Yoshimura Suzuki GS1000 Superbike

by John Ulrich

Look carefully at a competitive Superbike Production motorcycle and you'll see that it is much farther removed from its stock street origins than first glance would indicate. It has to be, considering that the bikes reach speeds above 150 mph, comer hard enough to drag engine cases on both sides, and brakes with enough violence to lift the rear wheel at comer entrances. Still, just how much different these street bikes-turned-racers really are isn't apparent until you take one apart piece by piece, asking, questions all the way.

That's what we did with the Yoshimura R&D of America Suzuki GS1000 Superbike. It is obvious that the bike is potent. The Yoshimuras entered it in five AMA Superbike Production races in 1978; the Suzuki led all five and won three, with one dnf due to an oil cooler failure and another dnf when the sprocket bolts pulled out of the rear wheel. The bike is the fastest machine in the class and handles well enough to run away from the competition at twisty Sears Point, the toughest track on the AMA circuit.

After two days of test riding and discussion of the Yoshimura GS1000 with Pops and Fujio Yoshimura and chief racing mechanic Suehiro Watanabe, we took the bike back to Cycle World's offices and dismantled it for photography and further inspection. What follows is what we learned:

Pops Yoshimura believes in extensive cylinder head porting and polishing. In finished form, his ports look more like modern art than a hunk of machinery. A view into a port reveals flowing lines and delicate shading patterns as light swirls onto the shimmering metal. The object is to remove flow-reducing, rough cast surfaces and edges and straighten out curved sections. Yoshimura points out that at 10,000 rpm, the cylinder must be filled with a gas/air mixture in just 0.012 seconds, or 83.3 times per second. Intake port mixture velocity reaches more than 280 mph. Every turbulence-producing port defect effectively reduces the port area and decreases flow, and at high-rpm/high - port-velocity, small defects are significant.

In his quest for maximum flow (and power), Pops increased the size of the valves. A stock GS1000 has 38mm intake valves and 32mm exhaust valves; the Yoshimura GS1000, 39mm intake and 34mm exhaust. Total valve area is thus increased 8.5 percent. Each valve is shaped for better flow at the tulip area. Valve face angle is a conventional 45'. Stellite is welded onto the valve face and stem tip for hardness, while an overall nitride treatment reduces stem friction within the Yoshimura nickel-bronze valve guides. Again in the interests of maximum flow, valve stem diameter is reduced 0.4mm, from 7mm to 6.6mm-the narrower stem takes up less room in the port and allows better flow.

Heavy-duty valve springs, anodized aluminum retainers and special titanium keepers dimensionally identical to Honda keepers from the original CB750 (which are larger and shaped differently than the stock Suzuki keepers) replace the standard parts. Instead of the stock valve buckets with large, adjustment shims riding between bucket and cam lobe, the Suzuki Superbike uses lightweight Yoshimura racing buckets with small adjustment shims located underneath. Radical camshafts tend to kick out stock shims at very high rpm, usually destroying the cylinder head in the process. That isn't a problem with the shim moved underneath the bucket. What's more, in combination with the other racing parts, the lighter buckets help reduce valve train weight by 40 percent.

Yoshimura's own ductile cast iron billet camshafts are ground, heat treated and coated for compatibility with the racing valve buckets. Measured at 1mm valve lift (including 0.005 in. running clearance), the intake opens 26' BTDC and closes 56' ABDC, while exhaust opens 56' BBDC, and closes 26' ATDC. Intake lift is 10.4mm, exhaust lift 9.7mm.

Stock Suzuki cam sprockets are used, but the rubber dampers are removed and the bolt holes slotted to allow more precise cam timing.

133 horsepower with reliability for endurance races lives inside the 997cc Yoshimura GS1000 engine.

Cam chain problems plagued the Yoshimura Suzuki early in the 1978 season, and it took time to come up with a cure. The race motor is capable of violently changing speeds, both accelerating and decelerating, creating waves in the roller cam chain, which can slightly alter the cam timing and send the valves crashing into the pistons. Modifying the stock automatic cam chain tensioner-which would back out and release tension at speeds above 10,000 rpm didn't help, even though a similar modification made to the Yoshimura 944cc GS750 Superbike had kept the cam chain under control. Unlike the GS750, the GS1000 doesn't have a cam chain idler roller between the cams, so the Yoshimuras welded aluminum plates to the cylinder head, machined them flat and installed a stock GS750 idler roller in the GS1000 head. The change required use of a GS750 cam cover.

That modification seemed to work in Superbike Production sprint races, but the problem still surfaced in long endurance events. At the 1978 AFM Six-hour, the Yoshimura team was in contention for the win when the GS1000 dropped it's valves in the fourth hour, again due to slack in the cam chain.

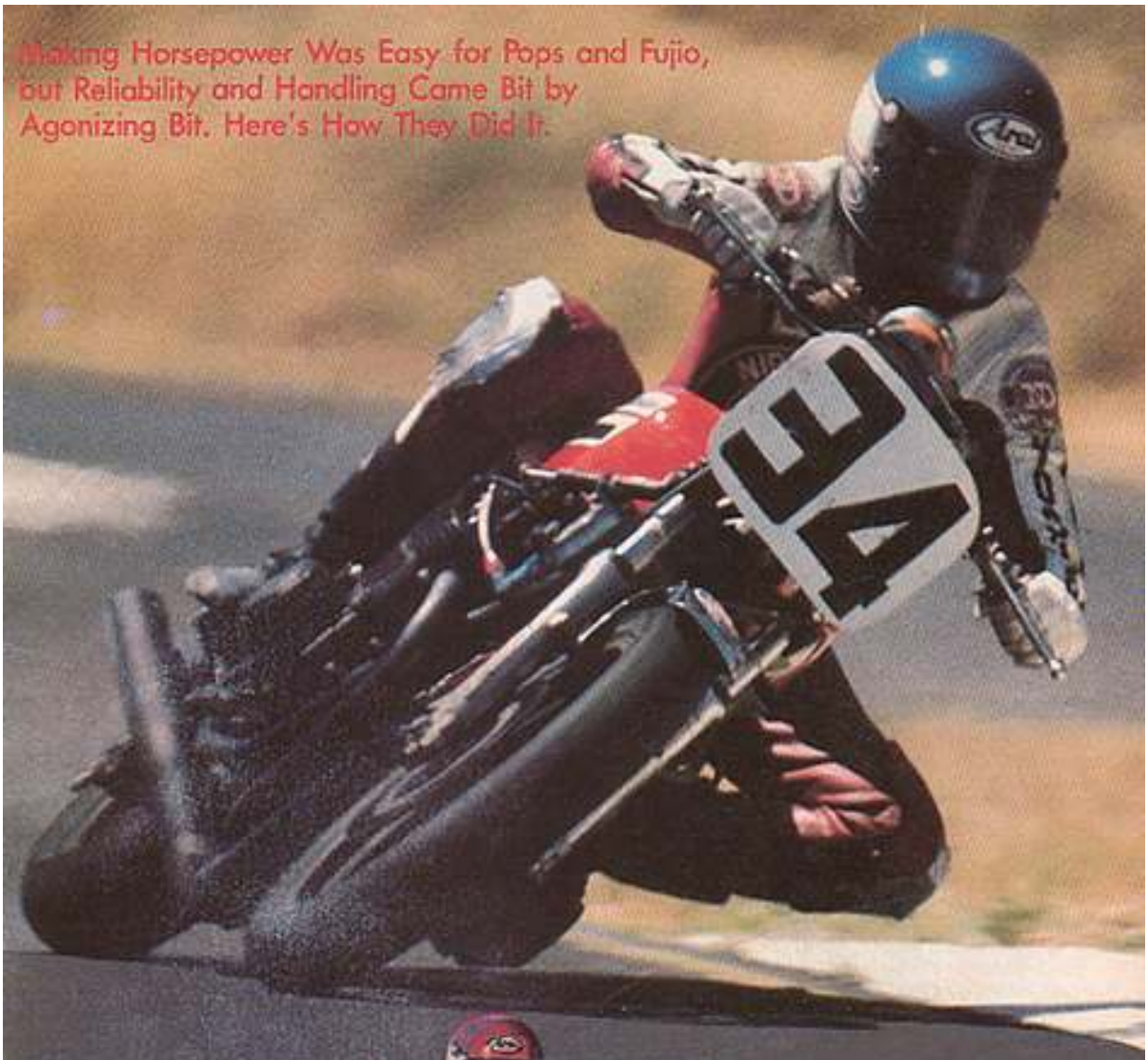
The Yoshimuras found chain side plates wore into the locked-in-place tensioner slippers, reducing tension as the rubber was ground off and the cam chain smoothed. So the mechanics polished the outside of the chain link plates with a buffer wheel and abrasive to remove the burrs normally present after the side plates are stamped out. Careful and thorough cleaning in solvent afterwards removed abrasive still on the chain.

