



STAGE



Mucchi



Engineered like no other frame in the world.

A great deal of research and development was invested before the Klein frame went into production. Over a span of nearly five years, a team of engineers at the Massachusetts Institute of Technology conducted extensive research into the mechanics of bicycle frame design. A grant from the M.I.T. Innovation Center plus additional technical assistance from leading aerospace firms also contributed to the development of the Klein frame.

The important criteria for cycling are:

- Power efficiency
- Minimum weight
- Handling and ride
- Durability
- Functional detail

Attention to these factors coupled with innovative design has resulted in the best bicycle frame ever made. Nothing else even comes close. The Klein is the frame of the future – for the rider who wants it *now*.



Patents Pending

POWER TUBING™ : High strength aluminum/magnesium alloy tubes in large diameters are used.

POWER EFFICIENCY: The Klein has the most deflection-resistant power train made. This minimizes the energy lost to frame deflection. While the increased efficiency occurs under all riding conditions, it is particularly evident under the high stress of a steep climb or a hard sprint, as it rigorously resists lateral (bottom bracket) deflection and transmits more of the rider's energy into forward motion. You can easily feel this performance advantage. Laboratory tests performed at M.I.T. show the Klein to be over 60% more rigid than the best steel frames.

RIDE COMFORT: The frame has a significant effect on ride comfort. In order to achieve a smooth ride, it is desirable for the frame to absorb road shock in a vertical suspension fashion. The Klein construction does this better than any other frame. The lightweight Power Tubing™ has more overall suspension ability than super light gauge steel tubing. This results in the incredibly smooth ride.

WEIGHT: Bare weight of a 57cm Team Super frame is 3.28lbs. This is more than one full pound lighter than the best steel frames. The frame with fork, Super Record headset, sealed bearing bottom bracket, shift levers, seat clamp bolt, and all frame fitted equipment weighs 5.8lbs. (less with optional titanium bottom bracket spindle).

CONSTRUCTION: Tubing is precisely mitered in special milling fixtures, and placed in an elaborate precision jig that rigidly and accurately aligns every tube. Frames are tungsten/inert gas welded and fully heat treated. The heat treating process causes the grain structure of the alloy to flow into a uniform unbroken pattern throughout the entire frame. This completely relieves welding stresses, creates the highest possible temper

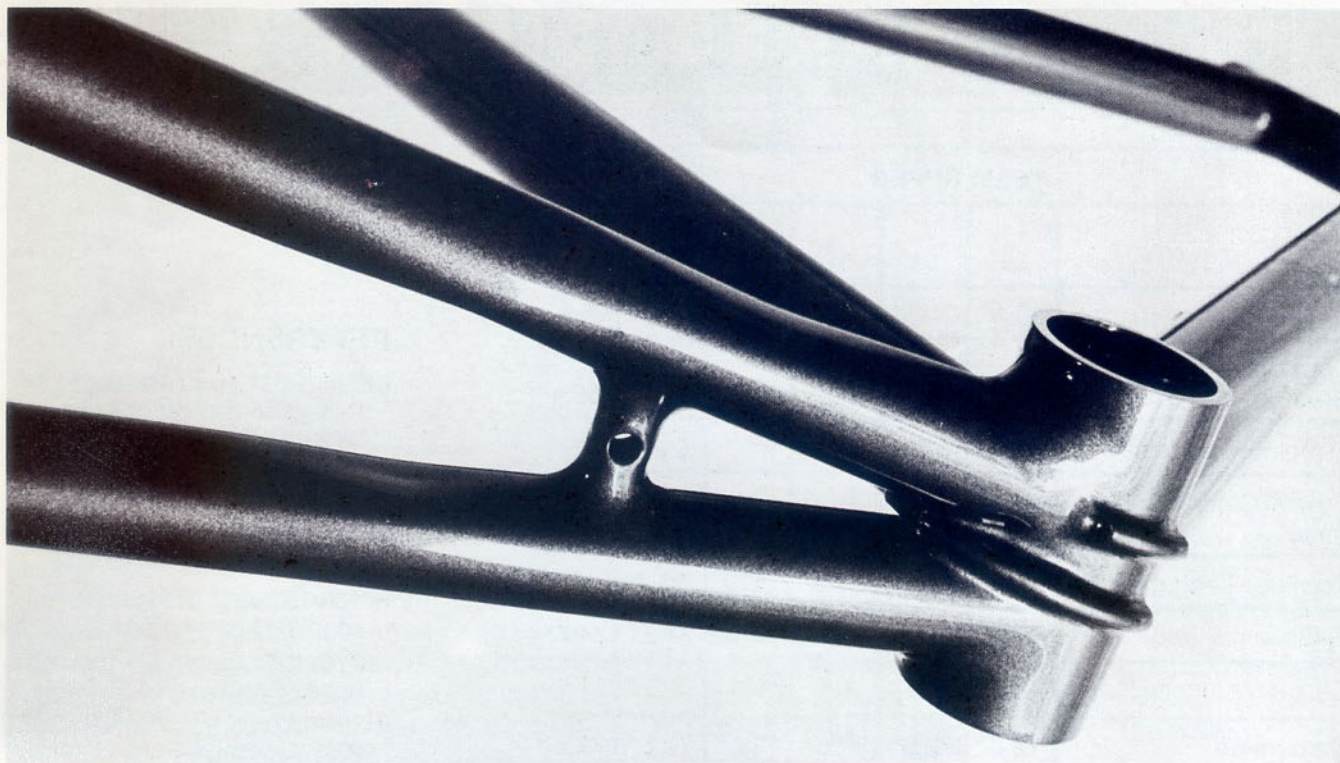
condition of the alloy, and increases its hardness, fatigue resistance and yield strength.

