Suspension Makeover

by Mark Barnes

IT SEEMS THE majority of motorcyclists seeking improved performance (read "more speed") from their bikes start by installing an aftermarket exhaust system. They believe adding the strength of a couple extra ponies will yield more dramatic acceleration, quicker lap times or at least a smoother, more consistent power curve.

The truth, however, can be quite different. That snazzy new pipe and canister may actually deliver no significant horsepower advantage, or it may rob power from low revs to stack it a little higher at redline, where most riders won't find it useful. We've even seen some aftermarket exhausts reduce power and introduce undesirable dips and spikes in power delivery. But that sexy look and throaty sound can still prompt riders to open their wallets, and perhaps even convince them they're going faster.

Certainly, some pipe swaps do allow for (very) minor improvements in engine performance, along with a weight savings compared to the jettisoned OEM system. But that increase in engine performance doesn't necessarily equal increased rider performance. Even if it did, the difference would be quite small.

Years ago, while standing inside turn seven at Road Atlanta, we realized the guy leaning against the fence next to us was Dale Quarterly, perhaps the most successful privateer superbike racer in American roadracing history. He was shaking his head and muttering about the amateurs passing by on their practice laps. He took inventory of what modifications were visible on each bike, as well as the usual absence of an aftermarket rear shock. He kept saying those guys would be going a lot faster through this corner if they'd just bought new rear shocks instead of all the other (more expensive) stuff.

Suspension that works well is far more likely to provide a genuine performance gain than would a stretched dyno graph. In fact, adding power when handling, traction and stability—and therefore rider confidence—are lacking is guaranteed to detract from overall bike-plus-rider competence. While many modern motorcycles come equipped with far better forks and shocks than even race bikes had a decade or so ago, they still have to accommodate the wide range of rider weights and applications that any particular machine is apt to encounter. So the stock setup might not allow for precise adjustment, or the adjustment range might exclude what's necessary for a particular rider or situation outside the original design parameters.

Also, true to the long-standing historical trend, stock units still tend to be (a) too loose (underdamped) to maintain a good feeling of control during low-speed suspension movement, producing wallowing at high ground speeds and loss of traction during vigorous corner exits, and (b) too harsh (overdamped) to maintain a plush feeling during high-speed suspension movement, resulting in jolts to the chassis and rider over sharp bumps and loss of traction over corner surface irregularities.

In addition to these damping problems, stock spring rates may not allow for ideal sag at one or both ends of the bike, given a particular rider's weight. This compromises damping function and chassis geometry, since an improperly sprung suspension will spend most of its time in a non-optimal portion of its range of motion, with the bike pitched too far forward or backward, or slung too low throughout.

When a motorcycle's suspension provides good control and a plush feel, the rider can go significantly faster with greater confidence. Or, even when higher speed is not the goal, he'll enjoy a smoother, safer, more relaxed ride. To achieve such optimal suspension action, forks and shock(s) must be in excellent working order (i.e. nothing bent, no leakage, no slop in bushing clearances), and spring and damping rates must be tailored for the rider's weight and the actual use of the bike. Suspension demands are very different for a 140-lb. pilot of a racing hyperbike versus a 230-lb. commuter on a standard.

While the average person might be able to figure out proper spring rates with a lot of expensive trial and error, damping science is far more complicated and way beyond the reach of mere mortals. If you've ever examined a stack of valving shims, and realized how many combinations and permutations of circumference, thickness and sequencing could exist, you know this is a terribly dark forest that should never be entered without expert guidance. Fortunately, there are a few people who have mapped that terrain already, and are willing to share their hard-won knowledge with the rest of us.

Meet the Pros

We've run articles about suspension parts from Race Tech and Penske, and the chassis geometry services available at G.M.D. Computrack. All three companies have impressed us with their technical expertise and quality workmanship. In case these names are new to you, here's a quick review:

Race Tech is probably best known for its "Gold Valves" (ingenious little devices that replace the stock valving in forks and shocks), and for the wealth of suspension set-up knowledge disseminated through its training seminars and trackside operations. Paul Thede is the brains behind all of these, and has been earning his reputation as one of the foremost experts in the field over the past 22 years, developing products for virtually every type of motorcycle competition. Gold Valve kits tailor suspension action to suit an actual rider's weight and riding intensity; they increase tunability and produce a ride that is both more supple and more controlled than the stock counterparts. Additionally, Race Tech sells its own springs, bushings, seals, lubricants and tools, all purpose-built with the benefit of their focus on perfecting suspension performance.