The next step was to modify the long slipper which controls the cam chain's forward descent from exhaust cam to crankshaft. After machining on each side of the face, the slipper only contacted the cam chain on the chain rollers, not the side plates.

But the modifications to the tensionier system that finally gave the Yoshimura Suzuki enough reliability to finish-and win-endurance races came in the form of a Kawasaki KZ1000 idler wheel, fitted into the cylinder head below the intake cam. With that second roller in place and the standard rear slipper tensioner shortened, machined on the edges (like the front slipper) and locked in place, the cam chain was steady and system wear wasn't a problem. To accommodate the extra rollers, the Yoshimura racing cam chain used is one link longer than the stock cam chain, 61 links versus the standard 60.

The Yoshimuras use 11.5:1

Making Horsepower Was Easy for Pops and Fujio, but Reliability and Handling Came Bit by Agonizing Bit. Here's How They Did It.



compression ratio, standard-bore (70mm) pressure cast, two ring pistons with flat tops narrow squish bands and cut-away dipper skirts. According to Fujio Yoshimura, the cast piston expands more evenly than a forged piston and weighs less (The Yoshimura piston weighs 6.0 oz. compared to 7.5 oz. for a stock Suzuki piston and 8.5 for a leading standard bore forged piston). Because the expansion is small and even, Fujio says, it is possible to use very small piston-to-cylinder tolerances (0.0015 in.) and minimize blowby and oil consumption in spite of the two-ring design. The dipper piston-skirt design results in less contact area and less friction generated. The compression ring is hard-chromed cast iron. Each wrist pin is nitrided to prevent seizure with the connecting rod small end, and standard circlips are used.

While manufacturers of forged racing pistons may disagree with the Yoshimura

Action photo by Jon Cook

reasons for preferring cast pistons and many forged pistons are run at the recommended clearances as small as the Yoshimura's 0.0015 in. – no one can argue the fact that the Yoshimura pistons work well and finish races.

The head gasket used in the Yoshimura Superbike is a standard Suzuki part. The Yoshimuras prefer the standard gasket because it is flexible enough to move with expanding cylinders and cylinder heads, while they believe that solid copper racing head gaskets are too inflexible and may lead to gas or oil leaks. The Yoshimura mechanics don't use any sealers on head gaskets.

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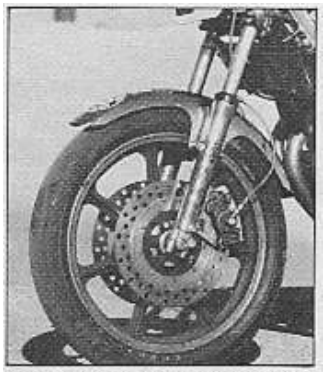
The stock Suzuki crankshaft is pressed together, with five roller main bearings and one ball bearing to take up lateral thrust. Built-up crankshafts are reliable in standard machines, but the pressed-together pieces often slip out of alignment at extraordinary rpm. The most common cure is to weld the crank pieces at the pressed together joints. But according to Fujio Yoshimura, welding the crankshafts can alter the heat treating and make the parts brittle in the area around the weld, as well as theoretically affecting crankshaft balance. Thus one might expect that when the Yoshimuras faced crank slip problems early-on during development of their GS1000, they would solve the problems in a novel way.

They did. The crankshafts used in Yoshimura Suzukis are built up of stock Suzuki parts, but are specially assembled at the Suzuki factory. In that assembly, the male crankshaft parts are dipped in Suzuki Super Lock (Suzuki's brand name for a strong glue which hardens only in the complete absence of air), before being pressed together to a tolerance of less than 0.0012 in. That fix ended Yoshimura crankshaft troubles.

The one exception to the "stock parts" statement above is the number one cylinder crankshaft counterbalancer and alternator taper. The Suzuki cranks used by Yoshimura are made with a .75-in. shorter taper to work with a magneto. That allows the alternator cover to be shortened and beveled, the result being improved left side cornering clearance.

Once the assembled cranks are received from the factory, Pops polishes the counterweights and connecting rods, being careful not to change the balance, then removes all traces of abrasives.

Besides the cam chain and crankshaft difficulties, the Yoshimuras also faced clutch problems of various sorts. The first modification was to install heavy-duty racing clutch springs. According to Fujio, the



Forks are adjustable in four ways for almost infinite combinations. Discs are drilled stockers with Lockheed calipers.

GS1000's clutch hub wouldn't have lasted another lap at Daytona in 1978, the bike's first victory. The extra loads imposed by the racing motor would shear off the rivets holding the clutch basket to the clutch drive gear. Two things were done: The clutch hub securing rivets were increased in size and strength, and six heavy-duty damper springs replaced the stock combination of three heavy and three light damper springs.

There were other problems. Clutch plates slipped, warped, broke. The steel driven plates beat grooves into the aluminum clutch hub teeth, and with the plates imbedded into the clutch hub, the clutch wouldn't disengage. At Sears Point, the clutch lasted on Wes Cooley's Suzuki, but failed on Ron Pierce's GS1000 while he led his heat race. Cooley led the final until the rear sprocket bolts pulled out of the Morris magnesium rear wheel hub, putting Cooley out with just three laps to go.

The Yoshimuras installed a Suzuki five spoke WM-6 magnesium rear wheel originally made for Barry Sheene's Suzuki RG500. The Suzuki wheel has more sprocket mounting bolts-a total of seven spread on a larger diameter mounting circle than the Morris wheel and has a cushdrive as well. With the new wheel mounted, the Tsubaki #630 drive chain wouldn't clear the rear tire (a Goodyear D 1997 3.75- 18 slick), so the left edge of the tire had to be trimmed slightly with a razor blade. For 1979, the Yoshimura Suzuki's rear wheel sprocket carrier was shimmed to allow greater chain/tire clearance.

While the new wheel assembly ended rear hub failures, clutch problems remained with the Yoshimuras to one degree or another until the day before the Suzuka Eight-Hour endurance race in Japan. A week of testing yielded nothing but disappointment and doubt that the bike could finish an endurance event. Finally, Suzuki engineers built a clutch hub out of steel ' instead of aluminum, and produced a few sets of special clutch plates. The trick plates-developed for use in an RG500 dry clutch-are coated with paper-fiber friction material, and engagement tangs are formed by folding-over tabs cut thinner than the plate itself. (Stock tangs are the same thickness as the plate, and are solid). The folded tangs have a little give to work as dampers.

Those two modifications carried the day for the Yoshimura Suzuki, which won the endurance race at Suzuka and returned to the U.S. to win at Laguna Seca without clutch incident either time.

From the clutch, the GS1000's power is directed through a Yoshimura close-ratio transmission with chrome-moly alloy gears. Gear teeth are polish-ground because the hard material is too tough for machine tools. Standard transmissions are machined by gear cutters. Gear dogs are undercut for more positive engagement, and all tolerances are minimal to avoid gear slop or drive-line snatch. Internal ratios are 33/17 (1.941:1) in first; 30/20 (1.500:1) in second; 28/23 (1.217:1) in

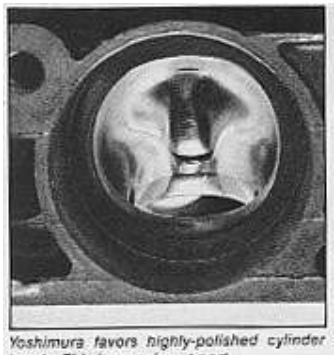
third; 26/25 (1.040:1) in fourth; and 25/26 (0.960:1) in fifth. The retail price of the transmission alone is $850.

Carburetors are 31 mm aluminum-body Keihin CRs. Made for racing, the CR carbs have smooth bores to eliminate turbulence caused by the protruding jets and fittings present in standard carburetors. Such turbulence can reduce the effective diameter of a carburetor throat. Because the CRs are designed for racing use only, the engineers who built them were not concerned with operation at less than half-throttle. While a slow-speed circuit is present in the carburetor bodies, there isn't an idle circuit. Besides the large nominal size and smooth bore. the CRs have good needle and main jet accessibility for fast changes at the racetrack-a mechanic can rejet the carbs without removing them from the motorcycle.