BORON: On a per weight basis, NASA publications indicate boron is the strongest and stiffest structural material in the world. More than 90% of all boron production goes into aerospace and advanced aircraft applications. Both use predominantly aluminum main structures with boron reinforcements in high stress and stiffness critical areas. Consider that these aircraft must meet extreme standards of lightness, strength, stiffness and endurance, and that they are among the most highly engineered advanced mechanical structures made.

In the Klein, boron fiber reinforcements are used on chainstays, seatstays, and fork blades. They serve two important functions. First, the fiber pattern is oriented to stiffen these tubes against lateral deflection. This is most beneficial on the stays and fork blades where lateral stiffness is critical (typically weak points in overall frame side to side stiffness). The second advantage is that boron composites absorb high frequency shock many times better than conventional structural materials. Consequently, it effectively helps the forks and stays dampen road shock for an exceptionally smooth ride.

We believe the boron reinforced aluminum bicycle frame will remain the ultimate in performance for a long time to come.

FINISH: The method of construction creates a frameset with clean lines and a natural aesthetic appeal. The finish is a multi-step process including sandblasting, anodizing and undercoating with an epoxy base, culminating in a beautiful final coat of durable Imron, in your choice of color. The fact that hours of painstaking hand labor go into each frame is evidenced by the smooth surface and depth of finish on the final product. A Klein frame was recently selected for display in an art museum.



TECHNICAL DATA: The sealed bottom bracket unit uses high quality precision bearings with a much greater load capacity and life than conventional bottom brackets. The axle has a standard taper that will accommodate Campagnolo and Campagnolo equivalent double chainring cranks. An optional titanium spindle and steel spindles to fit singles, triples and other brands of cranks are also available. Forks are made with Chrome-Molybdenum steel tubing and T.I./Haden investment cast Europa crowns. They are fully jig built. Fork blades are boron reinforced. Fork crown race is lathe cut for precision headset alignment. Klein vertical dropouts are designed for positive wheel retention and quick wheel change. Hanger threading is standard 10 by 1mm. Frames will accept up to 700 x 28c tires on the Team Super and 700 x 32c tires and fenders on the Stage. Optional 27.4mm seat posts are available to fit the frames.

TEAM SUPER: Designed for general purpose road racing and light touring. This has the high bottom bracket and fast handling characteristics desirable for criterium use. It has excellent high speed handling. It climbs and sprints like nothing else. Comfort is extremely good for a racing geometry machine.

STAGE: Designed for longer road races and all types of touring. This is the most comfortable frame you can buy. It has excellent high speed handling and stability. It climbs and sprints as well as the Team Super. It handles touring gear without shimmy.

STANDARD EQUIPMENT: Campagnolo Super Record headset, boron reinforced Chrome Molybdenum steel fork, specially frame fitted color matched pump, Campagnolo frame mounted down tube shifters, precision sealed bottom bracket and axle assembly, water bottle mounts, derailleur cable guides and seat clamp bolt all come with the Klein frameset.

KLEIN WARRANTY: Klein Bicycle Corporation will replace or repair, at our option, any bicycle frame, fork or other bicycle component manufactured by Klein Bicycle Corporation that is defective in material or workmanship; this warranty is in effect for a period of five years from the date of purchase. Klein Bicycle Corporation is not responsible for consequential damages. This warranty is extended to the original owner only. Warranty services are f.o.b. factory.

FRAME SPECIFICATIONS

TEAM SUPER

Frame Size (cm)	51	54	57	59	61	64
(Inches)	20.1"	21.3"	22.4"	23.2"	24.0"	25.2"
Top Tube Height From Ground (Inches)	29.7	31.0	32.3	33.2	33.9	35.1
Typical Rider Height	5'4"	5'7"	5'10"	6'0"	6'2"	6'5"
Typical Crank Length (mm)	165	170	172.5	175	177.5	180
Top Tube Length (cm)	52.8	54.4	55.9	56.9	57.7	59.2
Head Angle	72.3°	73°	73.6°	74°	74.2°	74.4°
Fork Rake (Inches)	1.5	1.5	1.5	1.5	1.5	1.5
Seat Angle	72.5°	72.5°	72.5°	72.5°	72.5°	72.5°
Bottom Bracket Height (Inches)	10.6	10.7	10.9	11.0	11.0	11.1
Chainstay Length (Inches)	16.3	16.3	16.3	16.3	16.3	16.3
Wheel Base (Inches)	37.4	37.9	38.3	38.6	38.8	39.1

REFERENCES:

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- BICYCLING! July 1975, page 51
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- BICYCLING! August 1975, page 53
Exotic Bicycle Development.
- SCIENCE DIGEST August 1976,
page 49 - Engineering a Better Bike.
- BICYCLING! June 1978, page 60
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- INTERNATIONAL CYCLING GUIDE
1981, Aluminum Frames, Anyone?
- BICYCLING January 1981,
Road Test - Klein Stage Tour