Penske Racing Shocks started servicing the needs of the car racing crowd about two decades ago, and has become a leader in virtually every branch of auto competition. Their Indy Car technology found its way into roadracing motorcycle applications in the mid 90s, partly because many within the company were motorcycle racing enthusiasts. All of their shocks are custom built to order, and individually tested on a shock dyno before going out to the customer, complete with extensive documentation. Plus, they offer a structured training program to teach customers how to service, repair, rebuild and re-valve their shocks.

G.M.D. Computrack is the invention of Greg MacDonald (hence the "G.M.D."), the Australian who came up with the original idea for this system of chassis measurement and modification back in 1982. Basically, a highly specialized theodolite (you're familiar with the much simpler version of this

scope used by surveyors) is used to triangulate multiple points on a bike's chassis. The resulting 3-D coordinates are then sent to a computer that analyzes their spatial relationships. Proprietary software allows a skilled interpreter to assess the alignment of multiple elements, such as whether the wheels are centered on the same plane, and whether there is any twist in the frame, fork or swingarm.

Other data, such as the actual rake and trail, fork offset, swingarm pivot location, and the declination angle of the swingarm, are also generated to inform decisions about possible modifications to the chassis geometry. There's even an auxiliary "What If?" program that can calculate how a change in any one of a dozen variables will affect each of the others. For instance, if a different rear tire with a larger circumference were used, or the rear ride height altered, what change would result in the rake and trail? More on this later.

A good example of an otherwise proficient motorcycle limited by lackluster suspension is Honda's VTR1000F Superhawk. Like Suzuki's SV650, which we used in the last major suspension makeover article (8/01), the Superhawk suffers from corporate cost-cutting in this area, with its mediocre fork and shock being "weak links" in its overall performance.

In the SV650 piece, we showed how to install one type of Gold Valve, the Cartridge Emulator, which gives an old-style damper-rod fork tuning flexibility more like that of a modern cartridge fork. Because the Superhawk's cartridge forks are considerably more complex than damper-rod assemblies, and require more specialized tools to service, we decided to have the work done by the good folks at G.M.D. Computrack in Atlanta, Ga. (All G.M.D. Computrack centers are authorized Race Tech installation facilities.) Replacing the Superhawk's stock shock's valving with a Gold Valve is an expert-only procedure anyway, since Honda/Showa didn't mean for it to be opened and rebuilt. This article is not so much a how-to piece as an effort to show some of what's involved in the process of re-valving a stock suspension, and why it's a very good idea—or sometimes an absolute necessity—to have such work done by professionals. We'll also give you some sense of what to expect in terms of costs and results.

Step One: Measurement

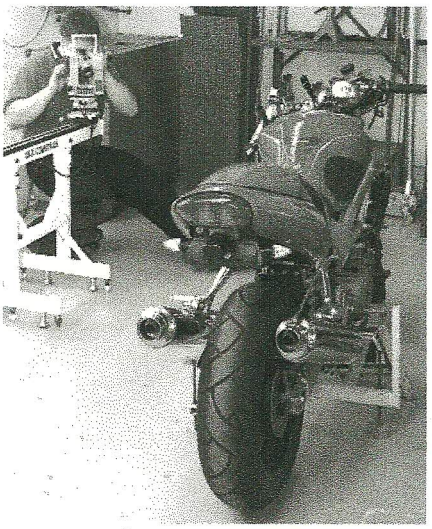
Kent Soignier and his wife, Tracey, opened the first G.M.D. Computrack center in the United States in November 1993. Since then, they've set up two more shops in Florida (Jacksonville and Ft. Lauderdale) in addition to the original in Atlanta (Clarkston, Ga. to be exact). They're both friendly, but straightforward people who get down to business right away—years of involvement in the upper echelons of competition have instilled a level of organization and efficiency you won't find at a typical dealership or local mechanic's garage.

Getting initial measurements on the Superhawk was the first task. Stripped of its fairing, the bike was positioned on a combination of stands to allow the fork to extend fully and swing freely between its extreme left and right positions. Thirty-some "dots" (small circular stickers with crosshairs drawn on them) were then applied in key places on the frame, wheels, swingarm, forks, etc., and a couple of special devices were attached to allow for tricky measurements, such as the location of the swingarm pivot center on the side of the bike opposite from the theodolite.