The 4-into- I exhaust system is hand-bent because a pipe made by hand can be built to more precise dimensions with

smoother bends-and thus better exhaust flow-than a machine-bent pipe. The Yoshimuras fit different pipes for different kinds of racetracks. Longer head pipes produce more low-end and mid-range power for shorter and tighter tracks like Sears Point, Laguna Seca and Loudon. Shorter head pipes deliver more top-end power and speed for fast tracks like Daytona and Pocono. The tail section remains unchanged at all tracks. The entire exhaust system is tucked in so well that it has survived crashes without damage, which can mean one less thing to fix if the bike is crashed in a heat race or practice before the main event.

The Kokusan Denki CDI ignition system is powered by a magneto mounted on the left side of the crankshaft. A magnetically- triggered pulsar on the right side of Kokusan Denki coils, which produce



Yoshimura favors highly-polished cylinder heads. This is an exhaust port.

30,000 volts throughout the rpm range and the crank is connected to a black box which will fire across plug gaps of up to which calculates advance and triggers 0.060 in. The pulsar is protected by the stock points cover, which is extensively drilled to admit cooling air - the pulsar must be kept cool to maintain signal accuracy. Ignition timing starts at 14.5' BTDC at 500 rpm, advancing to 20' at 2250 rpm, 29.5' at 3000 rpm, 36' at 5000 rpm, and 37' at 7000 rpm, which is the point of full advance. The bike is fitted with ND 31EPT racing spark plugs for warm-up and racing at all tracks, with gaps set at 0.035-0.040 in.

All told, the modifications made by Yoshimura increase the GS1000's power output to 133.54 bhp at 10,000 rpm and 76.64 ft. lb. of torque at 8000 rpm, rneasured at the countershaft sprocket on the Yoshimura R&D dyno. Output readings on one dyno may not match those achieved on another dyno. What is important is that the engine makes more power than its competition, is plenty fast enough to win races, is capable of lasting long enough to reach victory circle.

As expected, all that power produces a

Four-Into-Ones Over Los Angeles

The Startling Story of Pops Yoshimura

"At that time, I was crazy," said Hideo "Pops" Yoshimura, talking about his days as a Japanese Navy flight engineer during World War II. His assignment was to lead young kamakazi pilots–who knew little more than how to take off and who couldn't navigate–through the predawn darkness to the U.S. fleet at Okinawa.

"The kamakazi pilots followed my taillight," said Pops. "At Okinawa, ships started to shoot at us, and the kamakazi pilots had no trouble finding the ships. We climbed up and watched. I was crazy then. I wanted to hit the big ships."

Pops Yoshimura, 57, is the most successful and well-known independent four-stroke road-racing tuner in the world. His machines dominate American Superbike Production races and his Suzuki GS1000 last year won an important eight-hour endurance race at Suzuka in Japan. There, the Yoshimura Suzuki lapped the RCB Honda of Christian Leon and Jean-Claude Chemerin at the two-hour mark and went on to win by four laps over the second place TZ750 of David Emde and Isoyo Sugimoto. Third was a Yoshimura KZ1000 ridden by Graeme Crosby and Tony Hatton.

But if not for a few quirks of fate over 30 years ago, Hideo Yoshimura's name might now only mark a gravestone. A fluke accident kept Hideo from being sent to Pearl Harbor after his graduation from pilot's ground school at age 17. His parachute failed to open until he was very close to the ground in a training jump, and injuries from the impact ended his chances of getting a pilot's license.

Hideo decided to become a flight engineer instead, a decision which led to the study of aircraft engines. He received his flight engineer's license in 1941. Soon after, Japan was at war and young Hideo ended up flying cargo all over Southeast Asia.

"I flew 4000 hours during the war," said Yoshimura, "and three times I just missed having to die. Twice American P-51s attacked us. We only carried pistols. One more time was bad, bad weather."

In the closing stages of the war Yoshimura escorted kamakazis. Fate again intervened.

"Every day I was flying in a fast bomber," said Yoshimura. "Every day is scary, much shooting, and I started to drink. I cannot drink now, but then I was a heavy drunkard every day. My stomach went bad, I spit blood. Two months before the end of the war, I went into the hospital for an operation. That two months I didn't fly, most of my friends were shot down by American planes."

The war ended and Americans occupied Japan. Yoshimura stayed home in Fukuoka City, Kyushu Island, and learned a little English. "Living was very hard," he said. "No food. I started communicating with GIs, and GIs bring food, some fish or something. I make big trouble."

lot of extra heat, and extraordinary measures are necessary to keep the engine from melting into a pile of slag. The engine cases, cylinders, cylinder head, and cam cover are all treated with Kal-Gard, a grey-black coating originally developed to protect weapons carried by underwater demolition crews from the effects of salt water. Testing showed that the material could be used for other things, including increasing engine heat dissipation.

Blasting the parts with aluminum oxide increases surface area five times, An increase visible only under magnification. The Kal-Gard coating, which is only 0.0003 in. thick after spray application and baking, follows the microscopic contours created in the metal by the aluminum oxide blasting. The coating helps dissipate heat into the surrounding air or airstream, causing a typical engine to run 15 percent cooler. Only external surfaces are coated and treatment of a Japanese Four runs about $95.

Yoshimura's efforts to keep the engine cool involved much more than engine coating. The air passages present between the stock cylinder bores are hogged out for more air flow; 3/8-in. holes are drilled through cylinder and cylinder head fins to eliminate stagnant air pockets between fins and to induce cooling air turbulence; and holes are drilled into the cylinder head around each spark plug to increase the surface area available for heat radiance. An all-aluminum ND oil cooler rubber--mounted on the front frame downtubes is fed by a full-flow Yoshimura fitting which replaces the stock oil pressure sender unit plate and diverts the oil flow. The ND cooler was fitted with 16mm o.d. rubber hose for 1978, but AMA rules require braided stainless steel lines and fittings for 1979. Early last year, the Yoshimura bikes all ran coolers from Earl's Supply with stainless steel lines. After cooler failures at

Yoshimura was nicknamed "Pops" by American soldiers, and he founded a thriving black market business—which ended with a six-month jail term. Describing the intervening years as being empty, in 1955 Pops opened a foreign motorcycle dealership carrying BSA, BMW and Vincent. Most of his customers were GIs.

Soon road races were being held on the access roads around a nearby airbase, and Pops started hopping up machines. British bikes won most of the races until Honda introduced the CB72 and CB77.

"Honda Super Hawks beat the other bikes," said Pops, "and GIs bought Hondas. For eight years, 1957 to 1965, we raced at that airbase."

Honda was already involved in GP races and the rest of Japan knew nothing of the racing on Kyushu Island. When Honda built Suzuka circuit and hosted the first Suzuka 18-hour endurance race, no one paid attention to the Yoshimura team . . . until practice. Yoshimura bikes qualified fastest and ran one-two in the race until the second bike broke. The leading Yoshimura machine won.

"We beat Honda R&D team and Yamaha team," said Pops. "We beat them all."

The result was that Honda hired Pops to build machines for domestic races, in which entries were limited to production-based motorcycles.

More than winning races in Japan, Pops was earning a name overseas. Soldiers returned home from duty in Japan with Yoshimura Hondas and parts. Late in 1970, the Yoshimuras sold through a former GI a Honda 750 racing engine to a prominent Honda dealer who sponsored Gary Fisher. At Daytona in 1971, Fisher led until the cam chain broke.

It was a frustrating year for Fisher and Fujio Yoshimura, Pops' son, who had come over as a mechanic. Cam chain failures plagued the bike. Meanwhile, back in Japan, Pops decided to try a four-into-one exhaust system—like that used on his racing 800cc Honda sports cars—on a motorcycle. When he showed up for the 250-mile Ontario race late in 1971, he brought a collector system with him.

"I was the first in the world to put a 4-into-1 on a motorcycle," explained Pops. "The next year, 4-into-1 pipes were everywhere."

At Daytona in 1972, Fisher led 11 laps, until the oil tank cracked and sprung a leak.

Soon after, the Yoshimuras opened Yoshimura Racing in the United States with some American partners. Within three years the arrangement fell apart due to disagreements over how to spend income—on inventory and assets or on fancy cars and on lavish racing expeditions. The Yoshimuras set out on their own, establishing Yoshimura R&D of America in 1975.

"I lost everything," said Pops of the breakup. "They refused to pay me."

Without the Yoshimuras, Yoshimura Racing went bankrupt. One of the American partners later stood trial for U.S. Customs violations, with Pops and Fujio testifying as witnesses.