STAGE

Frame Size (cm)	46	48	50	52	54	56	58	60	62	64	66	68	70
(Inches)	18.1"	18.9"	19.7"	20.5"	21.3"	22.1"	22.8"	23.6"	24.4"	25.2"	26.0"	26.8"	27.6"
Top Tube Height From Ground (Inches)	27.0	28.0	29.0	30.1	31.0	31.8	32.7	33.6	34.4	35.2	36.1	36.8	37.0
Typical Rider Height	4'11"	5'1"	5'3"	5'5"	5'7"	5'9"	5'11"	6'1"	6'3"	6'5"	6'7"	6'9"	6'11"
Typical Crank Length (mm)	150	155	160	165	167.5	170	172.5	175	177.5	180	180	180	180
Top Tube Length (cm)	51.2	52.2	53.2	54.2	55.2	56.2	57.2	58.2	59.2	60.2	61.2	62.2	63.2
Head Angle	72°	72°	72°	72°	72°	72.5°	72.5°	72.5°	72.5°	72.5°	72.5°	72.5°	72.5°
Fork Rake (Inches)	1.5	1.5	1.5	1.75	1.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Seat Angle	74°	74°	74°	74°	74°	74°	74°	74°	74°	74°	74.5°	74.5°	74.5°
Bottom Bracket Height (Inches)	9.6	9.8	10.0	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.8	10.8	10.8
Chainstay Length (Inches)	16.5	16.5	16.5	18	18	18	18	18	18	18	18	18	18
Wheel Base (Inches)	38.2	38.7	39.2	40.7	41.1	41.2	41.6	42.2	42.6	43.0	43.6	44.1	44.5

KLEIN Bicycles

These are rugged competition machines suitable for rigorous European style road racing with the hard climbs, sprints and rough roads that this type of racing entails. We keep up to date on technical advances and know from our own experience, as well as that of hundreds of other racers and people in the industry, which components are holding up and how well they function.

We have drawn from a large number of suppliers to combine what we consider are the best components the world offers. Each component meets the highest available standards of function, strength, stiffness, durability and lightness. Our selection works together in perfect unison and is particularly well matched to the riding characteristics of the frame.

TEAM SUPER™ LIGHT: Intended use: excellent for criteriums, general purpose road racing and light touring. This bicycle emphasizes lighter weight components. It is intended for light riders less than 125lbs. Average weight 17lbs.

TEAM SUPER™ HEAVY DUTY: Intended use: excellent for criteriums, general purpose road racing and light touring. This bicycle emphasizes extra strength and stiffness of components. It is intended for riders over 125 lbs. Average weight 18.5 lbs.

STAGE™: Intended use: general purpose road racing, time trialing and light to medium touring. Excellent for longer distances. Stable handling. Components and gearing are similar to the Team Super. Available in both Light and Heavy Duty models.

STAGE TOUR™: Intended use: general purpose touring. This bicycle incorporates the wide range gearing necessary for handling touring gear and mountains. Excellent for long distance riding. Stable handling. Optional frame mounted racks are available. The frame and racks are designed to eliminate shimmy found in touring machines.

MERRICKLEIN™: We enjoy these immensely. They are the product of many hours of hand work. The MerrickKlein purchaser is buying not a better bicycle than our other models, but a rare and beautiful machine.

Bicycles are shipped unassembled with all components in their original packing, except wheels, which are tensioned and trued by our professional wheel builder. Assembly requires familiarity with components and appropriate tools. When ordering, specify any optional equipment precisely. The frame is covered by the Klein Warranty. Components are covered by the warranties of the companies that manufacture them.

BICYCLE SPECIFICATIONS

COMPONENT	TEAM SUPER™ HEAVY DUTY	STAGE™ HEAVY DUTY
Bottom Bracket Spindle	Steel	Steel
Brakeset	Modolo Professional Silver	Modolo Professional Silver
Chain	Sedisport	Sedisport
Chainwheel Set	Campagnolo Super Record - 42 x 53	Campagnolo Super Record - 42 x 53
Deraillieur Shifters	Campagnolo Braze-on	Campagnolo Braze-on
Front Deraillieur	Campagnolo Record	Campagnolo Record
Rear Deraillieur	Huret Jubilee	Huret Jubilee - Long Cage
Freewheel	Cyclo Pans Compact six speed kit - 13-24 teeth Steel	Cyclo Pans Compact six speed kit - 13-30 teeth Steel
Handlebar	Cinelli	Cinelli
Handlebar Extension	Cinelli	Cinelli
Headset	Campagnolo Super Record	Campagnolo Super Record
Hubs	Sealed Bearing Hi-E Heavy Duty 36°	Sealed Bearing Hi-E Heavy Duty 36°
Pedals	Campagnolo Super Record	Campagnolo Super Record
Pump	Silca Impero Custom Frame fitted, painted same color as frame. Campagnolo light-weight head.	Silca Impero Custom Frame fitted, painted same color as frame. Campagnolo light-weight head.
Quick Releases	Pino Patent Titanium	Pino Patent Titanium
Rims	Fiamme Ergal	Fiamme Ergal
Saddle	Sella Italia Superleggero Ergal	Sella Italia Superleggero Ergal
Seat Post	Campagnolo Super Record	Campagnolo Super Record
Spokes	DT double butted stainless steel	DT double butted stainless steel
Tires	Clement Criterium Seta 250 gram	Clement Campionato del Mondo 290 gram
Toe Clips	Cinelli Alloy	Cinelli Alloy
Toe Straps	Binda Extra	Binda Extra
Water Bottle Cage	Blackburn Color Matched Water Bottle Cage	Blackburn Color Matched Water Bottle Cage