Technician Nathan Kimbrough then went to work measuring the distance and angle of each dot from one end of the theodolite's raised track, and then did it all again from the other end, thus allowing for the precise triangulation of each point. When we say "precise," we mean it. Accuracy is within 0.01mm and 1/1800th of a degree! The measuring process takes about an hour, including fairing removal and bike positioning.

This Superhawk was bought used, and showed evidence of a low-speed fall to the right side (minor scuffs on the engine case and the exhaust canister's leading edge), so we wondered if some frame quirks would show up. Even without any crash damage, manufacturing tolerances can be wide enough to allow a brand new machine to arrive surprisingly far out of alignment in multiple dimensions. Fortunately, this bike passed inspection with only insignificant imperfections. A lengthy printout of the measurements showed both numerical and deliberately exaggerated graphical information on the relative position of various key chassis elements, making it fairly easy for a lay person to visualize and understand what problems exist. G.M.D. Computrack can correct misalignments with a hydraulic ram when necessary. Repairing impact damage makes up a fair amount of their business.

Interestingly, the geometry of any particular bike as measured by G.M.D. Computrack might vary quite a bit from the manufacturer's spec sheet. This isn't necessarily a matter of corporate subterfuge or sloppy assembly, since many of the dimensions can be assessed in different ways. For example, rake and trail will be significantly different with the fork fully extended versus compressed with an "average sized" rider in the saddle. When making any comparisons, measurements must have been taken in exactly the same way.



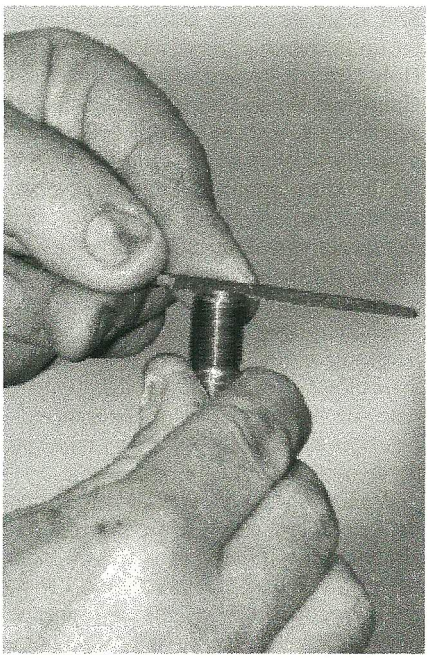
Nathan Kimbrough sets to work measuring the naked Superhawk with the special theodolite.

With these initial measurements as a baseline and the "What If?" computer program loaded, Kent showed us how a single manipulation, raising the rear ride height, would alter the rake and trail on this bike in a way that would likely prove beneficial. He considered the as-delivered geometry to be a bit on the "stately" side, and recommended this change to make the bike steer quicker and feel lighter. The stock setup has no provision for altering the ride height, but an aftermarket shock from Penske, with adjustable length, would make that change possible.

Step Two: Fork Rebuild

Although the Superhawk's fork sports Honda's fancy-acronymned HMAS technology, no one would mistake it for cutting-edge equipment. Its legs are conventional (female slider or non-upside-down) units with externally adjustable preload and rebound damping, but no provision for changing compression damping except to switch to different viscosity fork oil. The front end of this bike has always felt rather listless, even though it's too young and too low-mileage for the components to be worn out.

Spring rates are the proper place to start when revamping suspension, since damping curves will never feel right when the suspension is under- or over-sprung. Race Tech considers the stock springs too soft for this Superhawk's owner (155 lbs.), and indeed, I knew from experience that even the maximum preload wouldn't yield the usually prescribed sag measurements with the original coils. (If you're curious about your own machine's springs, you can enter a little information on the Race Tech web-



No detail is too small. Todd manicures the threads at the end of each rod.

site, www.racetech.com, and find out how their recommendations compare to what the factory actually installed.) Race Tech also favors straight-rate, instead of progressive-rate springs, such as the Superhawk's. Straight-rate springs give fork action a more linear character, which makes tuning simpler and also helps the front-end feel more "alive" and less wimpy at the beginning (top) of its stroke. (Progressive-rate springs are initially softer and firmer as more travel is used.) While some progression in resistance is desirable as the fork compresses, Race Tech feels that this is naturally provided by the increase in air pressure in the empty portion of the fork leg above the oil. Adjustments in progressiveness are therefore made by changing the volume of this "air spring"—that is, by raising or lowering the oil level.