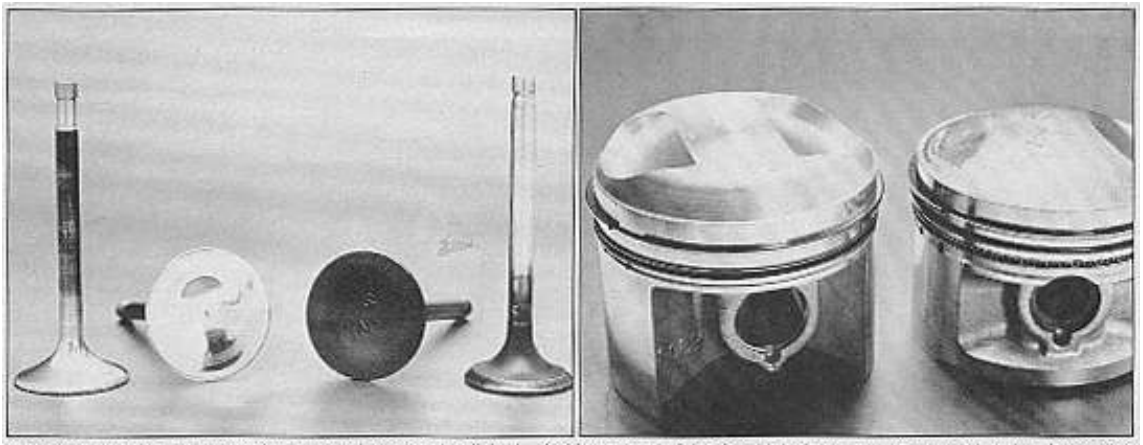
Fujio's visa expired, and it was up to Pops to get Yoshimura R&D on its feet. He often worked around the clock with no rest and little sleep. "We had no money," said Pops. "That first one and half years I take care of everything, build up company. That's too hard. Finally, Fujio came over in November, 1976."

The Yoshimuras struggled along, racing Superbike Production in America with an ungodly-fast, ill-handling Z-1 that kept trying to throw rider Wes Cooley. To make things worse, about six weeks before Daytona, 1977, Pops was seriously burned in a dyno-room fire. While Pops recovered in the hospital, Fujio took over direction of race preparation, which resulted in Cooley setting the highest top speed in pre-race practice at Daytona. Cooley led several laps of the final, but ended up third. The bike wobbled so badly that Cooley's feet flew off the pegs every lap. It was worse at Loudon. Thinking another rider could overcome the problems, Fujio hired Steve McLaughlin to ride at Sears Point. There, McLaughlin retired after the bike's tank-slapping threw his knee into—and broke off—a spark plug cap. The Yoshimuras gave Cooley the Kawasaki again and built a 944cc Suzuki GS750 for McLaughlin to ride at Laguna Seca.

McLaughlin won at Laguna Seca and led at Riverside until the Suzuki's clutch hub sheared, leaving victory to Cooley. McLaughlin, on a new Yoshimura GS1000, battled Cooley for the Daytona 1978 Superbike lead until Cooley's bike's oil cooler broke. McLaughlin won, but was fired from the team in a contractual dispute. John Bettencourt won at Loudon on another Yoshimura 944cc GS750, after early-leader Cooley—this time on the GS1000—was again sidelined by an oil cooler leak. At Sears Point, Cooley led for 13 of 16 laps, until the sprocket bolts pulled out of the rear wheel. Cooley won at Pocono on the GS1000, defeating Mike Baldwin, who rode an Isle of Man Replica Ducati; and again at Laguna Seca, beating Paul Ritter's 905cc Ducati Desmo.

Basking in the glory from his Superbike victories and from beating the factory Honda RCBs at Suzuka, Hideo Yoshimura has come a long way from the days when he wanted to crash into the big ships. ■

—John Ulrich



Valves are oversize with undersize stems, shaped and polished. Yoshimura cast piston has high dome, narrow squish band and two rings.

Daytona (on the Yoshimura Kawasaki) and Loudon (on the GS1000), the change was made to the ND cooler and rubber lines.

The switch to rubber lines was made at the same time as the changeover to the ND cooler because that's what the ND cooler was designed to accept. The Yoshimuras don't know if the more rigid stainless steel lines had anything to do with the earlier failures of Earl's Supply coolers. Cooler mounting position could have influenced the failures, since the coolers were mounted to the lower fork triple clamp on each bike at Daytona and Loudon, and moved back into the more protected frame position after those dnfs. Coolers mounted on triple clamps are vulnerable to damage from small stones kicked up by other bikes. The ND cooler was obtained for the Yoshimuras by the Suzuki factory, and is

RIDING THE YOSHIMURA SUPERBIKE

Watching, reading about or even discussing the Yoshimura R&D of America Suzuki GS1000 Superbike with its creators is one thing.

Riding it is another.

I had already sampled the bike's forerunner late in 1977, when I entered a club race at Ontario Motor Speedway to test the Yoshimura 944cc GS750 used by Steve McLaughlin to win Laguna Seca that year. The power was overwhelming; the stable, neutral handling amazing; the combination devastating. The bike hammered home the influence that machinery has on lap times. After two practice sessions and an Open GP third place behind the TZ750s of Steve McLaughlin and Roberto Pietri, I wheeled the GS750 back into the pits to find Pops, clipboard and stopwatches in hand, grinning ear-to-ear.

"John Ulrich go crazy," said Pops. "You go 2:10 lap time. First, 2:12, then 2:11, finally 2:10.76. You go crazy."

The Superbike Production lap record at the time was 2:08.9, held by class champion Reg Pridmore. My previous best lap had been a high 2:17.

The machine was magic.

I expected more of the same from Yoshimura's 1978 Superbike, a Suzuki GS1000. In the bike's Ontario debut, Cooley lowered the lap record to 2:06.25. In the AFM Six-Hour, the Yoshimura GS1000 blasted away from the 944cc GS750 I rode, leaving the smaller motorcycle behind on the straightaways. I could hardly wait to ride the GS1000.

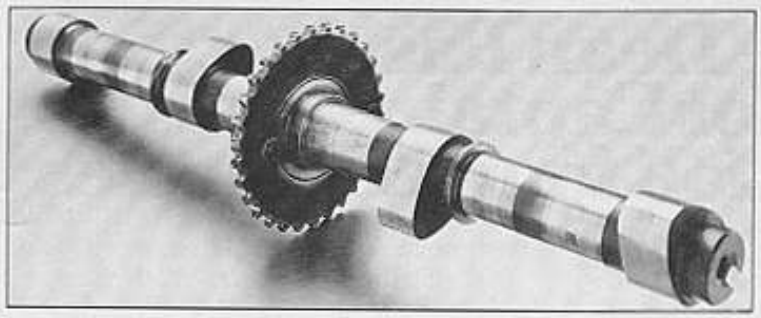
It wasn't until the last club race of the 1978 season, on the Riverside NASCAR course, that I had a chance to do so. I didn't feel quite right, not surprising since I would learn two days later that what I thought was a bad cold was actually pneumonia. With a soaring fever and illness-induced general weakness, it would have been difficult to ride the bike in any case. To make matters worse, it was bitterly cold, the sticks chattered and the bike wobbled like a fiend, oscillating through fast, bumpy turn one and also in turn eight, an almost-flat-out jog left at the end of the back straight. Attempts to tune the suspension and eliminate the wobbling failed during the limited practice.

Despite the problems, there was no doubt about the machine's power. Geared for Daytona, the GS1000 pulled 10,500 rpm at the end of the straight for an actual 167 mph. The track dropped onto a short straight coming off turn six, and there the Yoshimura Suzuki leapt up on its haunches every lap, seemingly ready to carry the front wheel nearly vertical until the next turn. The bike's acceleration was fearsome in the lower gears, but that's what you expect from racebikes. The shattering part was the way the machine gained speed even in the higher gears, making holding on a struggle and slamming the rider's butt back into the stepped seat (which helps the rider hang on more than anybody not familiar with riding Superbikes might realize). Make no mistake, accelerating up to 167 mph in the length of a ¼-mile straightaway is quite a rush.

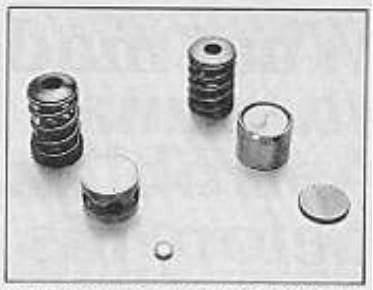
It was significant how much better the motorcycle handled at Willow Springs when I met the Yoshimuras for a private test session after my recovery from pneumonia. For someone with experience racing Japanese box stock, production and Superbike Production class motorcycles with very few rides on GP bikes, riding the Yoshimura Suzuki is like being in heaven—albeit a demanding heaven, since the speeds quickly reached shorten distances and make everything on a given course happen much faster. The bike makes power in massive doses, accelerating hardest between 7000 and the 10,500 rpm redline but making good power from 5000 rpm and up. It isn't peaky at all, and will charge out of a corner—or light up the rear tire even at relatively low (for a racebike) revs. Shifting through the close-ratio five-speed drops rpm less than 1000 with each upshift.