STAGE™ TOUR	TEAM SUPER™ LIGHT	STAGE™ LIGHT
Steel	Titanium	Titanium
Modelo Professional Silver	Galli Titanium 75 Silver	Galli Titanium 75 Silver
Sedisport	Sedisport	Sedisport
Campagnolo Super Record - 31 x 42 x 52	Campagnolo Super Record - 42 x 53	Campagnolo Super Record - 42 x 53
Campagnolo Braze-on	Campagnolo Braze-on	Campagnolo Braze-on
Campagnolo Record	Campagnolo Record	Campagnolo Record
Huret Jubilee Long Cage	Huret Jubilee	Huret Jubilee Long Cage
Cyclo Pans Compact six speed kit - 13-30-Steel	Cyclo Pans Compact six speed kit - 13-24-Aluminum	Cyclo Pans Compact six speed kit - 13-30-Aluminum
Cinelli	Cinelli	Cinelli
Cinelli	Cinelli	Cinelli
Campagnolo Super Record	Campagnolo Super Record	Campagnolo Super Record
Sealed Bearing Hi-E Heavy Duty 36°	Sealed Bearing Hi-E Heavy Duty 36°	Sealed Bearing Hi-E Heavy Duty 36°
Campagnolo Super Record	Campagnolo Super Record	Campagnolo Super Record
Silca Impero Custom Frame fitted, painted same color as frame. Campagnolo lightweight head.	Silca Impero Custom Frame fitted, painted same color as frame. Campagnolo lightweight head.	Silca Impero Custom Frame fitted, painted same color as frame. Campagnolo lightweight head.
Pino Patent Titanium	Pino Patent Titanium	Pino Patent Titanium
Fiamme Ergal	Super Champion Performance 265 gram.	Super Champion Performance 265 gram.
Sella Italia Superleggero Ergal	Sella Italia Superleggero Ergal	Sella Italia Superleggero Ergal
Campagnolo Super Record	Campagnolo Super Record	Campagnolo Super Record
DT double butted stainless steel	DT double butted stainless steel	DT double butted stainless steel
Clement Campionato del Mondo 290 gram	Clement Criterium Seta Extra 230 gram	Clement Criterium Seta Extra 230 gram
Cinelli Alloy	Cinelli Alloy	Cinelli Alloy
Binda Extra	Binda Extra	Binda Extra
Blackburn Color Matched Water Bottle Cage	Blackburn Color Matched Water Bottle Cage	Blackburn Color Matched Water Bottle Cage

OPTIONAL EQUIPMENT

(AVAILABLE ON SPECIAL ORDER)

BAR CONTROLS: Suntour or Campagnolo.

BOTTOM BRACKET SPINDLE: Titanium or steel bottom bracket spindles to fit a wide variety of cranksets. (Specify cranks.)

BRAKESETS: Campagnolo Super Record, Modolo Professional in silver, black, gold, red, blue and green or Galli 75 Titanium in silver or dark blue.

CABLE HOUSING: Plastic lined cable housing in addition to original, in black, white, red, yellow, blue, green or silver.

CHAIN: Shimano Dura Ace, Regina Oro, Record "S" or Titanium.

FRONT DERAILLEUR: Shimano Dura Ace.

REAR DERAILLEURS: Huret Jubilee, Jubilee long cage, Duopar, Campagnolo Super Record or Rally.

FREEWHEELS: Campagnolo Aluminum (six speed only), Zeus Aluminum, Suntour New Winner Ultra 6 or Regina Oro.

HUBS: Phil Wood.

RIMS: Fiamme Ergal 290 gram: Super Champion performance 265 gram or Prestige 355 gram heat-treated, Ambrosio Synthesis 290 gram or Crono 340 gram heat-treated, Rigida 1320 x 700c clinchers 450 gram. We recommend the heavier rims for heavier riders.

TIRES: Clement Criterium Seta Extra, Criterium Seta and Campionato Del Mondos, Continental 220 and 240 gram cotton, foldable high pressure clinchers with Imp'Air latex tubes. We recommend the Campionato Del Mondos or Clinchers for heavier riders or loads.

SEAT STAY CHAIN HANGER

EXTRA WATER BOTTLE MOUNTS

COLORS: Custom frame colors in metallics, solids and pearls.

RACKS: Front and rear racks for the Stage™ frame, rear only for the Team Super™.

SADDLES: Avocet or Sella Italia equivalent men's and women's racing and touring models, Unicanitor #4 and #65.



A COMPARISON OF FRAME

Mystery and aura surround bicycle frame-building materials. This is partly due to a lack of information available to the bicycling population and, perhaps more seriously, due to the promotional necessities of the tubing and frame-building companies. Advertising is usually designed to confuse by rhetoric. Words such as "Resilient", "Strong" and "Rigid" are used as an urge to passionate purchase rather than as clear, comparative fact. As an example, one recent advertisement shows an overly developed young male sweating and blowing in an attempt to stretch the, by implication, strongest fork blades made. In truth, any person of medium physique could bend those same blades all over creation without even oiling his muscles. The desire to sell, and the actualities of materials are two very different things!

The following discussion is an attempt to clarify some of the mystery and to give some perspective to the folklore of bicycling, and to explain in some detail why we are building an aluminum frame.

Materials have characteristics known as bulk properties which remain the same regardless of size or shape. The most important of these to framebuilders are stiffness, strength, and density. It is necessary to realize the following definitions before attempting to analyze frames.

Stiffness, also known as **Modulus of Elasticity**, is the amount of force that will deflect or stretch a one-inch cube of material a given distance. The material will return to its original position when the force is released. This is very different from strength.

Strength is the amount of force a one-inch cube will stand before it permanently deforms. At this point it will not return to its original shape when the load is released.

Density is the weight of the one-inch cube in each material.

The materials used in framebuilding all have measurable moduli, strengths, and densities; these measurements can be found in mechanical engineering texts.

Example: The Modulus of Elasticity of aluminum is about 10 million lbs. per square inch. This means that when we put one pound on a one-inch cube of aluminum, it is compressed one ten-millionth of an inch. If that doesn't sound like much movement, you're right. It's not. The next pound will compress it another ten-millionth of an inch. When we put 60,000 lbs. on our aluminum block, it smooshes. We have exceeded its yield strength. The block weighs .097 lbs. or about 1 1/2 oz.

In order to evaluate the feasibility of a material, we need to look at its properties in relation to each other. Typically, this relationship is expressed in ratio form. There are two ratios that interest us for application to the bicycle frame, namely the **Stiffness to Weight Ratio** and the **Strength to Weight Ratio**.