Although replacement springs are the first consideration in theory, they're the last parts to go in during the rebuild procedure; all the other work has to be done first.

Todd Dunn, whose resume includes having been a head mechanic for one of Pro Circuit's leading race teams, set to work dismantling the Superhawk's fork legs in his operating room. It is no exaggeration to compare his work space with an operating room, in that his dedication to contamination prevention and the extreme care with which he attended to the tiniest details would do a surgical team proud. Each and every part was cleaned thoroughly prior to and throughout disassembly, and it was amazing how much crud was hiding in cracks and crevices. Keep in mind these fork legs looked immaculately clean to the naked eye while they were on the bike. G.M.D. Computrack goes through a lot of solvent, and Todd is the reason why—he ran parts through the tank multiple times, scrubbing them with a variety of brushes, and rinsing the tank solvent off with spray contact cleaner. He even cleaned his tools like this at different points during the procedure.

As an example of the extreme level of care taken, Todd prepped the fork's central rods three ways before pulling them through their seals. First, the threads on the rod ends were meticulously filed to remove their sharp, irregular edges (which were quite noticeable with a quick pass of the thumb, as though the original machining had not been very precise). Next, a layer of Teflon tape was wrapped around the threads. And third, a coating of grease was applied to the outer surface of the tape. Todd explained that these procedures ensured that the rod's seal would not incur damage as the threaded rod end moved through it. Even though such damage would likely be slight, he had zero tolerance for any imperfection that was preventable.

Such care made the job take much longer than it might at your local shop, but when it's your own delicate suspension on the operating table, you want the most obsessively meticulous surgeon—er, mechanic—available. One of the realities of high-level racing is that winning and losing are separated by microscopic margins; there's simply no room for doubt or error in mechanical work. Watching Todd operate was a revelation. Many of his tricks and techniques are proprietary, and can't be revealed here. But after observing firsthand all the extra effort put into making everything work Just Right, the price G.M.D. Computrack charges to do this job for you is an extreme bargain. Sure, the Gold Valves come with installation instructions (which assume considerable familiarity with suspension components and assembly/disassembly procedures), and an experienced home mechanic could do the job after buying some extra tools. *But*, the hazards are many, the time and effort requirements—especially for the uninitiated—are extensive, and there's still a good chance of having to pay someone to fix the mess made trying to be frugal. Todd has seen plenty of examples.

Part of the G.M.D. Computrack protocol is measuring everything that comes out of the stock assemblies, as well as everything that is installed. Each valve shim gets the caliper and micrometer treatment to determine its exact dimensions, and the springs are measured to determine their true rates. This data goes into the company's database, allowing the entire Race Tech and G.M.D. Computrack network to benefit from the information. Also, it allows any subsequent modifications to be done very efficiently, since all the parts are known quantities. Everything is examined closely and touched up where necessary to make sure the reassembled unit is totally "blueprinted."

Although the Superhawk's forks did not require new bushings or seals, there were a surprising number of little defects, such as burrs in machined surfaces and fine metallic "hairs" extending from threads. We know from experience that brand-new forks with only a thousand miles on them can have an astonishing amount of metal suspended in their oil; it's not a bad idea to change fork oil as part of the initial service, and certainly advisable on any bike bought used. Todd explained that the use of air tools, wide tolerances in part manufacturing, and sloppy assembly-line practices all contribute to the creation of loose metal particles at the birth of a suspension unit. That circulating metal hastens the wear of every moving part, resulting in even more debris, and can rapidly erode damping capability. When this fork went back together, all the pieces were Smooth and Clean.

Race Tech recommends replacement of both the compression valving and the rebound valving in the Superhawk's forks; each gets a separate Gold Valve and new shim stack. However, a less expensive option would have been to install the compression Gold Valve (with its new shims), and re-use the stock rebound valve with different shims (a combination of original and Race Tech shims, specified in the instructions accompanying the compression Gold Valve). Work on both the rebound valves required the *extremely* careful removal (via grinding) of peening done at the factory to secure their retaining nuts.