The brakes decelerate the motorcycle more violently than the engine accelerates it. The fully-floating rear brake is sensitive due to weight transfer, but is far more controllable than most rear disc brakes.

At Willow, the bike handled perfectly, stable when tapped out in fifth gear in a straight line and steady in both fast and slow turns. Grabbing too much of the always-available power at turn exits set up a rear-end dance as the wheel broke traction and skipped sideways in a series of little steps. Because of the racing pipe, beveled alternator cover and rear-set footpegs the rider doesn't have to worry much



Intake and exhaust valve timing is 26-56 and 56-26, with 10.4 and 9.7mm lift, respectively. Intake cam is shown.

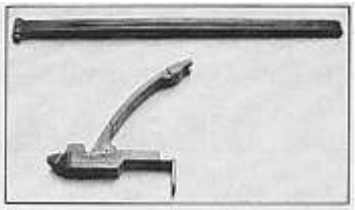


Race bike uses Yoshimura buckets with small shim located underneath, versus large shim on top of stock bucket.

not at this time available in the United States.

Throughout 1978. the Yoshimuras used 30w Castrol R (bean oil). Pops picked 30w, after dyno tests showed that using 40w cost about 1.5 horsepower, while 20W didn't have enough film strength for safe high rpm, high stress operation. For 1979, a new sponsorship agreement was reached with Bel-Ray, and the Yoshimura Superbikes will be running Bel-Ray 30w Racing Motor Oil

Cam chain has one more link then stock. Outside run is polished to reduce wear on tensioner slippers



Rear cam chain tensioner slipper is shortened. Front tensioner slipper is stock length, but is machined to only contact cam chain rollers, not sideplates.

Our man at Willow Springs. ". . . like being in heaven, albeit a demanding heaven."

about grounding out and crashing. But because the tires are so sticky and wide and the suspension so dialed in, it is possible at some tracks to drag the bottom of the alternator cover on the left and even the bottom of the points cover on the right.

Response to rider input is excellent, and it isn't hard to make the bike turn or switch direction of lean in left-right turn sequences. If the rider backs off entering fast, sweeping curves the bike tends to turn in, as opposed to straightening up.

It's difficult to compare the Yoshimura Superbike to a stock Suzuki GS1000 street bike, because there really isn't much comparison. A stocker is relaxing and easy to ride in its natural street environment; riding a Superbike fast on the racetrack is hard work because of the forces involved, even if the Superbike being ridden is the best in its class. It's also unfair to compare Yoshimura's Suzuki to a TZ750. The Yoshimura machine, although in its finished form isn't much like a streeter, does have its origins on the street, a limiting factor. The TZ750 came off the designer's drawing board destined for the racetrack alone.

Instead, the Yoshimura Suzuki—and all Superbike Production machines—exist in a never-never land between stone stock street motorcycles and pure racebikes. In that middle category, the Suzuki is at the top of the heap, a position not easily attainable.

When I rode the Suzuki at Riverside it wobbled fiercely, yet at Willow the handling was faultless. The Yoshimuras believe that suspension is the biggest factor in handling, more important than frame or swing arm bracing or rigidity. Their Superbike's suspension, which works so well when properly adjusted, has myriad possible combinations of air pressure, fork oil level, spring rates, damper rates, etc., etc. It must be tuned to each track and rider. The Yoshimuras hadn't raced the GS1000 at Riverside before I tried it, and so weren't familiar with the required suspension settings for that track, and there wasn't enough time during two shortened practice sessions to sort it all out.

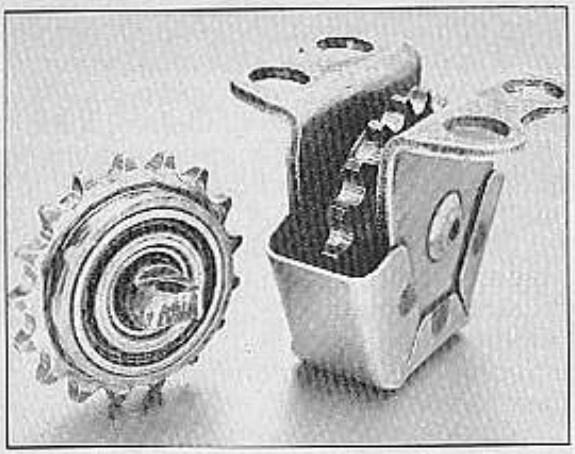
With plenty of experience from testing at Willow, they knew where to start with the suspension and only had to make minor adjustments for rider weight and riding style. As a result, the bike worked.

Buying all the parts and making all the modifications is obviously only part of a successful Superbike. The most important factors are who puts it together and what they know.

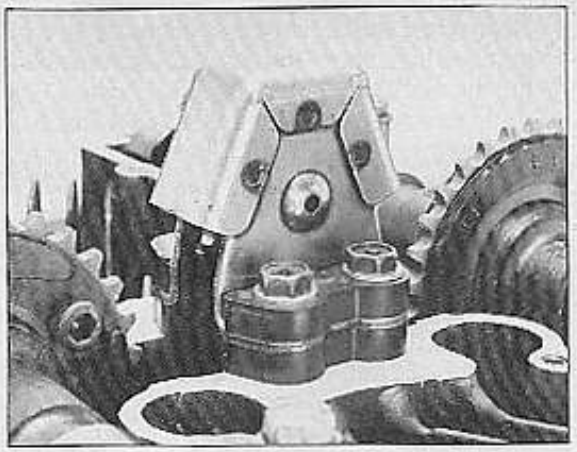
The most important ingredients in the Yoshimura R&D Superbike are named Pops, Fujio and Suehiro.

What they know is what makes it work.

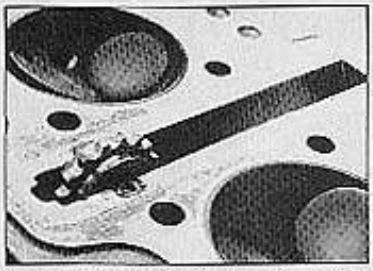
—*John Ulrich*



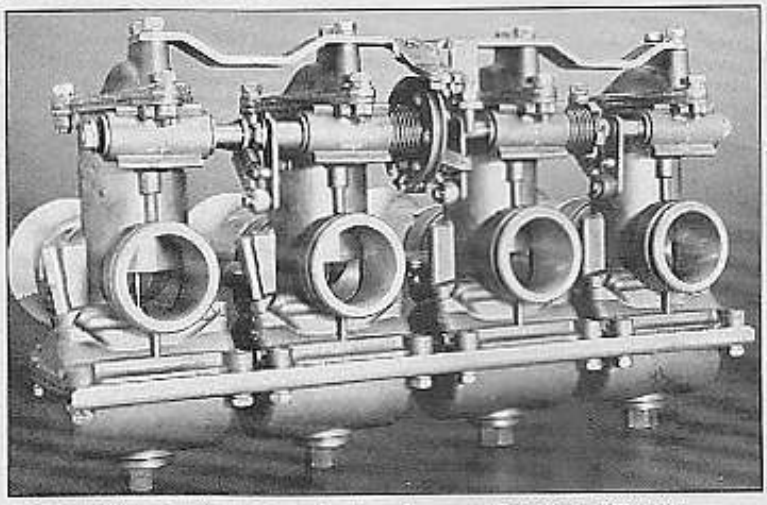
Additional cam chain idler rollers from KZ1000 (left) and GS750 are installed in GS1000 head to control chain whip.



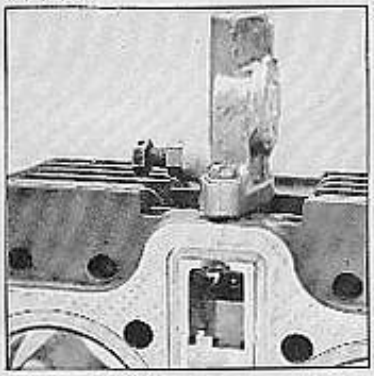
GS750 idler roller is bolted to welded-on, machined plates between camshafts.