Stiffness/Weight Ratio

It is surprising to most cyclists that all steel alloys, from humble gas pipe to Reynolds 753, Champion, Columbus, Ishiwata, Reynolds 531, and Vitus have identical moduli and densities. Gas pipe and Reynolds 753, in equal quantity, weigh the same and are equivalently stiff! No sales hype in the world can change this fact. All things equal, a frame made of light gauge steel tubing will be less rigid than a frame made of heavier gauge steel tubing.

The following chart gives the modulus and density of various materials.

BUILDING MATERIALS...

Material	Modulus	Density
Steel Alloys	30,000,000 psi	.284 lbs./cubic inch
Aluminum Alloys	10,000,000 psi	.097 lbs./cubic inch
Titanium	15,000,000 psi	.162 lbs./cubic inch
Boron Fiber	60,000,000 psi	.089 lbs./cubic inch

The stiffness/weight ratio expresses the modulus in relation to the density, and allows us to compare the materials.

By dividing the moduli by the densities, we arrive at the following ratios:

Stiffness/Weight Properties

All Steel Alloys	105.6	
All Aluminum Alloys	103.1	
Titanium	92.6	651.7
Boron Fiber		

Steel, aluminum, and titanium have similar stiffness/weight ratios. Boron, a product of the space program, is out of this world. It looks six times better than the metals. However, as we will see, other aspects of the design will decrease the utility of boron and show aluminum to be a better frame building material than steel.

STRENGTH

As we have indicated, the stiffness properties of steel are all identical, but the strength properties run up and down the charts. While strength has little effect on the riding characteristics of your frame, it is important for maintaining structural integrity. Frames are highly stressed structures. They can fatigue from pedaling forces, road shock, and braking stresses. Thus the strength of the material is critical.

Some of the highest strength materials are not usable for frames because of brittleness, stress corrosion, or inability to take welding or brazing. Consequently the steel, aluminum, and titanium tubing used to build frames are not the strongest alloys available, but the most practicable. The following table gives an idea of the strength characteristics involved.

Name	Strength	Density
Reynolds 531	120,000 psi	.284 lbs./cubic inch
Reynolds 753	150,000 psi	.284 lbs./cubic inch
Klein Aluminum	50,000 psi	.097 lbs./cubic inch
Titanium	75,000 psi	.162 lbs./cubic inch
Boron	500,000 psi	.089 lbs./cubic inch

In order to compare the materials, we need to look at the strength/weight ratio for each. This ratio expresses the strength in relation to the weight of a given material

Strength/Weight Properties

Reynolds 531	42	
Reynolds 753	53	
Klein Aluminum	52	
Titanium	46	
Boron		562

Surprisingly, the steel, aluminum, and titanium used in bicycle tubing are very similar to each other. Steel retains roughly two thirds of its strength after brazing. In order to compensate for this, this wall thickness is increased or "butted" at the joints. The thicker material compensates for the loss of strength. Aluminum can be brought back to full strength after welding by heat treating. Pure titanium has a

small strength loss after welding, and can be used as is.

Why then, since steel, aluminum, and titanium are more or less equal to each other in both stiffness and strength on a per weight basis, have the exotics been so unsuccessful? These frames were enthusiastically promoted, used for a few seasons, and then discarded as being too whippy and/or fragile, a far cry from the advertised qualities! Is this the inevitable outcome of attempts to improve upon the steel frame, or is it the fault of the builder who, for either a lack of knowledge of materials and the stresses imposed upon them, or a desire to give his frame traditional styling and sales appeal, builds an insubstantial product? Time and again companies have attempted to build ultra lightweight bicycles, sacrificing necessary strength and/or rigidity. They apparently felt that light weight was an end in itself. To make matters worse, the builders of exotic frames tended to stay close to the traditional tubing sizes, perhaps not wanting the product to appear peculiar in the eye of the buyer, but in any case, taking no advantage of the low density materials used. Teledyne's Titan was constructed from tubing that was slightly larger than normal, but not enough larger to have a significant effect, and the tubing walls were very thin. The Exxon Graftek Corporation, in addition to using small sized tubing could not weld or braze the graphite fiber. The solution of gluing the graphite-wrapped aluminum into stainless steel lugs created a joint poor in both stiffness and strength. Failures resulted.

Fibers in general have not been well utilized as structural elements in bicycle design. The Klein uses boron fiber as a reinforcement against particular types of bending, not as a structural component. The boron is applied to the frame after welding and heat treating and thus does not create problems.

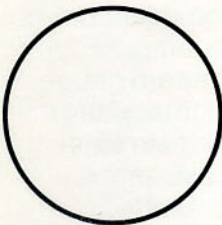
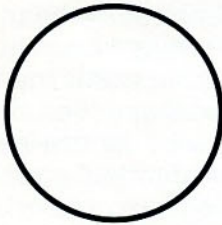
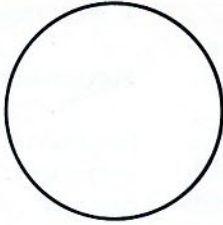
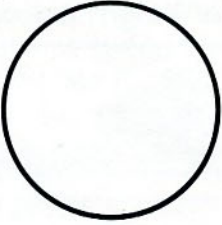
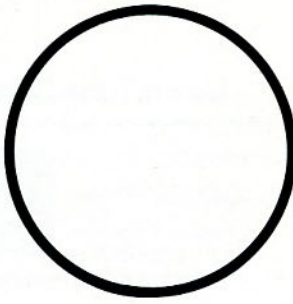
In steel, the only analagous "experimental" materials are the very light gauges; Reynolds 753 time trial gauge, Columbus KL, Ishiwata Alpha gauge and some other super lights. These tubes are billed as record attempt materials. Apparently, the tubing manufacturers think the loss in power efficiency is less important than the advantage of lighter weight. Although the strength of the 753 steel is way up, the stiffness of the 753 tube is down from standard gauge 531. And while the material strength is up, the lighter gauge tube is more highly stressed, flexes more and can break without warning. In pursuit of light weight, Reynolds created their own failure-prone machine, sharing with Teledyne's Titan the feel of a rubber band. The heavy gauge 753 is not bad, but then it is not as light, either.

