
Seat tube	356	400	445	489	533
Head tube	90	105	105	125	165
Eff top tube	551	574	595	611	627
Chainstays	417	417	417	417	417
BB height	290	295	300	303	305
Offset	38.1	38.1	38.1	38.1	38.1
Trail	80	77	73	73	73
Wheelbase	1017	1037	1055	1072	1090
Standover	26.5	27.8	29.1	30.5	32.2
Seat tube	14.0	15.8	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	24.1	24.7
Chainstays	16.4	16.4	16.4	16.4	16.4
BB height	11.4	11.6	11.8	11.9	12.0
Offset	1.5	1.5	1.5	1.5	1.5
Trail	3.2	3.0	2.9	2.9	2.9
Wheelbase	40.0	40.8	41.6	42.2	42.9

Rider Profile

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

International disc brake mount

The 2002 Attitude 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.

New for 2003

The Attitude was re-designed for 2002, and remains unchanged for 2003.

Mechanic's Specs and Notes

Seatpost diameter	31.6 mm
Seatclamp diameter	36.4mm
Headset size	25.4/34.0/30.0
Fork length	451 mm
Front derailleur	34.9 mm Top pull
Bottom bracket	73mm
Rear hub OLD	135mm
Cable stops	3 cables, 2 internal (rear brake housing is fully closed, and stops are adaptable to disc brake hydraulic hose)
Disc brake mount	International type
Bottle mounts	3 frame
Rack mounts	No

Dual crown suspension forks

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

Fitting the Attitude

To best fit the Attitude bikes, start with our recommendations for overall body height, titled "Rider height". This can be found in the Fit section at the bottom of each model spec page.

"Rider height" is our calculation of the height of rider, on average, who fits this bike with the stock stem and handlebars in their highest position.

If you are not average, these calculations may not apply directly to you. In particular, fitness, flexibility, and body mass distribution will effect the calculations.

Changing to a longer stem makes the bike fit a taller person. Lowering the stem, or changing to a shorter stem, makes the bike fit a shorter person.

If you are in-between sizes, we point out that with a larger frame it is easy to move the stem down (making the bike fit smaller), and we have provided lots of spacers to allow this adjustment. However, if the handlebars are too low, it can be difficult to raise them.

Once you've found the bike size which most closely gives the desired fit, check that the standover is at least one inch, with more clearance preferable on a mountain bike. Then adjust the saddle position to suit.

Attitude Comp

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS . . . . Klein Gradient aluminum
3.2 lb. (1.45 kg.) — *Frame weight (estimated)*
FORK . . . . RockShox Duke SL
80 — *Travel, mm*
451.0 — *Axle-crown length, mm*
HEADSET . . . . Alloy aheadset, semi-cartridge
25.4/34.0/30.0 — *Size*
27.0 — *Stack height, mm*

CONTROLS

HANDLEBAR . . . . . Bontrager Race
25.4 — *Clamp diameter, mm*
STEM . . . . Bontrager Select
41.0 — *Steerer clamp height, mm*
SHIFT LEVERS . . . Shimano Deore LX RapidFire+
BRAKE LEVERS . . Avid AD 3L, long pull
GRIPS . . . . Klein Instinct

DRIVETRAIN

FT DERAILLEUR . . Shimano Deore LX
Top pull — *Cable routing*
34.9 mm/ 1 3/8" — *Attachment*
RR DERAILLEUR . Shimano XTR SGS
CRANKSET . . . . . . Shimano Deore LX 44/32/22
04 — *Bolt hole circle, mm*
BB . . . . Shimano BB-ES50
73 x 113, Splined, Shimano — *Shell x axle, mm*
CHAIN . . . . Shimano HG-72
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE . . . . SRAM 7.0 11-32, 9spd

WHEELSET

FRONT WHEEL . . . Bontrager Race ATB, tubeless compatible, 24°
539 — *E.R.D., mm*
Tubeless — *Rim strip*
FRONT TIRE . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — *Tire size*
REAR WHEEL . . . . Bontrager Race ATB, tubeless compatible, 28°
E.R.D., mm
Tubeless, assymetric — *Rim strip*
REAR TIRE . . . . . . Klein Deathgrip SL, folding, 127tpi
26 x 2.35 — *Tire size*
SPOKES . . . . DT 14/15G butted SS, ProLock alloy nips
250, Radialx — *Front, mm*
265/268, 3x — *Rear, mm*
INNER TUBES . . . . Presta valve, ultra light

OTHER

SEATPOST . . . . Bontrager Race
31.6 — *Outer diameter, mm*
SADDLE . . . . Bontrager FS 2000
BRAKES . . . . Avid Single Digit 5, linear pull
PEDALS . . . . Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER . . . . Alloy w/integral QR
36.4 — *Inner diameter, mm*
ADDITIONALS . . . . 3 water bottle mounts (1 on 14)

COLORS

Burning Poinsettia Red • Red/Silver decals • Silver fork

FIT

Frame	Size	14	16	17.5	19	21
Rider height	Inches	64	68	70	71	75
	Cm	163	172	177	181	191
Handlebar	Width,mm	600	600	600	600	600
Stem	Length,mm	90	105	120	120	135
	Angle	5	10	10	10	10
Crank	Length,mm	170	175	175	175	175
Seatpost	Length,mm	300	390	390	390	390
Steerer	Length,mm	184.0	199.0	199.0	219.0	259.0

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength Fork has Hydra Air springs for low weight, excellent small bump sensitivity. 30mm stanchions add steering control. Accepts tires to

COMPONENTS HIGHLIGHTS

Shimano XT/LX mix- tough enough for racing
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Butted spokes, alloy nipples, and folding-bead tires- low weight
Tubeless compatible- your choice of tire/tube configuration
Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight. More threads per inch (tpi) means lower weight with higher strength.

GEARING

	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

BIKE WEIGHT (est.)

25.1 lb.
11.40 kg.

Attitude

RIDING STYLE . Everyday Enthusiast or Racer

FRAMESET

MAIN TUBES ZR9000
STAYS .... Klein Gradient aluminum
3.2 lb. (1.45 kg.) — *Frame weight (estimated)*
FORK .... RockShox Duke XC
80 — *Travel, mm*
451.0 — *Axle-crown length, mm*
HEADSET .... Aheadset, semi-cartridge
25.4/34.0/30.0 — *Size*
26.5 — *Stack height, mm*

CONTROLS

HANDLEBAR ..... Bontrager Select
25.4 — *Clamp diameter, mm*
STEM .... Bontrager Comp
41.0 — *Steerer clamp height, mm*
SHIFT LEVERS ... Shimano Deore RapidFire+
BRAKE LEVERS .. Avid AD 3L, long pull
GRIPS .... Klein Instinct

DRIVETRAIN

FT DERAILLEUR .. Shimano Deore
Top pull — *Cable routing*
34.9 mm/ 1 3/8" — *Attachment*
RR DERAILLEUR . Shimano Deore XT SGS
CRANKSET ...... Bontrager Race 44/32/22
64/104 — *Bolt hole circle, mm*
BB .... Bontrager Race, ISIS splined
73 x 113, Splined, ISIS — *Shell x axle, mm*
CHAIN .... Shimano HG-53
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE .... SRAM 7.0 11-34, 9spd

WHEELSET

FRONT WHEEL ... Bontrager Select Disc Compatible ATB, 28°
541 — *E.R.D., mm*
Velox 22mm — *Rim strip*
FRONT TIRE ..... Klein Deathgrip, folding
26 x 2.35 — *Tire size*
REAR WHEEL .... Bontrager Select Disc Compatible ATB, 28°
541 — *E.R.D., mm*
Velox 22mm — *Rim strip*
REAR TIRE ...... Klein Deathgrip, folding
26 x 2.35 — *Tire size*
SPOKES .... DT 14/15G butted SS, ProLock alloy nips
268/268, 3x — *Front, mm*
267/268, 3x — *Rear, mm*
INNER TUBES .... Presta valve

OTHER

SEATPOST .... Bontrager Sport
31.6 — *Outer diameter, mm*
SADDLE .... Bontrager FS 2000
BRAKES .... Avid Single Digit 3, linear pull
PEDALS .... Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER .... Alloy w/integral QR
36.4 — *Inner diameter, mm*
ADDITIONALS .... 3 water bottle mounts (2 on XS)

COLORS

Black Sudbury • Silver decals • Silver fork

FIT

Frame	Size	14	16	17.5	19	21
Rider height	Inches	64	68	70	71	75
	Cm	163	172	177	181	191
Handlebar	Width,mm	600	600	600	600	600
Stem	Length,mm	90	105	120	120	135
	Angle	5	10	10	10	10
Crank	Length,mm	170	175	175	175	175
Seatpost	Length,mm	300	350	350	350	350
Steerer	Length,mm	183.5	198.5	198.5	218.5	258.5

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Fork has Hydra Air springs for reduced weight, excellent small bump sensitivity. Large 30mm stanchions add steering control.

COMPONENTS HIGHLIGHTS

Deore and XT shifting- precise and long lasting
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Low maintenance, high performance - Engineered and tested
Low weight- Butted spokes, alloy nipples, ultralight tubes, and folding-bead tires
Big tire casing floats on soft terrain, has large contact patch for traction. Small knobs reduce weight and rolling resistance. Folding tire beads reduce weight.

GEARING

	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

BIKE WEIGHT (est.)

26.1 lb.
11.85 kg.