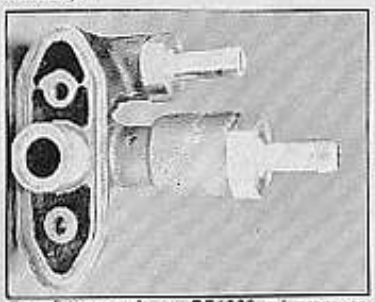
Kawasaki idler roller is precisely located below intake cam. Positioning and alignment are critical.



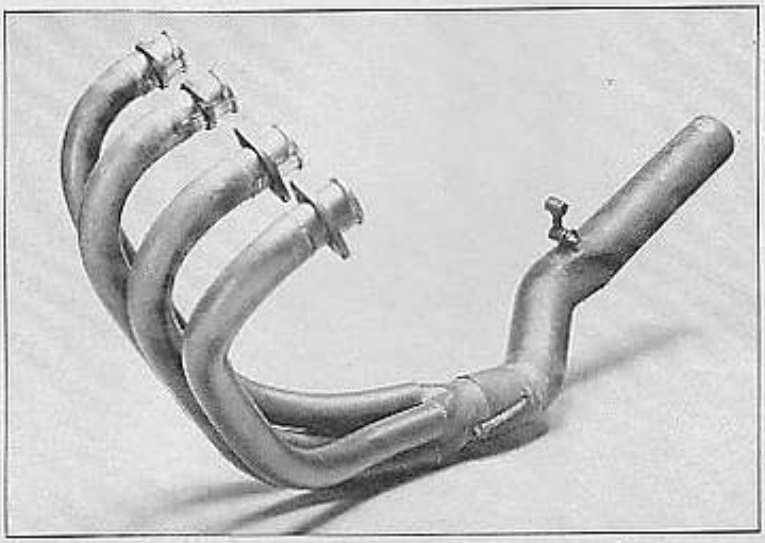
1979 Superbike rules allow racing carburetors. These are 31mm Keihin CR carbs.



Cam chain tensioner is modified to adjust manually.

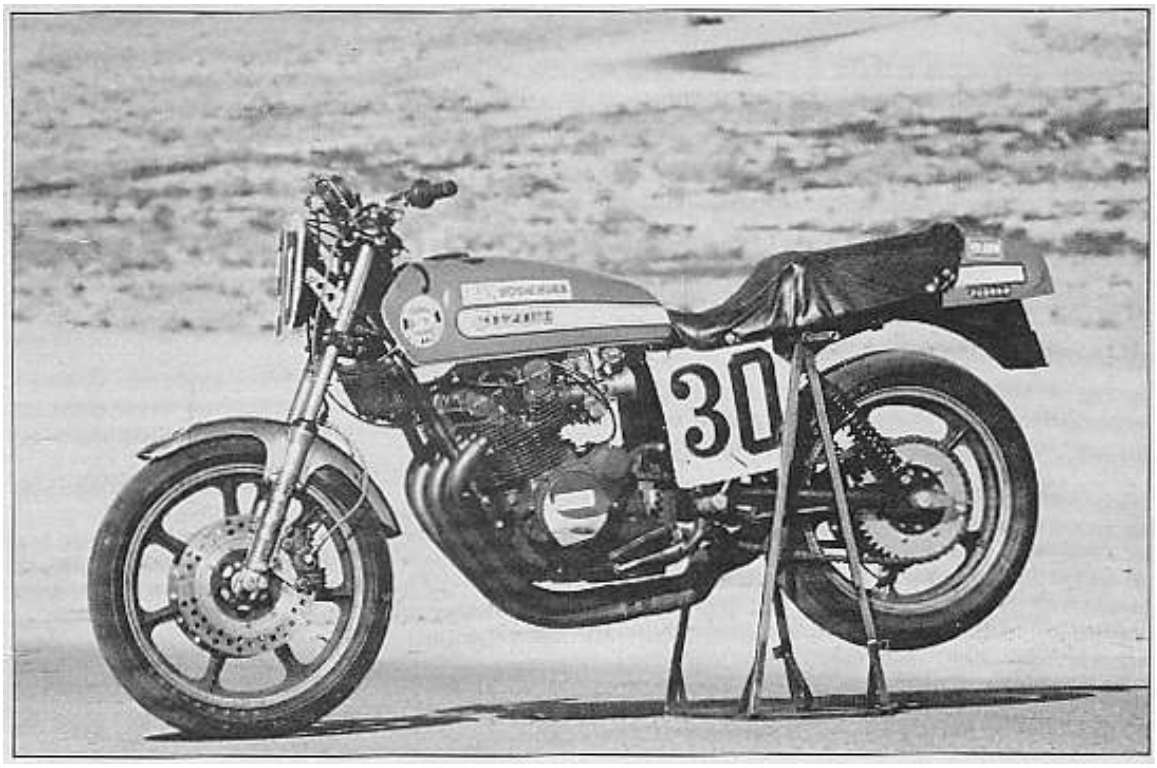


This fitting replaces GS1000 oil pressure sender plate and diverts the oil flow to Nippon Denso oil cooler.



Yoshimura racing pipes are hand-bent, as opposed to machine-bent street pipes.

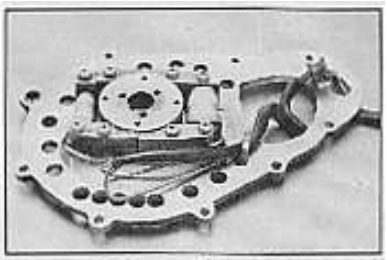
Teardown photos by Brian Blades and Robbie Bell



Having an engine that makes power stays together and doesn't overheat is a big part of a successful Superbike effort. Equally important is a quality sometime more difficult to obtain-handling. The Yoshimuras have obviously sorted out their GS1000, as its performance on short, difficult tracks has shown. The frame itself is not as heavily modified as one might expect. There is no additional front frame section bracing, and the steering head area is left stock. An oil cooler mount is welded to the frame downtubes, but does not affect frame rigidity. Engine mounts and mount bolts are all stock Suzuki parts. A tab for the shift linkage is welded onto the left bottom engine cradle tube, and rearset footpeg mounts are welded onto the swing arm mount gussets just below the swing arm pivot.

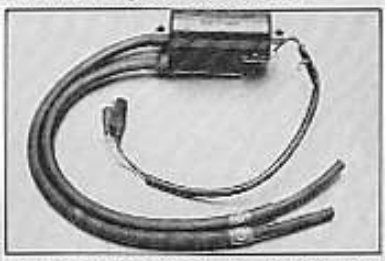
There is, however, significant bracing work done on the rear of the frame and swing arm. Mild carbon steel tubing (22mm o.d.) is brazed into position across the rear frame downtubes at the engine-mount/swing arm-mount gussets, above the swing arm pivot. The tube prevents frame twisting caused by the torque of the drive chain pulling the rear sprocket and left side of the swing arm. Shorter pieces of the same tubing are welded across the bottom of the triangle formed by the rear frame downtubes, rear section top tubes

and shock absorber mount tubes. Upper shock absorber mounts are relocated to provide 54.5' of shock laydown angle, and 11mm o.d. tubes are welded in behind the gusseted new upper shock mounts and the rear section top tube of the frame. The additional tubes and bracing of the rear section are necessary to handle the increased loading caused by the laydown shock position. Alignment of shocks and shock absorber mounts is critical.



Kokusan Denki magneto located on left side of crankshaft powers ignition system. It's mounted on hand-made aluminum plate.