Wall thickness
Diameter
Wall thickness/diameter ratio
Weight oz./inch
Weight average for tube ¹
Relative stiffness
Stiffness average for tube ²
Material strength 1,000 psi ³
Relative strength
Strength for entire tube ⁴

In any case, while the exotics are of high technology and many of the ideas are very good, they have to be labeled as flawed. The designs simply did not evolve to the point where the serious problems were worked out.

The key to the success of the Klein frame is the tubing size. A larger diameter tube is both stiffer and stronger in bending and torsion (twisting) than an equivalent weight, smaller diameter tube. Of course you can carry the larger diameter tube idea too far. If the wall gets too thin, the tube won't work right. It will crumple under light load, like a beer can. The engineer's rule of thumb is that the diameter should be no more than fifty times the wall thickness. As the diameter exceeds this, the tube becomes more and more prone to crippling failure. A beer can diameter is about two

DOWN TUBE COMPARISONS

Steel Chrome Molybdenum		Steel Chrome Vanadium		Aluminum Magnesium Silicon
Reynolds 531 Standard double butted		Reynolds 753 (Light Gauge) double butted		Klein 816 straight gauge
unbutted section	butted section	unbutted section	butted section	
				
.024"	.036"	.020"	.024"	.049"
1.125"	1.125"	1.125"	1.125"	1.500"
1:47	1:31	1:56	1:47	1:31
.377	.560	.315	.377	.347
	.447		.339	.347
88	128	74	88	137
	100		79	137
120	80	150	100	50
101	100	106*	84	149
	100		84	149

- 1 Averages are based on Reynolds double butted tube configuration of an 11" unbutted section, 3" butted sections on each end of the tube and two 2" taper regions.
 - 2 The stiffness of a butted tube is calculated in the following manner. Add the deflections of each section of the tube to obtain the total deflection (for a unit load) and take the reciprocal (inverse) to obtain total stiffness. Stiffness is load required per deflection.
 - 3 Butted sections are about $\frac{2}{3}$ the original material strength after brazing.
 - 4 An average figure here would be meaningless. The tube will fail at it's weakest point.
- * Strength is probably less because the 1:50 wall thickness to diameter ratio has been exceeded.

hundred times the wall thickness. Reynolds 531 in the unbutted sections is a safe forty-five. Reynolds 753 light gauge is pushing it at fifty-six. You can see the tube denting when you squeeze a light gauge 753 top tube between your fingers.

Within the safe limits of wall thickness, the strength of equivalent weight tubing increases linearly with the diameter. The stiffness of equivalent weight tubing increases as the square of the diameter. The larger diameter tube is a good deal stronger and tremendously stiffer than the small tube, and it weighs no more!

Remember that aluminum is about one-third the density of steel. A one-inch steel tube with a wall thickness of twenty thousandths (50:1)

would be equal in weight to a one and one-half-inch aluminum tube with a wall thickness of forty thousandths (37.5:1). The aluminum tube would be 50% stronger and 125% stiffer, and it would weigh no more!

The above Down Tube Comparison chart graphically illustrates the advantage Klein Power Tubing™ offers over both 531 and 753 frame tubes in both strength and stiffness. These are representative of the dimensions and properties of other brands of steel tubing as well. In addition, the welded and heat-treated aluminum frame has neither the extra weight in the lugs, nor fatigue-prone braze material in the joints.

Down Tube Strength/Weight Ratio

Reynolds 531	224	
Reynold 753	248	429
Klein Power Tubing™		

Down Tube Stiffness/Weight Ratio

Reynolds 531	224	
Reynolds 753	233	394
Klein Power Tubing™		

Thus far we have talked only about the effect of frame materials on power efficiency and durability. Comfort is also exceedingly important. Unfortunately, no comfort measuring device, outside of your very own buttocks, exists, which makes this a somewhat subjective aspect.

Experience shows that there are several factors which influence the relative comfort of a machine. Wheels, tires, and saddles are important comfort factors. But what we are examining here is frame comfort, and we have identified four factors which, to greater or lesser degree, will influence the comfort of your frame. These are (1) the damping coefficient of the frame material (shock absorption), (2) the vertical rigidity of the frame tubing (suspension), (3) the frame weight, and (4) frame geometry.

The damping coefficient of high strength metals (steel, aluminum, titanium) is so slight that it is unlikely it has noticeable effect on rider comfort. The paint on a frame is probably damping more shock than the metal tubing. The soft braze material of steel frames may have some small effect. However, frames using bonded (epoxied) joints, or frames using epoxy-bonded fiber composites are providing good shock absorption. The damping coefficient of the epoxy is high. It absorbs high frequency vibration like an automobile's shock absorber.

Vertical rigidity of the frame tubing is a small effect, but the amount a tube compresses

under impact has some bearing on rider comfort. The light weight aluminum tubing compresses more easily than standard gauge steel in this axial direction. The lighter gauge Reynolds 753 also compresses more in axial direction than standard gauge steel, and accordingly, is more comfortable to ride.