Although every Gold Valve kit comes with a large assortment of shims, only a subset is used for any specific application. Race Tech provides the necessary information on which shims to use, and how to arrange them in the stack, through their technical support program, which can be accessed online or by telephone. This information is available only once through the use of a code included inside each kit. Because their database has been time-consuming and expensive to develop, Race Tech protects against its unauthorized (unpaid for) dissemination. The custom setup in this case also included drilling a tiny bleed hole through one of the port walls on each compression Gold Valve.

After all valving and shim stacks were replaced, the fork cartridges were reassembled and returned to their respective fork legs. Todd then filled each leg with Race Tech's Ultra Slick fork oil, using the level

indicated by the code-accessed tech support information that had contained the shim specs. The new fork springs came next, followed by the stock spacers, which had been cut (and polished, of course) to produce the exact preload suggested by Race Tech. Once everything was buttoned up, the preload and rebound adjusters were set to the starting point recommendations from Race Tech's proprietary database.

Step Three: Shock Rebuild

As tricky as its forks were, the Superhawk's shock was even more of a challenge. Race Tech sells the Gold Valve kit for this shock only to its own installation centers, as working on a gas-pressurized unit that was not meant to be rebuilt requires special expertise and carries additional risk of physical injury. One of the unusual tasks required was the installation of a Schrader valve atop the shock body so that high-pressure nitrogen could be replaced after reassembly. This involved drilling and threading a hole, and machining the outer shock body surface so that the valve would seal properly—great precision was necessary to avoid turning the shock body into an expensive lump of junk metal. This would not have been necessary had the shock come with an external reservoir, which would have had its own valve to allow for the easy release and refilling of the gas charge (as was the case with the CRF suspension).

We won't go into as much detail here as on the forks, since many of the procedures were similar, and the odd maneuvers may have little application beyond this unique example. Todd applied the same extraordinary attention to detail while replacing the old valving and shims with Race Tech parts. It was interesting to note that the rebound and compression shim stacks sat on opposite sides of a single valve, rather than existing separately, as they had in the fork cartridges.

Although the stock shock spring was not exactly what Race Tech recommends, it was very close, just a little stiffer. The slight difference in spring rate was not deemed worth the expense of replacement, especially since this bike sometimes sees sport-touring duty—the addition of luggage would tip the scales in favor of the stock spring. As with the fork, the shock was reassembled using the code-accessed Race Tech specifications for shims, spring preload and rebound damping adjustment (there's no external compression adjustment).

Step Four: Chassis Optimization

With the rebuilt fork and shock in place, Kent could perform the "Sag and Clickers" service. This is a fairly quick operation, and while we were there, a half-dozen other riders came in to simply get this done. (For this as a stand-alone service, G.M.D. Computrack charges $50.) We've covered proper procedure for setting sag in previous articles, so we won't spell it all out here. Basically, the idea is to get the bike to compress its suspension to a certain degree with the rider in position. The bike should also compress the suspension slightly without the rider on it. If the proper measurements can't be obtained by adjusting preload, it means the spring rates are incorrect for that particular bike/rider combination.

Once Kent has set a bike's sag, he gets compression and rebound adjustments in the ballpark by pushing down sharply on each end of the bike and feeling the resistance created by the suspension's damping. This requires an extremely fine-tuned sensitivity to very subtle differences in movement, something only a person with a great deal of experience could achieve. Kent may tell the customer that his bike cannot be dialed in properly without more work (i.e. different springs or re-valving), but he gets it as close as possible.

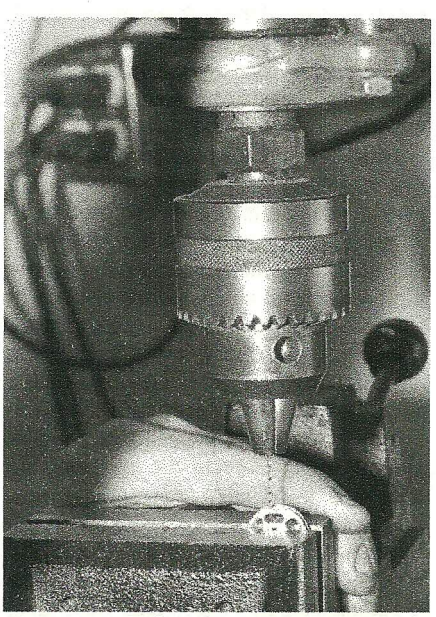
It was enlightening to listen in on Kent's conversations with the Sag and Clickers customers. I repeatedly heard these folks, many of whom were attending an upcoming local track day, voice erroneous (or simply vague) ideas about suspension operation. Kent would listen patiently, no doubt quite accustomed to hearing all sorts of misguided, superstitious or plain old ignorant notions about how suspension works and what changes were needed. He would then respond with a clear, concise, and even-handed explanation of where the poor fellow was mistaken, and what was actually required to make things better. Sometimes people listened intently, sometimes they stared blankly, and sometimes they seemed to cling to their original misunderstandings. Kent respectfully left everyone to make their own choices and didn't spend a lot of time on persuasion—he gave his expert advice and stopped there. We had a few of our own misconceptions gently corrected along the way, too (see the part below on target sag numbers).

Kent stressed that chassis optimization is always a matter of custom tailoring; there are no "correct" settings or geometry figures, only what works best for this rider on this bike in this application. However, G.M.D. Computrack does have some opinions about bettering the stock setup on a lot of bikes. These opinions are specified as "Sweet Numbers"—geometry settings that have proven themselves in the collective experience of G.M.D. Computrack experts. Still, these are simply better places to start the optimization process, rather than some Holy Grail to be pursued as a final goal. Optimization may require relatively minor adjustments, or it can be achieved through a variety of more extreme means, including bending or machining frame parts, installing adjustable or alternative triple clamps, or even fabricating special pieces where necessary. Usually, the most intensive measures are reserved for Superbike spec equipment. We didn't pursue any heroic efforts on the Superhawk, since the main effect we were interested in—raising rear ride height to sharpen the steering a bit—was to be accomplished by replacing the stock shock.

While we were there, we wanted to get the Penske unit set up as well as possible, although we put the re-valved stock shock back in for the next few weeks to allow a fair comparison to its original performance. In the process of temporarily installing the Penske, we learned it would foul one of the exhaust crossover pipes if extended far enough to achieve the desired ride height change. Kent whipped out an acetylene torch and ball-peen hammer, and—with our permission—set about heating and beating the offending pipe into submission. We ended up with a nicely contoured depression in the pipe that was insignificant for exhaust flow, but provided the new shock with enough clearance to make the geometry difference we wanted.

Riding Results: Re-Valved/Resprung Fork, Re-Valved Stock Shock

All the above work may be very compelling in theory, but does the difference in



The Superhawk's compression Gold Valves needed tiny bleed holes drilled into them.

actual performance justify the cost? We think so, at least in this case. Obviously, the degree of improvement will vary from one bike to another, and one rider may appreciate a change that is totally lost on another. Some differences may only be noticeable under more intense demands, whereas others can be felt before the bike even starts moving. You'll have to decide how dissatisfied you are with your current suspenders, and get clear on how you want it to feel different. The Superhawk's flaws became apparent mostly as a result of spending time on several other machines that were more composed during spirited riding. The more variety you're exposed to, the more you understand what's actually possible, and where your own bike sits on the continuum.

The most obvious difference was created by the stiffer fork springs. Ironically, they would be about the cheapest and easiest modification to do at home, second only to putting in fresh fork oil. Whereas it used to feel mushy and vague, the Superhawk's front end now feels stable and secure. Under braking, instead of diving deep into its range of motion, the revamped fork's movement is more controlled; it moves less and settles sooner. This is the result of both the stouter spring rate and more effective compression damping. It would be easy to assume that the compression damping rate is simply firmer, based on the decreased brake dive. But it's more complicated than that, since the fork now absorbs bumps more fluidly than it did before—that means the damping rate must be lighter, doesn't it? It's actually a matter of changing the damping rate in different directions for low- and high-speed fork movement. Low-speed movement is now more heavily damped in both directions, bringing motion to a halt more quickly under braking and at high road speeds, where the Superhawk had sometimes felt a little "floaty." Simultaneously, high-speed motion has been freed up so that sharp/sudden jolts move the fork sliders more and the rest of the bike less—the energy of impact is now dissipated, rather than being passed along to the chassis.

Out back, the shock's re-valving makes a more subtle difference. It wasn't as harsh as the forks to begin with, so it took less to make it feel fairly supple. The biggest contrast becomes noticeable at higher road speeds, when the shock provides a more planted feel than it had before. This seems to be the result of firmer rebound damping in particular, as there is no longer any "bobbing" following deep compressions.

Riding Results: Re-Valved, Re-sprung Fork, Penske Shock

We're going to talk about the front end again, because the largest single impact of installing the Penske shock was a change in the steering geometry. With the rear of the Superhawk sitting about an inch higher, the rake and trail were reduced significantly. We're not going to give you the numbers because we don't want anyone to think they apply elsewhere, nor is there anything magic about the 25mm chosen for the rear ride height change. That was dictated largely by the limited space available on the Superhawk to extend the shock, due to the proximity of exhaust tubing. With an aftermarket exhaust that allowed more room, we might like even more of an increase. Each bike will respond differently to such changes, and there are no blanket truths. The best figures for one machine may be disastrous on another.

We didn't have any problem imagining this in the case of rake, trail, swingarm angle, wheelbase, etc. But we were surprised to learn that Kent considers ideal sag just as variable. We've certainly read many times (and printed here on our pages) that "correct" sag front and rear for a streetbike should be between 25-30mm for racing and 30-35mm for street riding. When we found that we could just barely get under 35mm sag at the front of the Superhawk with the new stiffer springs and maximum preload, we wondered if something was amiss (at least it was finally within what we considered the acceptable range, unlike

Price List: Parts and Labor

The cost of re-valving both ends of the Superhawk's stock suspension was just over $1,000; re-valving only the fork and replacing the OEM shock with the Penske piece would have been right at $1,700. Before you calculate how much you'd save by just buying the parts and doing the labor yourself, consider the cost of any necessary special tools you don't already own (consult your shop manual)—they could cost more than the labor charges. Also, you may need to replace other parts, such as seals or bushings, if yours are worn or damaged.

Superhawk Fork
Springs $110
Compression Gold Valve kit $160
Rebound Gold Valve kit $160
Ultra Slick Oil (made for Race Tech by Motorex) (2 qts.) $50
Labor $200
Subtotal $680

Superhawk Shock
Gold Valve kit $160
Ultra Slick Oil (1 qt.) $25
Labor $150
Subtotal $335

Penske Shock
Model 8600 $965
Installation $55
Subtotal $1,020

Kent generally does not work on streetbike suspensions without checking for chassis problems. After all, efficient treatment requires accurate diagnosis, which is impossible with a bunch of unknown variables. The measurement process is not only rules out faulty alignment, but also provides a baseline for tailoring the suspension setup later. Even without a ride-height-adjustable shock, it could be advantageous to alter steering geometry by raising the forks in the triple clamps, or by manipulating spring rates and preload settings. The "What If?" program takes much of the guesswork out of the tuning process, but requires the original measurements as a starting point.

Chassis optimization covers a variety of services, including suspension setup on the bike (ride height, sag and damping settings), minor part modification (remember that exhaust pipe?), along with follow-up consultation. If a bike requires more extensive intervention, such as cutting, fabrication or replacement of stock equipment with aftermarket pieces, or the frame is to be aligned with the hydraulic ram, the work is priced on an individual basis.

G.M.D. Computrack Chassis Services
Computrack Measurement & Assessment $150
Chassis Optimization (price varies with procedures required) $550
Subtotal $700

So, when it was all done, the tab for our Penske-outfitted Superhawk was about $2,400, with the re-valved stock shock it would have cost about $1,700. Either way, that's a hefty sum for most folks, and certainly more than virtually any aftermarket exhaust system, even with a jet kit and a couple dyno runs thrown in for good measure. Nevertheless, we have no doubt that these suspension mods yield a much greater performance benefit than a fancy titanium canister.

what the stock springs with max preload could achieve). Kent assured us that it's not uncommon for a sportbike to do best in the 35-45mm range of front sag, that we should forget about the abstract numbers, try the full range of available preload, and base our opinion on how the bike actually behaved. If we still wanted it to ride higher up front, then we could try an even stiffer set of springs.

Well, we nixed that idea as soon as we got a taste of the new geometry.

Although we never really had any big complaints about the Superhawk's steering (at least during street use), now we'd never go back to its old configuration. The original steering might be described as residing at the solid, stable end of the sporting spectrum. Some might consider it somewhat heavy and slow compared to a current-spec racer-replica, but it was plenty agile and low-effort for spirited street use, except perhaps in the tightest of twisties, where most any liter-bike feels ungainly. With the added rear ride height, however, the Superhawk can do some serious carving! The front end now feels noticeably more precise and planted. Steering is quicker and lower-effort, making the whole bike feel lighter, yet there isn't a hint of twitchiness. We simply keep finding ourselves hugging the inside edge of corners more closely than we'd expected. The Superhawk now begs to do a track day, whereas before it seemed content to just play at it on curvy roads.

We haven't noticed the fork bottoming, nor have we been bothered by any apparent reduction in ground clearance, even at the lightest front preload setting. And, since the lower the front end rides, the more pronounced the positive effect on steering, we don't have any interest in stiffer springs, as they'd just cancel out the effect of raising the rear.

We ended up setting fork preload in roughly the middle of its range, as this seemed to provide the best compromise between sharpened steering and two (slight) negative effects of raising the rear: more brake dive and increased loads on the rider's wrists and shoulders.

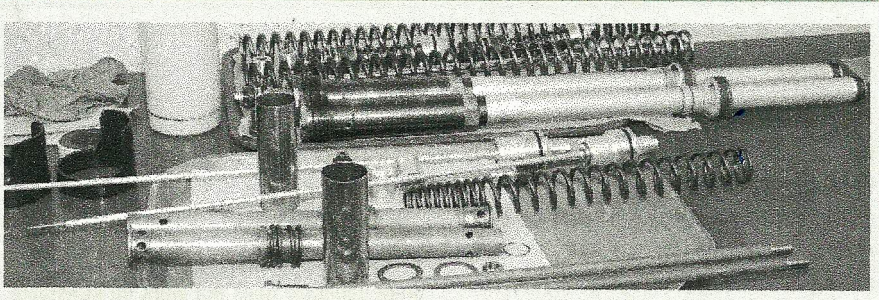
Note: Rear ride height changes, which also change the swingarm's angle of declination, can alter drive-chain tension and result in new points of contact between the chain and other parts. Depending upon a bike's swingarm design, the chain may rub more severely against the swingarm pivot area, for instance. The Superhawk's chain now makes slightly more contact with the plastic swingarm guard along the top of the pivot; this effect is mitigated somewhat by the fact that a larger-than-stock rear sprocket is mounted. The larger sprocket (now combined with the steeper swingarm angle) makes things worse at the bottom chain run, however, as it puts the chain in slight contact with one of the exhaust headers unless set to the tight end of its adjustment range. Swingarm angle adjustment is an art in itself, as it can be used to tune rear-end squat under acceleration. We haven't noticed any untoward side-effects from our modification on the Superhawk, but it could be an issue on another bike, or even on this one with more ride height dialed in.

The Penske shock seemed worthwhile, just to achieve the improved steering, but what about its function as a damper? Another reason to sign up for a track day! The new shock is absolutely unflappable, even with its settings at the soft ends of their ranges. Bump absorption is improved, yet the rear end supplies more feedback than ever, and is supremely stable exiting corners on the gas. The difference between the Penske and the re-valved stocker is more evident the harder the bike is ridden, so we won't be able to fully appreciate its advantages without some closed-course runs. In the meantime, we certainly can appreciate its much wider range of adjustment. Whereas the stock unit offered only rebound tuning, and that within a fairly narrow range, the Penske allows for substantial changes in both rebound and compression damping—something we also appreciate when switching to two-up riding or when adding luggage.

Whether such improvements are worth the cost to you will depend on several factors. First, how hard is the bike going to be ridden? These upgrades shine brighter under more demanding use. If track days are out of the question, re-valving the stock shock may be the most cost-effective option.

Also, how sensitive are you to damping issues? Many people never touch the damping adjusters they already have, or find fiddling with them confusing or futile. If you can't tell the difference between extreme settings, you may not appreciate the precision of a valving upgrade. Then again, your suspension may need an upgrade to get enough range of adjustability for there to be a noticeable difference between settings. Finally, what factors are most important for you on your bike? Maybe the damping feels fine, but you want to sharpen the steering. Or the biggest problem may be excessive dive under hard braking. Perhaps the changes you need could be accomplished with a simple fork spring swap and a different weight fork oil.

The broader your experience with different suspension setups, the more precisely you'll be able to define which factors you want to change—you may think your bike works fine until you ride one that works better. We went all out for the purpose of illustration here, but a more focused and less costly solution could be possible for your particular situation. Remember, each rider/bike/application combo is unique.



Can you name all these parts? If not, don't even think about doing this work yourself. The front tray contains the Superhawk's fork guts; the CRF's are in the back. The latter features a more complex, twin-chamber cartridge design.

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