Q-Pro Carbon 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	73.5	73.5	73.5	73.3	73.3
Standover	691	734	786	819	828	860
Seat tube	444	500	567	587	608	638
Head tube	92	109	128	144	168	199
Eff top tube	524	547	560	572	587	606
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
Standover	27.2	28.9	30.9	32.3	32.6	33.9
Seat tube	17.5	19.7	22.3	23.1	23.9	25.1
Head tube	3.6	4.3	5.0	5.7	6.6	7.8
Eff top tube	20.6	21.5	22.1	22.5	23.1	23.9
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 Q-Pro Carbon 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 Q-Pro, 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 Q-Pro uncomfortable? Klein has worked for years to milk the highest level of performance from aluminum frames. One of the results of Klein'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 Q-Carbon frames.

That statement should also tell you that the Q-Pro Carbon is an incredible racing machine, suitable for European stage racing, or American criteriums. And since Klein engineered comfort into such a high performance machine, the Q-Pro also works for the recreational go-fast rider or club century rider looking for a PR.

New for 2003:

The Q-Pro frame and fork were upgraded for the 2002 model year, and remain unchanged for the 2003 year.

Mechanic's Specs and Notes

Seatpost diameter	31.6 mm
Seatclamp diameter	36.4 mm
Headset size	27.0/1.75-1.5"/33.4 Road Airhead
Fork length	377 mm
Front derailleur	Braze-on type w/ 34.9 mm clamp Down pull
Bottom bracket	68mm
Rear hub OLD	130mm
Cable stops	Internal cables
Bottle mounts	2 frame
Rack mounts	No

Seatposts

Q-Pro Carbon is 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.

Fitting the Q-Pro Carbon

To best fit the Q-Pro Carbon bikes, start with our recommendations for overall body height, titled "Rider height". This can be found in the Fit section at the bottom of each model spec page.

"Rider height" is our calculation of the height of rider, on average, who fits this bike with the stock stem and handlebars in their highest position.

If you are not average, these calculations may not apply directly to you. In particular, fitness, flexibility, and body mass distribution will effect the calculations.

Changing to a longer stem makes the bike fit a taller person. Lowering the stem, or changing to a shorter stem, makes the bike fit a shorter person.

If you are in-between sizes, we point out that with a larger frame it is easy to move the stem down (making the bike fit smaller), and we have provided lots of spacers to allow this adjustment. However, if the handlebars are too low, it can be difficult to raise them.

Once you've found the bike size which most closely gives the desired fit, check that the standover is at least one inch. Then adjust the saddle position to suit.

Q-Pro Carbon Team

RIDING STYLE . Racer

FRAMESET

MAIN TUBES ZR9000

STAYS .... Carbon fiber composite/ ZR9000
2.6 lb. (1.20 kg.) — Frame weight (estimated)

FORK .... Klein Aeros carbon composite 110GSM
377 — Axle-crown length, mm

HEADSET .... Klein Airheadset lower/ Cane Creek integrated upper
25.4/34.0-1.75"/33.4 — Size
6.5 — Stack height, mm

CONTROLS

HANDLEBAR ..... Bontrager Race Lite
31.75 — Clamp diameter, mm

STEM .... Bontrager Race Lite
39.5 — Steerer clamp height, mm

SHIFT LEVERS ... Shimano Dura-Ace STI, Flite Deck compatible

BRAKE LEVERS .. Integrated brake/shift

GRIPS .... Powercork

DRIVETRAIN

FT DERAILLEUR .. Shimano Dura-Ace
Down pull — Cable routing
Braze-on type w/34.9mm clamp — Attachment

RR DERAILLEUR . Shimano Dura-Ace

CRANKSET ...... Shimano Dura-Ace 53/39
Bolt hole circle, mm

BB .... Shimano Ultegra
68 x 109.5, Splined, Shimano — Shell x axle, mm

CHAIN .... Shimano Dura-Ace
9 speed — Chain type
108 — Chain length (links)

CASSETTE .... Shimano Dura-Ace 12-23, 9spd

WHEELSET

FRONT WHEEL ... Bontrager Race X Lite, 20°
592 — E.R.D., mm
Velox 16mm — Rim strip

FRONT TIRE ..... Bontrager Race X Lite, folding
700 x 23c — Tire size

REAR WHEEL .... Bontrager Race X Lite, 24°
595 — E.R.D., mm
Velox 16mm — Rim strip

REAR TIRE ...... Bontrager Race X Lite, folding
700 x 23c — Tire size

SPOKES .... DT Revolution Aero 14/17G (New Aero drive side rear), ProLock alloy nipples
279, Radialx — Front, mm
291/291, 2x — Rear, mm

INNER TUBES .... Presta valve, 48mm stem

OTHER

SEATPOST .... Bontrager Race Lite
31.6 — Outer diameter, mm

SADDLE .... SSM Era, Ti/leather

BRAKES .... Shimano Dura-Ace

PEDALS .... -not supplied-
9/16" — Axle diameter

SEAT BINDER .... Alloy w/integral bolt
36.4 — Inner diameter, mm

ADDITIONALS .... 2 water bottle mounts

COLORS

Burning Poinsettia Red • Red/Silver decals

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Carbon composite stays- smooths the road buzz
The fork has OCLV 110 blades and crown which are extremely light, yet incredibly strong. Straight blades make for lightest structure possible. Carbon lay-up is tuned for super ride.

COMPONENTS HIGHLIGHTS

Shimano Dura-Ace- Professional level equipment
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Paired spokes for high strength, low drag
DT Revolution Aero spokes, alloy nipples, and folding-bead tires- low weight
Tires have silica-based tread compound for low rolling resistance and extra wet traction. Ultra-round profile for smooth cornering. 4-layer casing for puncture resistance. High thread count for low weight, high strength. Top German quality tire.

FIT

Frame	Size	49	52	54	56	58	61
Rider height	Inches	64	66	69	71	74	76
	Cm	164	168	176	181	187	193
Handlebar	Width,mm	400	400	420	420	440	460
Stem	Length,mm	70	70	90	100	110	110
	Angle	7	7	7	7	7	7
Crank	Length,mm	170	170	172.5	172.5	175	175
Seatpost	Length,mm	250	250	250	250	250	250
Steerer	Length,mm	173.5	190.5	209.5	226.0	249.5	281.0

GEARING

	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

BIKE WEIGHT (est.)

16.2 lb.
7.35 kg.

Q-Pro Carbon

RIDING STYLE . Racer

FRAMESET

MAIN TUBES ZR9000
STAYS . . . . Carbon fiber composite/ ZR9000
2.6 lb. (1.20 kg.) — *Frame weight (estimated)*
FORK . . . . Klein Aeros carbon composite 110GSM
377 — *Axle-crown length, mm*
HEADSET . . . . Klein Airheadset lower/ Cane Creek integrated upper
25.4/34.0-1.75"/33.4 — *Size*
6.5 — *Stack height, mm*

CONTROLS

HANDLEBAR . . . . . Bontrager Race Lite
31.75 — *Clamp diameter, mm*
STEM . . . . Bontrager Race Lite
39.5 — *Steerer clamp height, mm*
SHIFT LEVERS . . . Shimano Ultegra STI, Flite Deck compatible
BRAKE LEVERS . . Integrated brake/shift
GRIPS . . . . Powercork

DRIVETRAIN

FT DERAILLEUR . . Shimano Ultegra
Down pull — *Cable routing*
Braze-on type w/34.9mm clamp — *Attachment*
RR DERAILLEUR . Shimano Ultegra
CRANKSET . . . . . . Shimano Ultegra 53/39
130 — *Bolt hole circle, mm*
BB . . . . Shimano 105
68 x 109.5, Splined, Shimano — *Shell x axle, mm*
CHAIN . . . . Shimano HG-92
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE . . . . Shimano Ultegra 12-25, 9spd

WHEELSET

FRONT WHEEL . . . Bontrager Race Lite Road, 20°
592 — *E.R.D., mm*
Velox 16mm — *Rim strip*
FRONT TIRE . . . . . Bontrager Race X Lite, folding
700 x 23c — *Tire size*
REAR WHEEL . . . . Bontrager Race Lite Road, 24°
595 — *E.R.D., mm*
Velox 16mm — *Rim strip*
REAR TIRE . . . . . . Bontrager Race X Lite, folding
700 x 23c — *Tire size*
SPOKES . . . . DT New Aero, ProLock alloy nipples
279, Radialx — *Front, mm*
291/291, 2x — *Rear, mm*
INNER TUBES . . . . Presta valve, 48mm stem

OTHER

SEATPOST . . . . Bontrager Race Lite
31.6 — *Outer diameter, mm*
SADDLE . . . . SSM Era Luxe, CrMo/leather
BRAKES . . . . Shimano Ultegra
PEDALS . . . . -not supplied-
9/16" — *Axle diameter*
SEAT BINDER . . . . Alloy w/integral bolt
36.4 — *Inner diameter, mm*
ADDITIONALS . . . . 2 water bottle mounts

COLORS

Tahoe Frost Silver • White decals

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Carbon composite stays- smooths the road buzz
The fork has OCLV 110 blades and crown which are extremely light, yet incredibly strong. Straight blades make for lightest structure possible. Carbon lay-up is tuned for super ride.

COMPONENTS HIGHLIGHTS

Ultegra- Race-worthy Shimano package
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Paired spokes for high strength, low drag
DT New Aero spokes, alloy nipples, and folding-bead tires- low weight
Tires have silica-based tread compound for low rolling resistance and extra wet traction. Ultra-round profile for smooth cornering. 4-layer casing for puncture resistance. High thread count for low weight, high strength. Top German quality tire.