However, rigidity and damping coefficient are less important than frame weight and geometry. Light weight frames transmit less road shock. They follow the contour of the road more easily. To use the terminology of the auto industry, the frame and components are unsuspended mass, and the rider is suspended weight, his arms and padding (body tissues) acting like the suspension springs of an automobile. A heavy frame will move further and stop moving less quickly when it hits a bump than a light frame. In addition, all things equal (stiffness, strength, geometry), a lighter frame will also handle better. "Road holding" is a direct result of the tire's ability to follow the road contour.

Lastly, frame geometry seems to have a large effect on comfort. All things equal, longer dimensioned frames with a more equal weight distribution between the wheels tend to be more comfortable than short wheel base, rear wheel weight biased machines.

This is our hypothesis of factors that affect comfort. Since we know of no exact formula for frame comfort, we have made one up. It may not be correct, but here goes. Assuming good rider fit, and keeping frame geometry as constant, we would describe comfort as a function of the inverse of the weight, and, because it is less critical, the inverse of the cube root of vertical rigidity, multiplied by a damping factor for those frames with significant damping. I estimate that a fully epoxy-bonded composite frame would show something like a 15% - 20% improvement in ride

comfort as a result of damping. The boron composite on the Klein probably makes only a 5% improvement; the basic structure of the frame is high strength, heat-treated aluminum with boron only on chainstays, seatstays, and fork blades, which cannot have as much damping effect as a frame completely made of epoxy composite. The following chart shows data on seatstays, and compares typical frames equipped similarly to the Klein.

Comfort Factor Comparisons

Material	Frame Weight (fully equipped)	Seatstay Axial Rigidity	Frame Damping Factor
Columbus-Road Standard	8.3lbs.	1.64	100
Columbus-Road Light	7.6lbs.	1.18	100
Klein Power Tubing™	5.8lbs.	.79	105

The axial rigidity and frame weights are well represented figures, but the damping factor is a guess. The comfort ratings, using our theories, are as follows:

Comfort Ratings

Columbus Road Standard		10.2
Columbus Road Light		12.5
Klein Power Tubing™		19.6

These ratings agree well with our experience of different frames.

Change does not come about for its own sake. The attempt of developing a bicycle frame from new materials is not a result of boredom, but rather because the steel frame has reached a proximity of its optimal point. How can it be improved upon? In order to make it more rigid, tubing diameters have to increase with consequent weight increase and comfort decrease. In order to increase comfort, the wheel base must increase in length with consequent loss in rigidity and/or increase in weight. Or else the weight must decrease with consequent losses in rigidity and strength. A vicious circle. The steel frame is approximately as good as it can be. This means that we are now seeing a static state of design resulting in the likes of oval tubing (with supposed aerodynamic gains but actual rigidity losses). That the current steel frame is so well designed is no accident. The basic design work was done early in this century. Any flaws were realized and corrected long ago. The more advanced technologies were not available then, but if they had been, we would likely be riding on something very different than steel today.

A properly constructed aluminum frame is a real breakthrough in the search for more effective frame-building materials. The lighter weight material used in large tubes gives a frame which is more comfortable to ride without sacrificing rigidity, is far more rigid without sacrificing comfort, is stronger and more durable, with a clean aesthetic all its own. This is not to say our present frame is the best that will ever be made. We are still looking for something more comfortable and more rigid. A bicyclist can have too much of neither.

DEAR SIRs,

PLEASE SEND ME AN UP-TO-DATE PRICE LIST ON YOUR TEAM SUPER ROAD BICYCLE. ALSO, IF YOU HAVE A NEW BROCHURE PLEASE SEND ME THAT TOO. I HAVE INCLUDED 25 CENTS TO COVER IT.

I WOULD LIKE TO COMMENT ON YOUR PRODUCT. A FRIEND WHO I RIDE WITH RECENTLY BOUGHT A KLEIN. ON HIS FIRST RIDE ON IT, I WENT WITH HIM. JUST BEFORE WE LEFT, HE SAID TO ME THAT IF THIS BIKE JARS AND RATTLES ME LIKE SOME PEOPLE HAVE CLAIMED; IT WILL HIT THE WANT-ADS IN THE PAPER TOMORROW. THIS WASN'T JUST AN AROUND THE BLOCK RIDE. EITHER, IT WAS 60 MILES, AND THAT'S A TEST FOR ANY BIKE. WELL, WE LEFT, AND HE IMMEDIATELY FELL IN LOVE WITH IT. AROUND THERE, (COOS BAY, OREGON) THEY HAVE THEIR SHARE OF ROUGH ROADS AND HILLS. HE LET ME RIDE IT AND IT FELT LIKE

I WAS IN HEAVEN. ON HILLS WHEN YOU REALLY GET UP AND JAM IT JUST FLIES. INSTEAD OF FLEXING AROUND IT GOES. AND ON ROUGH ROADS IT'S AS SMOOTH AS SILK. I'LL HAVE YOU KNOW, IT DIDN'T HIT THE WANT ADS.

UNFORTUNATELY IT WILL BE A WHILE BEFORE I CAN GET ONE BECAUSE I'M ONLY 14 YEARS OLD. BUT I CAN TELL YOU NOW, YOU HAVE A FUTURE CUSTOMER IN ME. I THANK YOU.

ERIC SAMPSON



ANE
1
101

KLEIN BICYCLE CORP.
1305 MAPLE AVENUE
SAN MARTIN, CALIF.
95046





Gary Klein, 207B South Prairie Road, Chehalis, Washington 98532 • Telephone (206) 262-9823



207-B SOUTH PRAIRIE ROAD • CHEHALIS, WASHINGTON 98532 • TELEPHONE (206) 262-9823

Direct Order Prices - July 1, 1981

Framesets

Price

Klein Team SuperTM Frameset - includes Campagnolo Super Record or Chris King sealed bearing headset, Campagnolo shift levers, sealed bearing bottom bracket assembly, cable guides, water bottle mounts and specially frame fitted color matched pump. Finished in DuPont Imron Metallic Blue No. 44426UH \$2,272

MedusaTM Racing - includes the same basic features as the Team Super, finished in Deltron Venetian Red 1,295

Klein StageTM Frameset - includes the same features as the Team Super, with the addition of front and rear fork eyelets.