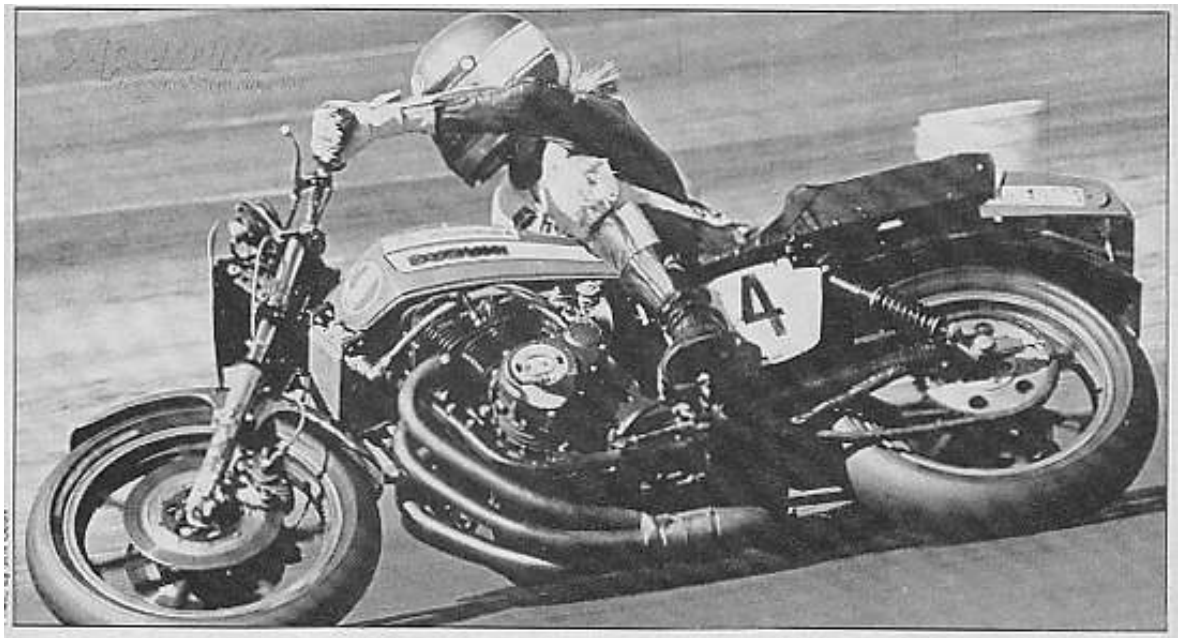
Kokusan Denki CDI magnetic pulser is powered off right end of crankshaft.

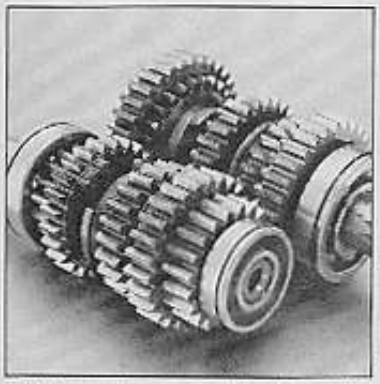


Kokusan Denki coils fire 30,000 volts throughout rpm range

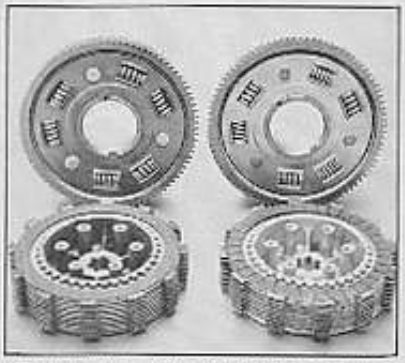
A bridgework of 22mm tubing is built across and along the bottom of the stock Suzuki swing arm to minimize flexing. However, at the Suzuka eight-hour, a braced frame with laydown shocks and a totally stock swing arm was used without handling problems resulting, implying that swing arm bracing is in fact unnecessary, at least at that racetrack. In any case, the fact that the drive chain grinds on the left side swing arm bracing under certain suspension load conditions doesn't seem to affect the handling or stability of the U.S. Superbike.

For the 1979 season, the Yoshimura Suzukis will have additional front engine mount gusseting. That's because the frame used at Suzuka cracked less than one hour





Yoshimura racing transmission has undercut engagement dogs, polish-ground teeth. It retails for $350.



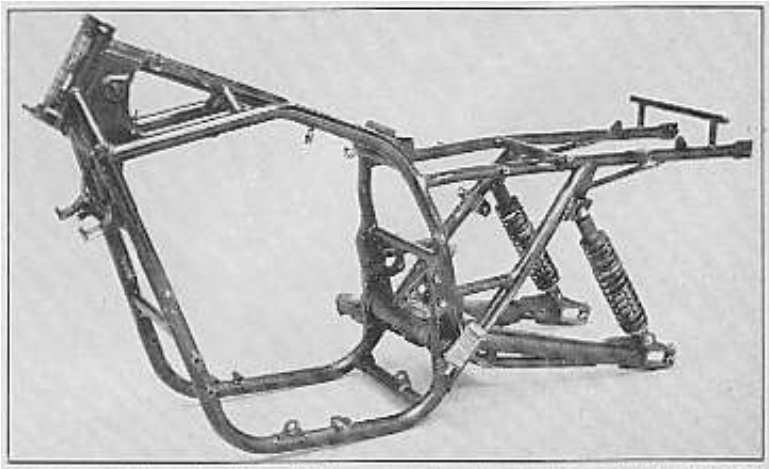
Racing clutch (left) has steel inner hub, larger rivets, heavy-duty damper springs and different plates.

Suzuki factory racing clutch plates (left) feature paper fiber friction material and folded-over engagement tangs, which help absorb shock loads.

before the end of the endurance race, causing the bike to wobble. The Yoshimuras theorize that the break was caused because the straight right engine mount transmits engine vibration directly to the frame downtube, and the strain of eight racing hours was too much for the mild steel to take. The left engine mount, on the other hand, has a bend in it, which would tend to absorb, rather than transmit, vibration.

The shock absorbers are gas-charged, 13 in. long, made by Kayaba and feature six damping adjustment positions, five-preload positions and a choice of six springs, with two springs used together. One shorter and lighter spring handles small and initial jolts, while a longer and stronger spring comes into play in the case of secondary reaction and large bumps. There are 270 possible shock damping, preload, and spring combinations.

The Kayaba air forks are even more



Suzuki GS1000 frame is reinforced between rear downtubes, between rear downtubes and shock-mount tubes, between shock-mount tubes and rear top tubes, and underneath swing arm. Shock angle is 54.5°.

complex in the possible adjustments and number of potential combinations. The triple clamps are stock Suzuki parts. The aftermarket forks started out with standard length tubes, but the Yoshimuras lengthened the tubes 35mm by welding on pieces cut from a spare fork tube. The extra tube length increases rake by half a degree, from 26.5' to 27', and changes trail from 4.57 in. (for the stock GS1000E) to 5.90 in., though the steering head is not modified. The geometry changes contribute to top speed stability while the extra fork tube length increases the height of the engine side covers relative to the ground, thus improving cornering clearance as well. Spacers inside the fork tubes compensate for the lengthened tube and determine spring preload.

Stock air caps are connected to a single Goki air balance fitting mounted on the upper triple clamp behind the steering head. Fork air pressure is normally set somewhere between 14 and 20 psi.

Fork oil viscosity and level are both variable. The Yoshimuras measure the quantity of oil in each fork with a calibrated dip stick, removing the caps and springs and collapsing the forks before each reading. Level is varied by removing oil with a suction gun or by adding oil from a burette.

Maximum fork travel is 5.7 in. (145mm), but the Yoshimuras try to set the forks up to deliver 5-5.3 in. (130-135mm) travel at each track.

Various fork adjustments can be made necessary by rider weight, track surface. ambient temperature, available traction (which affects possible braking force) and even riding style. Setting up the front suspension is in itself an exacting and time-consuming job, and must be done in concert with rear suspension adjustments, it's not surprising that the Yoshimuras usually need an entire practice day to tune the suspension on a track they haven't raced on before.

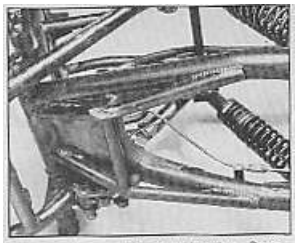
The mechanics begin by setting fork ride height, (with the motorcycle stationary and off the stand with the rider aboard), at 1.6 in. (40mm) less than full extended length. Air pressure largely determines ride height. The Yoshimuras find that another 2.8-3.9 in. (70-100mm) of travel should be used on turns, bumps, and under braking, but getting the desired amount of dynamic travel isn't as simple as setting static air pressure or spring preload.

For example, air pressure not only sets ride height, but also determines resistance to fork bottoming under braking. As the: fork compresses, air pressure increases progressively and offers more resistance to further compression. Too much static air pressure will reduce travel and induce front wheel chatter in the corners.

Air quantity also comes into effect, since a larger volume at a given beginning psi will offer a different compression resistance curve, relative to travel, than a smaller volume at the same beginning psi. Fork oil level determines air volume in the forks. Oil quantity in each fork leg, then, sets the amount of fork travel under braking. If the rider complains of too much fork dive under braking, adding oil will reduce air volume and induce greater pressure increases-and resistance to dive and bottoming-per unit of fork travel distance.

Initial loads are taken by the springs, and so spacer length (and thus, spring preload) determines reaction , to the point where air compression resistance takes over the major part of reaction control.

Fork damping action is affected by fork oil weight, which varies from 5w to 30W (in increments of five), depending upon the track and conditions. The Yoshimuras use Bel Ray Racing Fork Oil.



Closeup shows swing arm bracing. Drive chain machined notch in left side of bracing

It's easy to see that the possible combinations presented by the four major fork adjustments-spring preload, air pressure, oil level, oil weight-are almost infinite even in practical use. Another possible alteration would be spring rating, but that isn't one currently used by the Yoshimuras.

Steering lock is limited by 6mm Allen head screws with locking nuts fitted into the stock lower triple clamp and a KYB steering damper with six damping adjustment positions helps stabilize and control the steering in the event of marginal control situations (as when the rider gets on the gas too hard exiting a turn and the rear end steps out violently.)

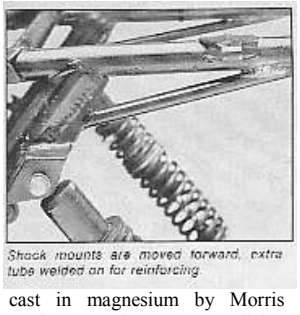
The handlebars are from Graham Sheet Metal (GSM), the grips from American Pro, the quick quarter turn throttle from Magura and the easy-to-use-in-mid-race clutch adjuster mechanism and the tachometer (with 10,500 rpm redline) from an RG500.

The front brake master cylinder and calipers are Lockheed. Braided stainless steel lines from Earl's Supply are 1/4-in. outside diameter. Front brake discs are Suzuki, drilled for lightness and to reduce warpage. The Yoshimuras used plasma-sprayed aluminum discs early in the season, but found that the discs warped seriously-which reduced braking power - during races. Undrilled stock discs also warped, but the drilled discs haven't caused any problems. The discs are not thinned.

Non-floating rear brakes restrict rear suspension movement when applied, often causing wheel hop and resultant instability at comer entrances. That makes it difficult or impossible to use the rear brake hard all the way into a turn apex or to throw the motorcycle into a corner. So the Yoshimura GS1000 has a floating rear brake-the caliper mounting plate is anchored to the frame, not the swing arm, and the mount is free to pivot (on needle roller bearings) on the axle. The floating brake doesn't eliminate the problem completely, but does improve it about 90 percent. The rear master cylinder and disc are standard Suzuki. Yoshimura mechanics fabricated the mounting plate and installed an American bearing.

After Cooley took the checkered flag last year at Laguna Seca, Yoshimura mechanics went to push the bike into victory circle and found that the front brakes had locked. It took three men to move the machine into place. Later examination revealed no mechanical malfunction, and Fujio Yoshimura blamed the problem on the use of brake fluid which had absorbed excessive amounts of water during rainy races at Ontario (the AFM six-hour) and Pocono (the AMA Superbike Production event which Cooley also won). The fluid hadn't been changed since Daytona. After Laguna Seca, the Yoshimuras switched to BelRay DOT 5 silicone-base brake fluid and report no problems with water absorption in practice sessions since then.

The WM-4 19-in. front wheel is



Shock mounts are moved forward, extra tube welded on for reinforcing

cast in magnesium by Morris and carries a Goodyear 3.25-19 slick.

The gas tank is stock, and the seat at least started life as a Suzuki part. The steel pan and vinyl cover are retained, but the padding is removed and sheet aluminum used to shape a bucket to help the rider hang on during acceleration and at top speed. Minimal padding is used at the front of the seat, which lowers the rider about four inches. Superbike rules for 1979 require (as of this writing) stock seat profiles, which should provide quite a few spectator (and pilot) thrills on the faster tracks.

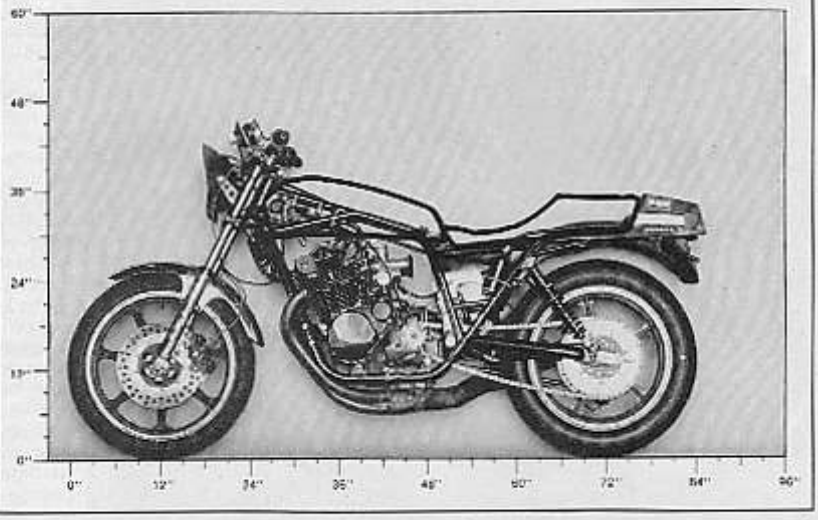
Yoshimura Suzuki GS1000

SPECIFICATIONS

List price	$10,000
Engine	dohc Four
Bore x stroke	70 x 64.8mm
Piston displacement	997cc
Compression ratio	11.5:1
Carburetion	(4) 31mm Keihin CR
Air filter	none
Ignition	Kokusan Denki CDI
Claimed power	133.54 @ 10,000 rpm
Claimed torque	76.64 ft./lb. @ 8000 rpm
Lubrication system	wet sump
Oil capacity	3.8 pt.
Fuel capacity	5 gal.
Recommended fuel	premium
Starting system	push
Alternator	none
Headlight	none
Clutch	10-plate, wet
Primary drive	helical-cut gear
Final drive	#630 roller chain
Gear ratios, overall:1	
5th	4.78
4th	5.17
3rd	6.05
2nd	7.46
1st	9.65
Suspension, front	Kayaba air/spring forks
travel	5.7 in.
Suspension, rear	Kayaba adjustable damping shocks
travel	4.72 in.
Tire, front	3.25 Goodyear slick
rear	3.75-18 Goodyear slick
Brake, front	dual 11.5 in. disc
Brake, rear	11 in. disc, floating
Total brake swept area	278 sq. in.
Brake loading (160-lb. rider)	2.14 lb./sq. in.
Wheelbase	60.25 in.
Fork rake angle	27°
Trail	5.9 in.
Handlebar width	26.25 in.
Seat height	30.25 in.
Seat width	12 in.
Footpeg height	15 in.
Ground clearance	6 in.
Test weight (w/half-tank fuel)	436 lb.
Weight bias, front/rear, percent	48/52
Gross vehicle weight rating	na
Load capacity	na

PERFORMANCE

Engine speed @ 60 mph	3759 rpm
Power/weight ratio (160-lb. rider)	4.46 lb./bhp
Fuel consumption	5.56 mpg
Speedometer error: 30 mph indicated	na
60 mph indicated	na
Braking distance from 30 mph	31 ft.
from 60 mph	124 ft.
Standing start ¼-mile	10.66 sec. @ 132.74 mph
Speed after ½ mile	147 mph
Maximum speed in gears	
1st	82.97 mph
2nd	107.37 mph
3rd	132.33 mph
4th	154.86 mph
5th	167.59 mph



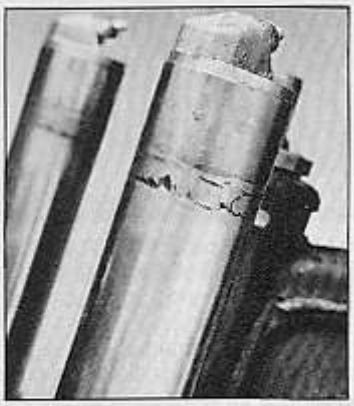
Pressure in air forks is balanced by Goki fitting. Air caps are stock.

Fork lock is limited by round-head Allen screws and self-locking nuts installed in lower triple clamp.

The crankcase breather tank is actually a discarded brake fluid can with tubes running from the cam cover breather to the tank, and then to the atmosphere behind the seat. A tiny six-volt minibike battery mounted on a drilled sheet metal cage on the forward part of the rear fender powers the AMA-required functioning taillight. A toggle switch on the left side plate turns the power source on and off. Number plates are sheet aluminum.

Ready-to-race with a full tank of gas, the Yoshimura Superbike weighs 450.5 lb. Add a 140-lb. rider and the bike has a power to weight ratio of just 4.42 lb./bhp. Compare that to a stock GS1000's 8.14 lb./bhp; a stock Honda CBX's 6.99 lb./bhp; and a KZ1300's 6.93 lb./bhp.

That's why Superbikes are what they are and do what they do, and that's why the Yoshimura GS1000 Suzuki wins races. ☒



Kayaba fork tubes are extended 35mm by welding on new tubing. Front end extension adds 0.5° rake.