FIT

Frame	Size	49	52	54	56	58	61
Rider height	Inches	64	66	69	71	74	76
	Cm	164	168	176	181	187	193
Handlebar	Width,mm	400	400	420	420	440	460
Stem	Length,mm	70	70	90	100	110	110
	Angle	7	7	7	7	7	7
Crank	Length,mm	170	170	172.5	172.5	175	175
Seatpost	Length,mm	250	250	250	250	250	250
Steerer	Length,mm	173.5	190.5	209.5	226.0	249.5	281.0

GEARING

	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

BIKE WEIGHT (est.)

16.4 lb.
7.45 kg.

Q-Carbon Frame Specs

Frame sizes	49	52	55	58	61
Head angle	72.0	72.5	73.0	73.5	73.5
Seat angle	73.5	73.5	73.0	73.0	72.5
Standover	718	726	742	760	786
Seat tube	481	485	493	510	537
Head tube	97	118	146	173	204
Eff top tube	530	545	565	585	605
Chainstays	414	414	414	414	414
BB height	260	260	263	263	265
Offset	47	47	47	43	43
Trail	61	58	55	56	56
Wheelbase	976	987	999	1010	1025
Standover	28.3	28.6	29.2	29.9	31.0
Seat tube	18.9	19.1	19.4	20.1	21.1
Head tube	3.8	4.6	5.7	6.8	8.0
Eff top tube	20.9	21.5	22.2	23.0	23.8
Chainstays	16.3	16.3	16.3	16.3	16.3
BB height	10.2	10.2	10.4	10.4	10.4
Offset	1.9	1.9	1.9	1.7	1.7
Trail	2.4	2.3	2.1	2.2	2.2
Wheelbase	38.4	38.9	39.3	39.8	40.4

Rider Profile

The Q-Carbon shares most of the frame features of the Q-Pro Carbon, except the Aeros fork and Airheadset™. As such, it offers an incredible level of performance. Many ultra-light bikes lack frame rigidity and can be whippy. The Q-Carbon, 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 Q-Carbon uncomfortable? Klein has worked for years to milk the highest level of performance from aluminum frames. Part of the Klein 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 Klein engineered comfort into such a high performance machine, the Q-Carbon also works for the recreational go-fast rider or club century rider looking for a PR (Personal Record).

New for 2003:

Entirely new frame and fork

New 'Compact' geometry

ZR9000 frame material

New carbon fork

Mechanic's Specs and Notes

Seatpost diameter	31.6 mm
Seatclamp diameter	36.4mm
Headset size	25.4/34.0/30.0
Fork length	371mm
Front derailleur	Braze-on type w/ 34.9 mm clamp Down pull
Bottom bracket	68mm
Rear hub OLD	130mm
Cable stops	Internal cables
Bottle mounts	2 frame
Rack mounts	No

Seatposts

Q-Carbon frames 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.

Fitting the Q-Carbon

To best fit the Q-Carbon bikes, start with our recommendations for overall body height, titled "Rider height". This can be found in the Fit section at the bottom of each model spec page.

"Rider height" is our calculation of the height of rider, on average, who fits this bike with the stock stem and handlebars in their highest position.

If you are not average, these calculations may not apply directly to you. In particular, fitness, flexibility, and body mass distribution will effect the calculations.

Changing to a longer stem makes the bike fit a taller person. Lowering the stem, or changing to a shorter stem, makes the bike fit a shorter person.

If you are in-between sizes, we point out that with a larger frame it is easy to move the stem down (making the bike fit smaller), and we have provided lots of spacers to allow this adjustment. However, if the handlebars are too low, it can be difficult to raise them.

Once you've found the bike size which most closely gives the desired fit, check that the standover is at least one inch. Then adjust the saddle position to suit.

Q-Carbon Team

RIDING STYLE . Racer

FRAMESET

MAIN TUBES	ZR9000	
STAYS	Carbon fiber composite/ ZR9000	
	2.7 lb. (1.24 kg.)	*Frame weight (estimated)*
FORK	Bontrager Race Lite	
	370.0	*Axle-crown length, mm*
HEADSET	Cane Creek Internal	
	25.4/34.0/30.0	*Size*
	8.0	*Stack height, mm*

CONTROLS

HANDLEBAR	Bontrager Race	
	26.0	*Clamp diameter, mm*
STEM	Bontrager Race	
	40.0	*Steerer clamp height, mm*
SHIFT LEVERS	Shimano Ultegra STI, Flite Deck compatible	
BRAKE LEVERS	Integrated brake/shift	
GRIPS	Powercork	

DRIVETRAIN

FT DERAILLEUR	Shimano Ultegra	
	Down pull	*Cable routing*
	Braze-on type w/34.9mm clamp	*Attachment*
RR DERAILLEUR	Shimano Ultegra	
CRANKSET	Shimano Ultegra 53/39	
	130	*Bolt hole circle, mm*
BB	Shimano 105	
	68 x 109.5, Splined, Shimano	*Shell x axle, mm*
CHAIN	Shimano HG-72	
	9 speed	*Chain type*
	108	*Chain length (links)*
CASSETTE	Shimano HG70 12-25, 9spd	

WHEELSET

FRONT WHEEL	Bontrager Race Lite Road, 20°	
	592	*E.R.D., mm*
	Velox 16mm	*Rim strip*
FRONT TIRE	Bontrager Race Lite	
	700 x 23c	*Tire size*
REAR WHEEL	Bontrager Race Lite Road, 24°	
	595	*E.R.D., mm*
	Velox 16mm	*Rim strip*
REAR TIRE	Bontrager Race Lite	
	700 x 23c	*Tire size*
SPOKES	DT New Aero, ProLock alloy nipples	
	279, Radialx	*Front, mm*
	291/291, 2x	*Rear, mm*
INNER TUBES	Presta valve, 48mm stem	

OTHER

SEATPOST	Bontrager Race	
	31.6	*Outer diameter, mm*
SADDLE	SSM Era Luxe, CrMo/leather	
BRAKES	Shimano Ultegra	
PEDALS	-not supplied-	
	9/16"	*Axle diameter*
SEAT BINDER	Alloy w/integral bolt	
	36.4	*Inner diameter, mm*
ADDITIONALS	2 water bottle mounts	

COLORS

Kalahari Blood Red • Tone on Tone Red deboss

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength

Fork has OCLV 110 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Ultegra- Race-worthy Shimano package

Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance

Paired spokes for high strength, low drag

DT New Aero spokes, alloy nipples, and folding-bead tires- low weight

Tires have natural carbon rubber tread for long tread life. Ultra-round profile for smooth cornering. 3-layer casing for puncture resistance. Folding bead reduces weight.

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	65	67	71	73	75
	Cm	166	170	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	80	80	100	110	110
	Angle	7	7	7	7	7
Crank	Length,mm	170	170	172.5	172.5	175
Seatpost	Length,mm	250	250	330	330	330
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

GEARING

	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

BIKE WEIGHT (est.)

17.8 lb.
8.08 kg.

Q-Carbon Team T

RIDING STYLE . Racer

FRAMESET

MAIN TUBES ZR9000
STAYS .... Carbon fiber composite/ ZR9000
2.7 lb. (1.24 kg.) — Frame weight (estimated)
FORK .... Bontrager Race Lite
370.0 — Axle-crown length, mm
HEADSET .... Cane Creek Internal
25.4/34.0/30.0 — Size
8.0 — Stack height, mm

CONTROLS

HANDLEBAR ..... Bontrager Race
26.0 — Clamp diameter, mm
STEM .... Bontrager Race
40.0 — Steerer clamp height, mm
SHIFT LEVERS ... Shimano Ultegra STI, Flite Deck compatible
BRAKE LEVERS .. Integrated brake/shift
GRIPS .... Powercork

DRIVETRAIN

FT DERAILLEUR .. Shimano Ultegra T
Down pull — Cable routing
Braze-on type w/34.9mm clamp — Attachment
RR DERAILLEUR . Shimano Ultegra
CRANKSET ...... Shimano Ultegra 52/42/30
74/130 — Bolt hole circle, mm
BB .... Shimano 105
68 x 118, Splined, Shimano — Shell x axle, mm
CHAIN .... Shimano HG-72
9 speed — Chain type
108 — Chain length (links)
CASSETTE .... Shimano HG70 12-25, 9spd

WHEELSET

FRONT WHEEL ... Bontrager Race Lite Road, 20°
592 — E.R.D., mm
Velox 16mm — Rim strip
FRONT TIRE ..... Bontrager Race Lite
700 x 23c — Tire size
REAR WHEEL .... Bontrager Race Lite Road, 24°
595 — E.R.D., mm
Velox 16mm — Rim strip
REAR TIRE ...... Bontrager Race Lite
700 x 23c — Tire size
SPOKES .... DT New Aero, ProLock alloy nipples
279, Radialx — Front, mm
291/291, 2x — Rear, mm
INNER TUBES .... Presta valve, 48mm stem

OTHER

SEATPOST .... Bontrager Race
31.6 — Outer diameter, mm
SADDLE .... SSM Era Luxe, CrMo/leather
BRAKES .... Shimano Ultegra
PEDALS .... -not supplied-
9/16" — Axle diameter
SEAT BINDER .... Alloy w/integral bolt
36.4 — Inner diameter, mm
ADDITIONALS .... 2 water bottle mounts

COLORS

Kalahari Blood Red • Tone on Tone Red deboss

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Fork has OCLV 110 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Ultegra- Race-worthy Shimano package with triple chainrings to make hillclimbing easier
Bontrager bars, stem, and seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Paired spokes for high strength, low drag
DT New Aero spokes, alloy nipples, and folding-bead tires- low weight
Tires have natural carbon rubber tread for long tread life. Ultra-round profile for smooth cornering. 3-layer casing for puncture resistance. Folding bead reduces weight.

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	65	67	71	73	75
	Cm	166	170	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	80	80	100	110	110
	Angle	7	7	7	7	7
Crank	Length,mm	170	170	172.5	172.5	175
Seatpost	Length,mm	250	250	330	330	330
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

GEARING

	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	66
23	35	48	60
25	32	44	55

BIKE WEIGHT (est.)

18.0 lb.
8.17 kg.

Q-Carbon Race

RIDING STYLE . Racer or fast Century rider

FRAMESET

MAIN TUBES ZR9000
STAYS .... Carbon fiber composite/ ZR9000
2.7 lb. (1.24 kg.) — *Frame weight (estimated)*
FORK .... Bontrager Race
370.0 — *Axle-crown length, mm*
HEADSET .... Cane Creek Internal
25.4/34.0/30.0 — *Size*
8.0 — *Stack height, mm*

CONTROLS

HANDLEBAR ..... Bontrager Select
26.0 — *Clamp diameter, mm*
STEM .... Alloy quick change, direct connect
40.0 — *Steerer clamp height, mm*
SHIFT LEVERS ... Shimano 105 STI, Flite Deck compatible
BRAKE LEVERS .. Integrated brake/shift
GRIPS .... Powercork

DRIVETRAIN

FT DERAILLEUR .. Shimano Ultegra
Down pull — *Cable routing*
Braze-on type w/34.9mm clamp — *Attachment*
RR DERAILLEUR . Shimano Ultegra
CRANKSET ...... Shimano 105 53/39
130 — *Bolt hole circle, mm*
BB .... Shimano 105
68 x 109.5, Splined, Shimano — *Shell x axle, mm*
CHAIN .... Shimano HG-72
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE .... Shimano HG70 12-25, 9spd

WHEELSET

FRONT WHEEL ... Bontrager Select Road, 20°
592 — *E.R.D., mm*
Velox 16mm — *Rim strip*
FRONT TIRE ..... Bontrager Race Lite
700 x 25c — *Tire size*
REAR WHEEL .... Bontrager Select Road, 24°
603 — *E.R.D., mm*
Velox 16mm — *Rim strip*
REAR TIRE ...... Bontrager Race Lite
700 x 25c — *Tire size*
SPOKES .... DT 14/15G butted stainless
278, Radialx — *Front, mm*
293/294, 2x — *Rear, mm*
INNER TUBES .... Presta valve, 48mm stem

OTHER

SEATPOST .... Bontrager Sport
31.6 — *Outer diameter, mm*
SADDLE .... CRZ+ Road, Cro-Moly rails
BRAKES .... Shimano 105
PEDALS .... Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER .... Alloy w/integral bolt
36.4 — *Inner diameter, mm*
ADDITIONALS .... 2 water bottle mounts

COLORS

Higher Cloud Silver • Tone on Tone Silver deboss

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Fork has OCLV 150 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Thrifty Ultegra and 105- Upgraded derailleurs and full featured 9 speed performance
Bontrager bars, stem- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Paired spokes for high strength, low drag
DT New Aero spokes, alloy nipples, and folding-bead tires- low weight
Tires have natural carbon rubber tread for long tread life. Ultra-round profile for smooth cornering. 3-layer casing for puncture resistance. Folding bead reduces weight.

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	66	67	71	73	75
	Cm	167	171	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	85	85	100	110	110
	Angle	17	17	17	17	17
Crank	Length,mm	170	170	172.5	172.5	175
Seatpost	Length,mm	300	300	350	350	350
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

GEARING

	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

BIKE WEIGHT (est.)

19.6 lb.
8.90 kg.

Q-Carbon Race T

RIDING STYLE . Racer or fast Century rider

FRAMESET

MAIN TUBES	ZR9000	
STAYS	Carbon fiber composite/ ZR9000	
	2.7 lb. (1.24 kg.)	*Frame weight (estimated)*
FORK	Bontrager Race	
	370.0	*Axle-crown length, mm*
HEADSET	Cane Creek Internal	
	25.4/34.0/30.0	*Size*
	8.0	*Stack height, mm*

CONTROLS

HANDLEBAR	Bontrager Select	
	26.0	*Clamp diameter, mm*
STEM	Alloy quick change, direct connect	
	40.0	*Steerer clamp height, mm*
SHIFT LEVERS	Shimano 105 STI, Flite Deck compatible	
BRAKE LEVERS	Integrated brake/shift	
GRIPS	Powercork	

DRIVETRAIN

FT DERAILLEUR	Shimano Ultegra T	
	Down pull	*Cable routing*
	Braze-on type w/34.9mm clamp	*Attachment*
RR DERAILLEUR	Shimano Ultegra GS	
CRANKSET	Shimano 105 52/42/30	
	74/130	*Bolt hole circle, mm*
BB	Shimano 105	
	68 x 118, Splined, Shimano	*Shell x axle, mm*
CHAIN	Shimano HG-72	
	9 speed	*Chain type*
	108	*Chain length (links)*
CASSETTE	Shimano HG70 12-25, 9spd	

WHEELSET

FRONT WHEEL	Bontrager Select Road, 20°	
	592	*E.R.D., mm*
	Velox 16mm	*Rim strip*
FRONT TIRE	Bontrager Race Lite	
	700 x 25c	*Tire size*
REAR WHEEL	Bontrager Select Road, 24°	
	603	*E.R.D., mm*
	Velox 16mm	*Rim strip*
REAR TIRE	Bontrager Race Lite	
	700 x 25c	*Tire size*
SPOKES	DT 14/15G butted stainless	
	278, Radialx	*Front, mm*
	293/294, 2x	*Rear, mm*
INNER TUBES	Presta valve, 48mm stem	

OTHER

SEATPOST	Bontrager Sport	
	31.6	*Outer diameter, mm*
SADDLE	CRZ+ Road, Cro-Moly rails	
BRAKES	Shimano 105	
PEDALS	Shimano SPD M515, clipless	
	9/16"	*Axle diameter*
SEAT BINDER	Alloy w/integral bolt	
	36.4	*Inner diameter, mm*
ADDITIONALS	2 water bottle mounts	

COLORS

Higher Cloud Silver • Tone on Tone Silver deboss

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength

Fork has OCLV 150 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Thrifty Ultegra and 105- Upgraded derailleurs and full featured 9 speed performance, in triple chainrings to make the hills easier

Bontrager bars, stem- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance

Paired spokes for high strength, low drag

DT New Aero spokes, alloy nipples, and folding-bead tires- low weight

Tires have natural carbon rubber tread for long tread life. Ultra-round profile for smooth cornering, 3-layer casing for puncture resistance. Folding bead reduces weight.

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	66	67	71	73	75
	Cm	167	171	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	85	85	100	110	110
	Angle	17	17	17	17	17
Crank	Length,mm	170	170	175	175	175
Seatpost	Length,mm	300	300	350	350	350
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

GEARING

	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	66
23	35	48	60
25	32	44	55

BIKE WEIGHT (est.)

19.8 lb.

8.99 kg.

Q-Carbon

RIDING STYLE . Racer or fast Century rider

FRAMESET

MAIN TUBES ZR9000
STAYS . . . . Carbon fiber composite/ ZR9000
2.7 lb. (1.24 kg.) — Frame weight (estimated)
FORK . . . . Bontrager Race
370.0 — Axle-crown length, mm
HEADSET . . . . Cane Creek Internal
25.4/34.0/30.0 — Size
8.0 — Stack height, mm

CONTROLS

HANDLEBAR . . . . . Bontrager Select
26.0 — Clamp diameter, mm
STEM . . . . Alloy quick change, direct connect
40.0 — Steerer clamp height, mm
SHIFT LEVERS . . . Shimano Tiagra STI Dual Control
BRAKE LEVERS . . Integrated brake/shift
GRIPS . . . . Powercork

DRIVETRAIN

FT DERAILLEUR . . Shimano 105
Down pull — Cable routing
Braze-on type w/34.9mm clamp — Attachment
RR DERAILLEUR . Shimano 105
CRANKSET . . . . . . Shimano 105 53/39
130 — Bolt hole circle, mm
BB . . . . Shimano 105
68 x 109.5, Splined, Shimano — Shell x axle, mm
CHAIN . . . . Shimano HG72
9 speed — Chain type
108 — Chain length (links)
CASSETTE . . . . Shimano HG70 12-25, 9spd

WHEELSET

FRONT WHEEL . . . Shimano Tiagra hub, 32°, Matrix Aurora rim
610 — E.R.D., mm
Velox 16mm — Rim strip
FRONT TIRE . . . . . Bontrager Select
700 x 25c — Tire size
REAR WHEEL . . . . Shimano Tiagra hub, 32°, Matrix Aurora RDR rim
603 — E.R.D., mm
Velox 16mm — Rim strip
REAR TIRE . . . . . . Bontrager Select
700 x 25c — Tire size
SPOKES . . . . DT 14G stainless
299, 3x — Front, mm
293/294, 3x — Rear, mm
INNER TUBES . . . . Presta valve

OTHER

SEATPOST . . . . Bontrager Sport
31.6 — Outer diameter, mm
SADDLE . . . . CRZ+ Road, Cro-Moly rails
BRAKES . . . . Shimano Tiagra
PEDALS . . . . Shimano SPD M515, clipless
9/16" — Axle diameter
SEAT BINDER . . . . Alloy w/integral bolt
36.4 — Inner diameter, mm
ADDITIONALS . . . . 2 water bottle mounts

COLORS

Reef-to-Sky Blue • Tone on Tone Blue deboss

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	66	67	71	73	75
	Cm	167	171	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	85	85	100	110	110
	Angle	17	17	17	17	17
Crank	Length,mm	170	170	172.5	172.5	175
Seatpost	Length,mm	300	300	350	350	350
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Fork has OCLV 150 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Shimano105 and Tiagra- 105 cranks and derailleurs for durability, Tiagra for full featured 9 speed performance Bontrager bars, stem, seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Butted spokes- stronger wheels and low weight Tires have slick tread for minimum rolling resistance. 60 tpi (Threads per Inch) casing for durability.

GEARING

	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

BIKE WEIGHT (est.)

20.3 lb.
9.22 kg.

Q-Carbon T

RIDING STYLE . Racer or fast Century rider

FRAMESET

MAIN TUBES ZR9000
STAYS .... Carbon fiber composite/ ZR9000
2.7 lb. (1.24 kg.) — *Frame weight (estimated)*
FORK .... Bontrager Race
370.0 — *Axle-crown length, mm*
HEADSET .... Cane Creek Internal
25.4/34.0/30.0 — *Size*
8.0 — *Stack height, mm*

CONTROLS

HANDLEBAR ..... Bontrager Select
26.0 — *Clamp diameter, mm*
STEM .... Alloy quick change, direct connect
40.0 — *Steerer clamp height, mm*
SHIFT LEVERS ... Shimano Tiagra STI Dual Control
BRAKE LEVERS .. Integrated brake/shift
GRIPS .... Powercork

DRIVETRAIN

FT DERAILLEUR .. Shimano 105 T
Down pull — *Cable routing*
Braze-on type w/34.9mm clamp — *Attachment*
RR DERAILLEUR . Shimano 105 GS
CRANKSET ...... Shimano 105 52/42/30
74/130 — *Bolt hole circle, mm*
BB .... Shimano 105
68 x 118, Splined, Shimano — *Shell x axle, mm*
CHAIN .... Shimano HG72
9 speed — *Chain type*
108 — *Chain length (links)*
CASSETTE .... Shimano HG70 12-25, 9spd

WHEELSET

FRONT WHEEL ... Shimano Tiagra hub, 32°, Matrix Aurora rim
610 — *E.R.D., mm*
Velox 16mm — *Rim strip*
FRONT TIRE ..... Bontrager Select
700 x 25c — *Tire size*
REAR WHEEL .... Shimano Tiagra hub, 32°, Matrix Aurora RDR rim
603 — *E.R.D., mm*
Velox 16mm — *Rim strip*
REAR TIRE ...... Bontrager Select
700 x 25c — *Tire size*
SPOKES .... DT 14G stainless
299, 3x — *Front, mm*
293/294, 3x — *Rear, mm*
INNER TUBES .... Presta valve

OTHER

SEATPOST .... Bontrager Sport
31.6 — *Outer diameter, mm*
SADDLE .... CRZ+ Road, Cro-Moly rails
BRAKES .... Shimano Tiagra
PEDALS .... Shimano SPD M515, clipless
9/16" — *Axle diameter*
SEAT BINDER .... Alloy w/integral bolt
36.4 — *Inner diameter, mm*
ADDITIONALS .... 2 water bottle mounts

COLORS

Reef-to-Sky Blue

FRAME AND FORK HIGHLIGHTS

ZR9000 Gradient aluminum- custom tubing shaped for a tuned ride, variable wall thickness for low weight and high strength
Fork has OCLV 150 blades for low weight, high strength. Alloy crown and steerer for stiffness, resistance to clamping forces. Straight legs are lightest possible design. Custom design for precise steering and comfort.

COMPONENTS HIGHLIGHTS

Shimano105 and Tiagra- 105 cranks and derailleurs for durability, Tiagra for full featured 9 speed performance
Triple chainring 105 cranks make hillclimbing easier
Bontrager bars, stem, seatpost- designed for durability, light enough to race

WHEELSET HIGHLIGHTS

Bontrager Wheelworks- engineered for low maintenance, high performance
Paired spokes for high strength, low drag
DT New Aero spokes, alloy nipples, and folding-bead tires- low weight
Tires have slick tread for minimum rolling resistance. 60 tpi (Threads per Inch) casing for durability.

FIT

Frame	Size	49	52	55	58	61
Rider height	Inches	66	67	71	73	75
	Cm	167	171	179	186	191
Handlebar	Width,mm	400	420	420	440	460
Stem	Length,mm	85	85	100	110	110
	Angle	17	17	17	17	17
Crank	Length,mm	170	170	175	175	175
Seatpost	Length,mm	300	300	350	350	350
Steerer	Length,mm	180.5	202.0	230.0	257.0	287.5

GEARING

	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	66
23	35	48	60
25	32	44	55

BIKE WEIGHT (est.)

20.5 lb.
9.31 kg.

Attitude Cable Routing

Install the top tube cable stops

1. With a hammer, lightly tap a punch, broad blade screwdriver, or similar tool (Fig. 10) against the cable housing stop (Fig. 9) until it sits flush with the frame dimple.

   Do not over-drive the cable housing stop or it may crush in the frame.

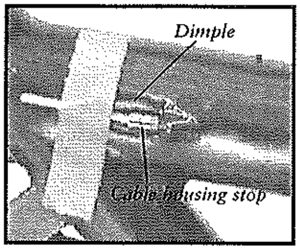

Fig. 9

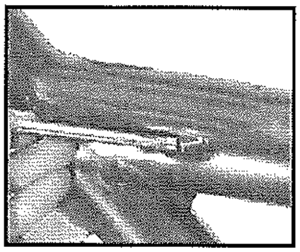

Fig. 10

Install the front cable housings

1. Thread the shift cables through the front housings.
2. Thread the cables into the front of the top tube liners (Fig. 11).
3. The cables go around the head tube; the left shift cable enters the front of the top tube on the right side. The right shift cable enters the top tube on the left side (Fig. 12). This routing results in low cable friction and prevents the housing from rubbing on the paint of the head tube.

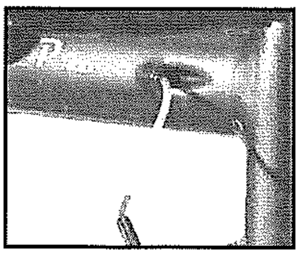

Fig. 11

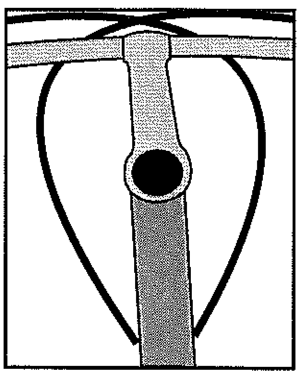

Fig. 12

Install the rear housings

1. With the cable extending out the rear of the frame, slide the liner out of the top tube, and off the cable.

The liner is really just an installation guide. Save the liners for future cable installations.

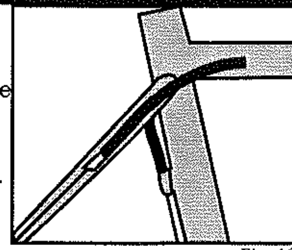

Fig. 13

2. Slide the housing onto the cables. The longest rear housing, for the rear derailleur, exits the top tube on the right side. Thread it from the right side of the bike to reach the cable stop on the seatstay (Fig. 13).
3. The front derailleur housing exits the rear of the top tube on the left side. Thread it to its cable stop on the seat tube (Fig. 13).

Wheel Installation with MicroDrops

Introduction

Some Klein road bicycles use a Klein exclusive dropout design called MicroDrops. This design provides a stiff, strong junction of the seat stays and chain stays. Micro Dropouts create an abbreviated connection from the stays to the rear derailleur hanger, making the hanger both stiffer and stronger. With MicroDrops the chainstays can be shorter without creating interference when installing a wheel. And if that's not enough, MicroDrops reduce the frame weight.

MicroDrops require a slightly different method for wheel installation and removal than the old traditional design.

Rear wheel removal

1. Shift onto the smallest rear cog (Fig. 14).
2. Open the rear brake quick release. Open the rear wheel quick release as normal.

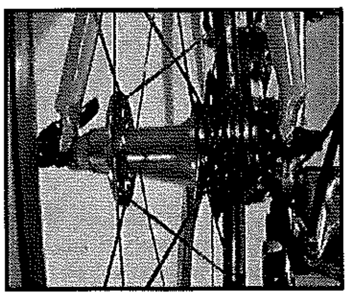

Fig. 14

3. Pull the wheel straight back (Fig. 15) until it is disengaged from the Micro Dropouts.

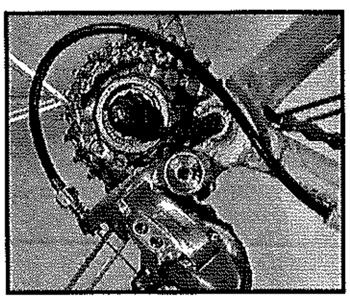

Fig. 15

4. Move the rear wheel to the left side (Fig. 16). At the same time, push the derailleur in toward the bike's centerline to keep the derailleur pulleys in line with the smallest rear cog (the one the chain is resting on).

Fig. 16

5. Place your thumb on the rear derailleur cage (Fig. 17) and rotate the cage to move the upper derailleur pulley to a lower position.

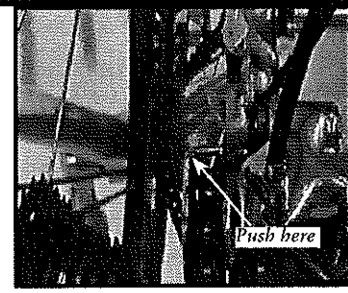

Fig. 17

6. Rotate the derailleur body back (Fig. 18) to increase the space between the derailleur and the dropout.

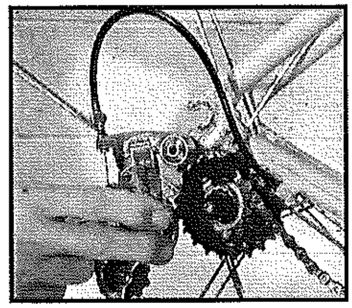

Fig. 18

7. When the right-side end of the quick release has cleared the inside of the right dropout, rotate the derailleur back. Push the wheel forward and down to disengage the chain (Fig. 19).

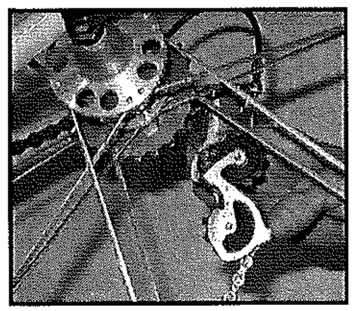

Fig. 19

Rear wheel installation

To install the wheel, reverse the removal procedure. As you prepare to engage the chain onto the smallest cog, focus on the installation points; rotate the derailleur cage with your thumb while pivoting the derailleur back on its mounting bolt.

Remember to keep the derailleur cage in line with the smallest cog as you move the wheel past, and behind, the dropout.

When the wheel is in position, release the derailleur and simply slide the rear wheel into the MicroDrops. The Re-Entry Ramps™ of the MicroDrops will guide the wheel in smoothly, and the chain tension will hold the wheel snugly in the dropouts while you close the wheel quick release. While you are closing the wheel quick release, don't forget to also close the brake quick release, and safety check both systems.

Introduction

Some Klein bicycles have internally routed cable systems. This system requires special assembly and cable replacement techniques. Here we describe those techniques.

Cable routing- road bikes

Identify the correct cable route for the cable you would like to install. On a Klein road bike the front shift cable originates on the left side of the bike, enters the front of the down tube on the left side, and exits the lower end of the down tube on the left side.

Similarly, the rear shift cable originates on the right side of the bike, enters the front of the down tube on the right side, and exits the lower end of the down tube on the right side.

The rear brake cable originates on the right side of the bike, enters the front of the top tube on the right side, then exits the rear of the top tube on the left side. In some areas, the left brake lever is used to actuate the rear brake, such that the cable would cross over in front of the head tube and then follow "normal" routing.

Cable routing- mountain bikes

Identify the correct cable route for the cable you would like to install. On a Klein mountain bike the front shift cable crosses from the left side of the bike, ahead of the head tube, to enter the front of the top tube on the right side, and exits the rear end of the tube on the left side.

Similarly, the rear shift cable originates on the right side of the bike, crosses ahead of the head tube to enter the front of the top tube on the left side. It exits the rear of the tube on the right side.

The rear brake cable is covered by a continuous housing, held in the cable guides with wire ties. This system allows the alternate use of full hydraulic brake hose as needed.

Cable installation- new bikes

Klein bikes using internal cable routing are packaged with cable liners (Fig. 20) in place. The liners are installed at the factory. Follow these instructions to install the cables.

Before installation, identify the correct cable routing for the cable you are installing (see the previous section if you are unsure).

1. Attach the cables to the levers as normal.
2. Size the first piece of housing. This piece goes from the lever to the entry ferrule at the front of the top or down tube. Follow standard procedures to cut, square, and lubricate the housing. Attach the correct housing end cap. Run the cable through the first piece of its housing.
3. Insert the cable into the cable liner (Fig. 20).
4. As the cable exits the cable liner at the back of the tube, pull the liner out of the frame (Fig. 21). The liner just barely fits through the ferrules, so it may require you to apply some rotation or wiggling to pass it though a ferrule.

   Do not throw the cable liner away; it makes a useful tool when replacing internally routed cables (for more information, see Cable Replacement).
5. Slide the ferrule up the cable (Fig. 22) and center it in the frame hole.
6. Use a light steel hammer, and a round punch with a flat end, to lightly tap the ferrule into place (Fig. 23). Ensure that the ferrule follows a straight path into the hole, tapping around the edges as needed.
7. Slide the housing into place (Fig. 24), and complete the assembly as normal.

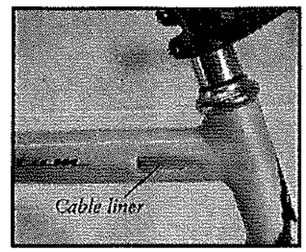

Fig. 20

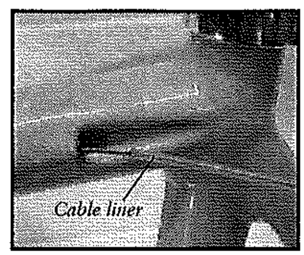

Fig. 21

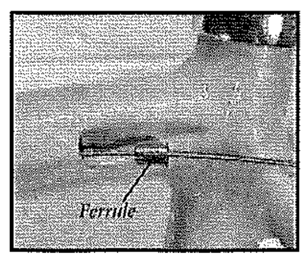

Fig. 22

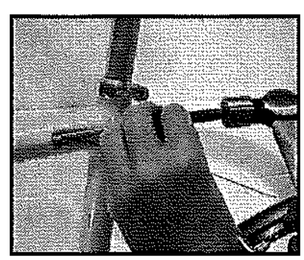

Fig. 23

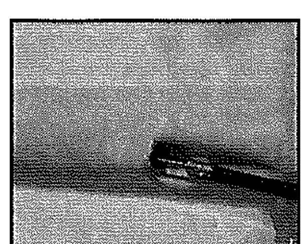

Fig. 24

Cable replacement

Replacing internally routed cables on Klein bikes is fairly easy, assuming the cable is still in place. If that is the case, follow these instructions to replace the cable. If the cable is not in place, see the next section "Cable replacement- after cable removal".

1. Loosen the cable clamp bolt for the cable you are replacing.
2. Cut the end of the cable so that is has a clean, square, and round end. If the cable has been flattened, frayed, or misshapen, cut off that portion of the cable.
3. Remove any housing that is behind the internal portion of the cable.
4. Find a piece of cable liner long enough to go completely through the tube. It must be long enough to simultaneously protrude an inch or so from both ends of the section of tube which holds the internal cable.
5. Slide the selected cable liner up the cable (Fig. 25).
6. Slide the cable liner all the way through the tube until it exits the other end.

   The liner just barely fits through the ferrules, so it may require you to apply some rotation or wiggling to pass it through each ferrule. To get the liner through the front ferrule, it may help to pull the cable from the front while grasping the cable with pliers, behind the liner (Fig. 26)

7. Once the liner has exited the front of the tube and protrudes slightly from both ends of the tube, the cable can be removed.

   DO NOT remove the liner.

8. Install a new cable in the lever. Install the front housing.
9. Slide the cable through the cable liner.
10. Remove the cable liner from the back of the tube (Fig. 27). Again, it may take some coaxing to get the liner to slide through the ferrules.
11. Run the cable through the bottom bracket cable guide, or install the rear housing (Fig. 28), and connect the cable as normal.

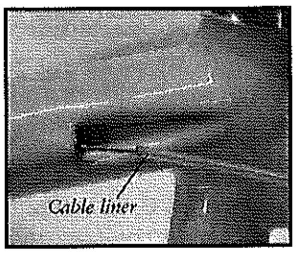

Fig. 25

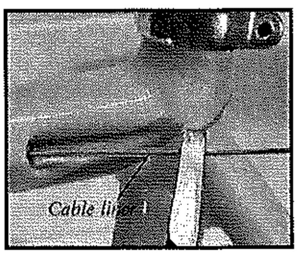

Fig. 26

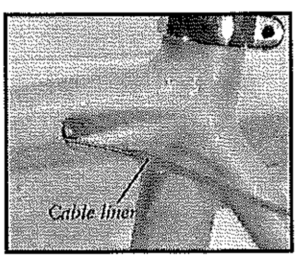

Fig. 27

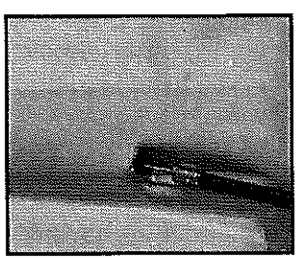

Fig. 28

Cable replacement- after cable removal

There are a variety of reasons someone might remove the cable from a bike. It makes your job harder, but it's not impossible. Follow these instructions to install a cable liner "from scratch".

1. Find a piece of cable liner long enough to go completely through the tube. It must be long enough to protrude an inch or so from both ends of the section of tube which holds the internal cable.
2. If the cable routing includes one, remove the rear ferrule. To do this, your need a screw and a pair of pliers.

   With newer bikes the inside, small diameter hole of the ferrule is threaded. Select a 4x0.6mm screw that is at least 1" (25mm) long. Insert the screw several turns. Grasp the head of the screw with a pair of pliers and pull straight out, being careful not to scratch the paint.

   On older models, the ferrule is not threaded. Find a small-diameter drywall screw at least 1" (25mm) long. Gently insert the screw until finger tight. Grasp the head of the screw with a pair of pliers and pull straight out, being careful not to scratch the paint.

   Note: Do not attempt to remove ferrules that have been painted in; the paint may tear back onto the tube and look ugly.

3. Insert a new cable from the front of the bike and continue pushing the cable straight in until the cable is near the rear exit hole.

Do not rotate the cable, as it's possible to wind it around another cable. If this happens you will get dual actuation as tension is applied to either cable.

4. If the cable exit hole is ferrule-sized, it's fairly easy to get the cable to exit. Simply push the cable out the exit hole, slide a cable liner up the cable, and follow the instructions in "Cable installation- new bikes".

   In the case of down-routed cables with a small exit hole near the bottom bracket, several additional techniques may be useful or necessary.

5. If you are having trouble getting the cable to exit the tube, try this first; Put a slight crimp in the cable about 1/2" (12mm) from the end. This will allow the cable to better follow the tube wall.

   If you are still having trouble getting the cable to exit, try using a large magnet to guide the cable. Since the cable is ferrous and the frame tubing is not, the magnet can be used to pull the cable to the exit hole. Since the magnet isn't selective about which part of the cable it guides, you can then push the cable while still guiding it with the magnet.

   Once the cable exits the frame hole, slide a cable liner up the cable, and follow the instructions in "Cable installation- new bikes".

Palomino Rear Suspension Service

Prepare the bike

1. Clamp the frame in a workstand upright by its seatpost.
2. Remove the rear wheel and right crankarm.

Usually you will need to remove the chain, and disconnect the cables to the rear brake and both derailleurs.

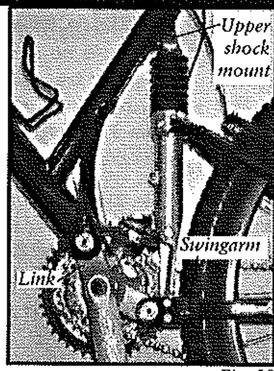

Fig. 29

Remove the pivot axles

1. Insert a 5mm allen wrench into the flat end of the pivot axle in the upper main pivot (Fig. 30). On the other end of the pivot axle, loosen the domed cap screw several turns.
2. Tap the domed cap screw lightly to loosen the pivot axle. Remove the cap screw and washer.
3. Remove the pivot axle. If necessary, use an 8mm socket as a drift (Fig. 31) to finish driving the axle out of the frame.
4. Repeat steps 1-3 for the lower main pivot to remove the link from the swingarm.

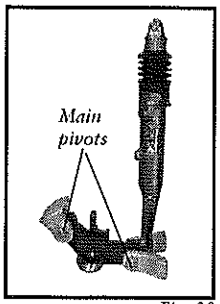

Fig. 30

Remove the shock mount

1. Support the swingarm and remove the bolt at the upper shock mount (Fig. 29).

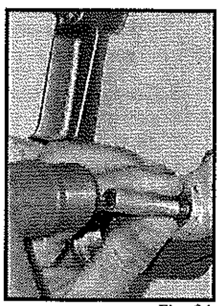
Fig. 31

Remove the bearings

1. Use an 11mm deep socket as a drift to drive the cylindrical bearings from the link. These parts are held in place with Loktite; you may need to tap the drift lightly with a steel hammer.

   The socket must contact the metal portion of the bearing, barely fitting inside the link. Do not use heat to loosen the Loktite. Heat may damage the frame or paint.

2. Remove the "top hat" bearings (Fig. 32) from the main frame and swingarm. These are also installed with Loktite, so again tap them out with a hammer and an 11mm socket. Avoid damage to the frame or swingarm by properly supporting and padding each as you drive out the bearings.
3. Inspect the Igus bearings from the shock mount (Fig. 33). If they are in good shape, you can leave them. If not, remove them.

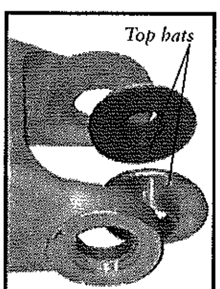

Fig. 32

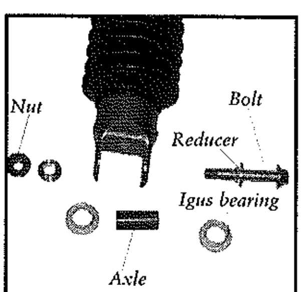

Fig. 33

The Igus bearings are installed dry, so simply push them out. Do not use a screwdriver or other sharp tool which may cut or gouge the bearing surface. If needed, try something blunt like an allen wrench.

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 axles are discoloration or a high degree of polish.

Some dark deposits may be left as the bearings and axle 'seat in' to each other. When this happens, some of the bearing material is plated onto the axle. It's normal, and actually makes the pivot run smoother.

The bearings are harder to inspect; some discoloration is normal as the bearings and axle 'seat in' to each other. If wear looks uneven or non-concentric, replace the parts.

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

1. Clean the bonding surfaces of the bearings and frame. These surfaces include the outside of the cylindrical main pivot bearings, the seating surfaces of the main pivot 'top hat' bearings that go into the main frame and swingarm, and the parts of the frame, link, and swingarm that the bonding surfaces of the bearings contact. These surfaces should be cleaned with Loktite Kleen 'n Prime.

   Do not allow Kleen 'n Prime to get on the paint or bearing material. It will remove paint and the lubrication in the bearings.

2. With the shock mount bearings, simply wipe them clean of dust or other debris.
3. Do not lubricate any bearings.
4. Clean the pivot and link bolts with Kleen n Prime.

Parts list

Domed cap screw	(2) 232201
Washer	(2) 211439
Pivot axle	(2) 231602
Cylindrical bearing	(2) 231606
Top hat bearing (metal backed)	(4) 231666
Link	(1) 232109
Shock mount bolt w/nut	(1) 231667
Upper shock mount axle	(1) 231605
Igus bearings (yellow)	(2) 231692
Reducers	(2) 232226
2003 Fox shock	(1) 230166
Fox damper cartridge	(1) 84266
Damping adjustment knob	(1) 84829
Damper set screws	(2) 84830

Install the main pivot bearings.

1. Check the fit of the bearings in the frame and swingarm by dry-assembling them (practice installation, but without Loktite). Normally the bearings are a light press fit, meaning they are snug but easily go into place with hand pressure. If the parts fit correctly, use Loktite 290. If they seem very loose, use Loktite RC680.

   Loktite 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.

2. Apply Loktite to all contact surfaces between the bearings and the frame or swingarm, and install the bearings. The "top hats" are installed into the frame and swingarm from the middle towards the outside, with the large, flat surface facing inside (Fig. 28).
3. After installing the bearings, wipe off any excess Loktite, particularly removing any Loktite that contacts the bearing surfaces.

Install the upper shock mount bolt.

1. Install the upper shock bolt through the reducers, axle, and Igus bearings (Fig. 29). The shock mount bolt uses Spiralkut threads, so does not require Loktite. Tighten the bolt to 61-75 lb•in (6.9-8.5Nm).

Install the main pivot axles.

1. Carefully align the link with the main frame. The fit may be tight. Avoid contact between the bearings and any residual Loktite.
2. Install a pivot axle from the right side of the bike. Slide it all the way through the frame and link.
3. Apply Loktite 290 to the threads of the domed cap screw. Install the screw, with its washer, into the pivot axle from the left side of the bike. Tighten to 61-75 lb•in (6.9-8.5Nm).
4. Attach the swingarm to the link following steps 1-3 of this section.

Allow to Dry

Loktite normally requires 24 hours to fully 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.

Removing the damper

This procedure can be done as part of a pivot service, or as a stand-alone operation. Here we give the steps for doing it stand-alone.

1. Prepare the bike. Clamp the frame in a workstand upright by its seatpost.
2. Remove the rear wheel.
3. Support the swingarm so that it can not drop or pivot down. One method is to tie a rope around the swingarm and attach the other end to the saddle rails.
4. Release all air pressure from within the shock by depressing the schraeder valve (Fig. 34).

   Warning: The shock, when preloaded, is under high pressure. Failure to release this pressure before performing these procedures will cause a sudden, possibly explosive, release of pressure with potentially harmful results.

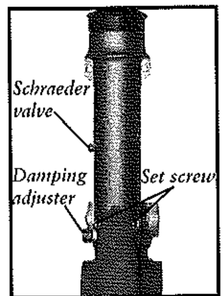

Fig. 34

5. Remove the upper shock mount bolt and associated hardware.
6. With a 5mm allen wrench, remove the two damper set screws at the rear of the shock body (Fig. 34).
7. Grasp the upper shock mount and pull the damper from the shock body (Fig. 35).

   Be careful not to lose the damping adjuster knob, which will tend to fall out as the damper is removed.

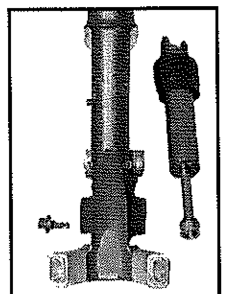
Fig. 35

Installing the damper

Make sure the damper and the interior of the shock body are clean prior to installation. Also inspect the O-rings on the damping adjuster and set screws to make sure they are clean and without cuts or abrasions.

1. Gently slide the damper into the shock body, making sure to maintain alignment.
2. With the damper fully inserted, insert the two damper set screws. Tighten to 20-30 lb•in (2.2-3.9Nm).
3. Attach the upper shock mount hardware (Fig. 29) and tighten the shock mount bolt to 61-75 lb•in (6.9-8.5Nm).
4. Set the preload of the shock.

Introduction

For the 2002 model year introduced a new Q-Pro Carbon road frameset, with a new Aeros fork using OCLV 110 carbon fiber composite.

The Q-Pro Carbon frame and Aeros fork use a proprietary system. At this time, only the supplied parts are compatible with this system. No other frame, fork, or lower headset system can be substituted for parts in this system as supplied. The upper bearing uses a standard 1 1/8" Aheadset system (Fig. 32), from which many substitutions are available as aftermarket parts.

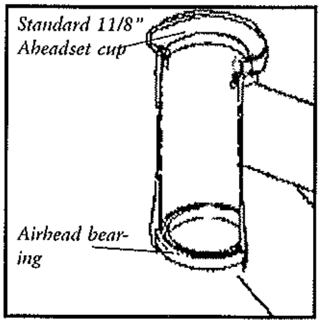

Fig. 36

Tools and equipment required

Headset cup removal tool

Headset press

Klein AirHeadset™ tool kit

Star-fangled nut tool

Metal-faced hammer

Loktite RC680

Loktite Kleen 'n Prime

Fork removal

Remove the fork from the frame

1. Place bike upright in a workstand, clamped by the seatpost.
2. Remove the Aheadset top cap.
3. Remove stem and spacers from the steerer tube.
4. Remove compression washer, cone, and bearings from upper Aheadset leaving only the upper bearing cup in the upper head tube.
5. Thread the star-fangled nut insertion tool into the star-fangled nut already installed in the fork steerer tube (Fig. 37).

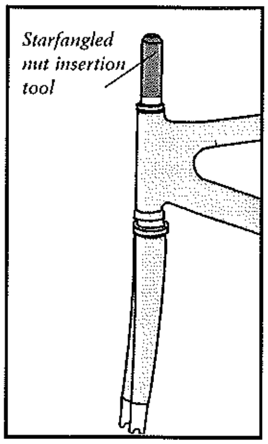

Fig. 37

We recommend the next step be done by two people. The first person must support the fork so that it does not fall. The other person should firmly support the frame near the head tube with one hand.

6. Hammer straight down on the star-fangled nut insertion tool. The fork is bonded in with Loktite, so it may take repeated blows to break loose the fork and bearing.
7. After the fork loosens, remove the star-fangled nut insertion tool, and slide the fork from the frame.

Remove the fork bearing

1. Clamp the steel channel in a vise allowing enough room for the fork to be inserted from either direction.
2. Thread the star-fangled nut insertion tool into the star fangled nut already in the fork.
3. Carefully position the steerer in the steel channel so that the steerer rests on the channel with the bearing on the side nearest the star-fangled tool (Fig. 38). Hold the fork so it cannot fall.
4. Strike the star-fangled nut insertion tool with a hammer until the bottom bearing slides off the steerer.
5. Remove the fork from the steel channel.

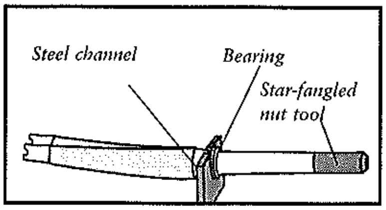

Fig. 38

Removing upper headset cup

1. With the fork removed from the head tube, the top Aheadset cup should be the only thing left in the head tube.
2. Use a headset cup removal tool to tap the top Aheadset cup out of the upper bonded insert.

Fork installation

Top Aheadset cup installation

1. Using a standard headset press install the top bearing into the frame. Make sure the press engages the lower bonded insert such that no damage or deformation occurs to the bonded insert.

Fork bearing installation- Cleaning the parts

1. To properly install the bottom bearing on the steerer and into the frame, all surfaces must be clean of dirt, oil, grease, or other residue. The best cleaning agent is Loktite Kleen 'n Prime, which not only cleans the surfaces but will speed the curing of the bonding agent. As an alternative you can also use acetone, trichloroethylene, or similar compounds. Do not use paint thinner, gasoline, or similar compounds which will leave an oily film and prevent bonding of the Loktite.
2. Clean the contact bearing areas of the steerer, the lower bearing cup, and both the inside and outside surfaces of the lower bearing. Once the surfaces are clean, avoid any contact with your hands, since they have oil on them.

   IMPORTANT- be very careful to avoid any contact of the cleaning agent with the painted finish of the frame. These cleaning agents remove paint. Also avoid getting cleaning agents on the bearing seals, which may destroy the bearing grease.

Fork bearing installation

1. Place the steel channel in a vise. Place the Fork dropout rod in the fork dropouts (Fig. 39) and snug up the attachment bolts.

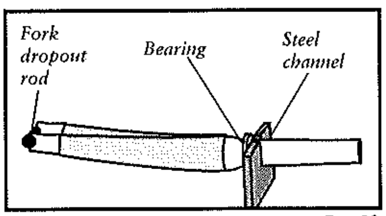

Fig. 39

2. Apply a thin layer of Loktite RC680 on both the steerer and inside surface of the bearing.
3. Slide the bearing on the steerer.
4. Slide the bearing and steerer, with bearing above the channel, into the slot of the steel channel which best fits the steerer.
5. Place the fork dropout rod in the fork dropouts and secure it by tightening down the hex head bolts and washers located on both ends of the rod.
6. With the hammer, tap the fork dropout rod until the bottom bearing is pressed into place, flush against the shoulder of the steerer.

Fork (with bearing) installation into frame

1. If needed, install the upper Aheadset cup as in "Top Aheadset Cup Installation" (see above).
2. With the frame upside down (the bottom bracket upward), secure the frame in a workstand by the seatpost.
3. Place the fork dropout rod into the fork dropouts and snug up the attachment bolts.
4. Apply a thin layer of Loktite RC680 to the inside of the lower bearing cup and outside of the headset bearing.
5. Slide the fork into the head tube.
6. We recommend this step be done with two people. One person supports the frame near the head tube. The other person, while centering the steerer in the upper Aheadset cup , lightly taps the fork dropout rod with a hammer to drive the bearing into the lower cup. While keeping the fork centered and aligned in the frame, carefully drive the bearing fully into the bearing cup in head tube.
7. Install the upper Aheadset parts; bearings, cone and compression wedge, spacers, stem, and top cap.
8. The frame may be moved, but should not be ridden yet. Allow 24 hours for the Loktite to fully cure before riding.

A Word about Torque Specifications

Torque is a measurement of the tightness of a threaded fastener such as a screw or bolt, determined by using a torque wrench. The torque specifications in this manual are listed to help you determine the correct tightness of parts and their threaded fasteners. More than anything, these should be used to make sure you do not over tighten the fasteners. Applying more than recommended torque to a fastener does not provide extra holding power and may actually lead to damage or failure of a part. For example, over tightening bar ends can crush a handlebar. Once a part is tight enough to stay tight and be safe, it rarely does any good to tighten the part any further.

We offer a range of torque specifications. Similar parts in different bikes may require different torques due to slight differences.

There are simple function tests you should perform to make sure a part is properly tightened. They should be performed whether a torque wrench was used or not and will suffice as a test for proper tightness if you do not have a torque wrench. As an example after assembling a bike you should determine if a stem is properly tightened to the fork. Place the front wheel between your knees and try to rotate the stem by twisting the handlebars from side to side. If the stem does not twist, it is properly tightened. While this test is somewhat subjective, it places a much greater force on the system than is required of the stem clamping force in normal riding.

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
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
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	95-150	10.7-17
Double seat attaching w/4mm allen	35-55	4-6.2
Seat post binder bolt	50-180	17-20.3
Cranks		
Crank arm bolt, Shimano	310-380	35-43
Chainring bolt	50-70	5.7-7.9
Pedal attachment	350-380	40.2-42.9
Shimano cartridge fixed cup	350-608	40-70
Wheels		
Shimano cassette lock ring	261-434	30-50
Derailleurs/Shifters		
Front derailleur clamp bolt, clamp	20	2.3
Front derailleur clamp bolt, braze-on	44-60	4.9-6.8
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	44-60	5-6.8
Integrated shift/brake lever attach bolt	53-69	6-8
Brake caliper attaching bolt	69-87	8-10
Cantilever/direct pull brake attach bolt	44-60	4.9-6.8
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
Int'national disc brake adapter, outer bolt	95-115	10.7-13
Int'national disc brake adapter, inner bolt	50-75	5.7-8.5
Rotor attachment bolt	40-60	4.5-6.8
Hayes caliper attachment bolt	60	6.8
Hayes lever clamp bolt	15-25	1.7-2.8
Frame Attachments		
Water bottle attaching bolt	20-25	2.3-2.8
Derailleur hanger attachment bolt	50-70	5.7-7.9
Palomino		
Shock mount bolts	61-75	6.9-8.5
Pivot bolts	100-110	11.3-12.4
Damper set screws	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:

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 (OCLV Superlight)	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 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.
- Splined bottom bracket axle (only) interface with crank arm - Grease the splines before installing the crankarm.

Places to Avoid Grease

- Bottom bracket axle/crank arm interface with square/tapered axle- Avoid greasing the square 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.