Standard sizes: 52 - 64 cm 2,336

Special sizes: 46 - 50 cm 2,436

66 - 70 cm 2,536

Medusa Touring - includes the same features as the Klein Stage, finished in Deltron Persian Aqua Metallic.

Standard sizes: 52 - 64 cm 1,295

Special sizes: 46 - 50 cm 1,395

66 - 70 cm 1,495

Options

OMAS Titanium spindle 103

Stronglight Titanium spindle 133

Seat stay chain hanger 44

Handlebar control stops 10

Extra bottle cage painted to match frame (included with bicycles) 18

Front Blackburn rack, includes mounting and finishing 95

Rear Blackburn rack, includes mounting and finishing 120

Set of front and rear Needle Works custom racks and panniers 650

Avocet 180 x 27.4 mm seat post, 8.2 oz 23

Laprade 200 x 27.4 mm seat post, 8.2 oz 29

Campagnolo Record 180 x 27.4 mm seat post, 11.3 oz 28

Campagnolo Super Record 180 x 27.4 mm seat post, 7.6 oz 39

113119

	<u>Price</u>
Custom color, per color - any DuPont Imron or Ditzler metallic or solid color	100
Campagnolo Nuovo Record Road Group	560
Campagnolo Super Record Road Group	800

Clothing

Klein Jersey	32
Klein Shorts	29

Bicycles (in addition to frameset price above)

MerrickKlein (built with the Stage frame)	2,760
Light Bicycle	1,550
Heavy Duty Bicycle	1,280
Touring Bicycle	1,346

Please request prices for additional options. We furnish many things not listed.

Repairs

Refinish frameset - includes checking the alignment of the frameset, inspecting the fittings and repairing minor nicks and scratches - standard color . . .	220
Replacement fork - Team Super or Stage - standard color	307
Replacement fork - Medusa Touring or Racing	180

Terms

1. 25% deposit with order, balance plus shipping charges C.O.D.
2. Visa or Master charge (telephone orders accepted).
3. 2% discount and free shipping within the contiguous US when full prepayment accompanies order.

Delayed deliveries may occur. Please consult us for delivery date. Prices and specifications subject to change without notice.



207-B SOUTH PRAIRIE ROAD • CHEHALIS, WASHINGTON 98532 • TELEPHONE (206) 262-9823

Direct Order Form

In order to serve you better, we would appreciate the following information:

Name: _____

Address: _____

Phone: _____ Height: _____ Weight: _____ Sex: _____ Inseam: _____

Shoe size: _____ Shoulder width: _____ Arm length: _____

Type of riding for which bicycle is intended: _____

Currently riding: _____ Frame size: _____ Seat angle: _____

Top tube length: _____ Stem length: _____ Comments on fit: _____

Thank you for your response.

Frameset—The most important part of any good bicycle

Price

1. Racing Frames—Team Super ☐ or Medusa Racing ☐
Size: 51 54 57 59 61 64 \$ _____
2. Touring Frames—Stage ☐ or Medusa Touring ☐
Size: 46 48 50 52 54 56 58 60 62 64 66 68 70 _____
3. Custom dimensioned frameset ☐ _____

Options

1. Headset: Chris King ☐ or Campagnolo Super Record ☐ No charge
2. Bottom bracket spindle:
Steel [standard] ☐ OMAS Titanium ☐ Stronglight Titanium ☐
[Type of crankset to be used, _____]
3. Seat stay chain hanger ☐ _____
4. Down tube shift levers [standard] ☐ or Bar control stops ☐ _____
5. Extra water bottle mounts ☐ _____
6. Color matched water bottle cage ☐ _____
7. Front Blackburn rack ☐ _____
8. Rear Blackburn rack ☐ _____
9. Set of front and rear Needle Works custom racks and panniers ☐ _____
10. Seat posts:
Avocet ☐ Laprade ☐ Campagnolo Record ☐
Campagnolo Super Record [standard on all complete bicycles] ☐ _____
11. Custom color ☐ _____
12. Campagnolo Nuovo Record Road Group, complete _____

13. Campagnolo Super Record Road Group, complete
14. Any other features desired ☐
-
-

Clothing

1. Klein Jersey 50% cotton, 50% polyester, beige with chocolate printing and piping
 extra small ☐ small ☐ medium ☐ large ☐ extra large ☐
 30-32 34-36 38-40 42-44 46-48
2. Klein Shorts chocolate with beige print
 extra small ☐ small ☐ medium ☐ large ☐ extra large ☐
 28 30-32 34-36 38-40 42-44

Complete Bicycle— on the frameset of your choice, above

1. MerrickKlein —our show bike, built with a Stage frame, including a
 special color ☐
2. Light Bicycle ☐
3. Heavy Duty Bicycle ☐
4. Touring Bicycle ☐

Additional information for complete bicycle

1. Stem length
2. Crank length
3. Handlebars
 Reach: short #64 width 38 cm ☐ 40 cm ☐
 medium #63 width 38 cm ☐ 40 cm ☐
 deep #66 width 38 cm ☐ 40 cm ☐ 42 cm ☐
4. Any other special equipment or modifications desired:
-
-
-

Order Total \$

Washington residents must add 5% State sales tax

Form of Payment

1. I enclose the minimum 25% deposit
2. Please charge my Visa ☐ or Master charge ☐
 Account number Expiration Date
3. I would like the 2% discount and free shipping Less 2% -

Payment in full enclosed

Signature Date: