

The Future of DIRT BIKE

Roosting with Both Wheels

STORY BY JIMMY LEWIS • PHOTOS BY SCOTT HOFFMAN

Not voicemail! Beep. "Steve, Jimmy here. I've got good news and bad news. The good news is I broke your bike and it really showed me how well the two-wheel-drive works. The bad news is I don't know what broke or how to fix it, and I know we don't have any parts out here in the sticks. I'll just leave it and wait for you to call back soon."

Ten minutes later, gears, spindles, chains, nuts, bolts and a lot of greasy things were all over the garage floor. Our Christini all-wheel-drive Honda CRF450R was a shell of its former self with a couple of snapped shafts, and the possibility of fixing it was looking pretty slim. Inventor Steve Christini had left his baby with *Dirt Rider* when he returned home after showing it off to a large number of the OEMs' R&D departments in California. So, of course, we took it out and gave it a thrashing. During a photo shoot we were hooking a spinning rear wheel on a log then having the front wheel slam down to throw a roost. It turned out the load was too much for the bike and its prototyped parts. A snap and a clank later, the front end became very dead-feeling, and suddenly the bike refused to lunge forward as it had earlier in our ride.



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2WD



Not as drastic as you think, but always working for you, 2WD will take some getting used to in order for you to take full advantage of it.

About a half hour later the phone rang, and it was Christini. I explained in detail what was broken and asked if there was any way of repairing it.

"You took it apart?" he inquired.

Thankfully, I have hands-on friends in the neighborhood with car-restoration and machine shops in their garages, and in five hours they welded and machined enough pieces to give us another shot at photos and additional riding time on the bike.

Two-wheel-drive bikes are nothing new. Rokon has made 2WD bikes since 1965, albeit without suspension. Strange and wild creations have popped up since then, but they were very complex, especially in suspension design, with no possibility of seeing production in quantity. In about 1998, Yamaha, in conjunction with Ohlins, started testing prototype hydraulic-drive systems on YZ250s and TT660s. Lately, the Ohlins system and Yamaha grabbed some attention with a WR450F effort in last year's Paris to Dakar Rally. Now a production-version

felt. This led to further development to counteract this effect for motorcycle applications. By transferring the power equally to both sides of the steering center and counter-rotating the direction of the spinning shafts, the torque-steer is minimized, or for you engineers out there, theoretically eliminated. The system, compared with previous mechanical front-wheel-drive efforts, is simple and lightweight, plus it's claimed to be more efficient and generate less heat than a hydraulic system. Another positive aspect of the mechanical drive is the ability to make simple gearing changes, a tuning tool that may well become as important as gearing the rear wheel.

How does it power the front wheel? Basically, a second countershaft sprocket drives a chain to a gearbox with a spiral miter (matched diameter) gear and through an adjustable clutch that limits power transfer to approximately 60 percent. From there a shaft directs power into the steering tube. Inside are two counter-rotating miter gears sending power through a central sleeved shaft down to the lower triple clamp. Two sprockets inside the triple clamp (also counter-rotating) engage small chains and transfer power out to the telescoping drive shafts. Specially designed and machined axle brackets attach to the bottom of each fork leg. Inside each is a spiral-bevel gear arrangement to transfer power through a slotted adapter and drive the front hub via a one-way sprag clutch. The system allows the wheel to spin free if it is going faster than the drive, but once it tries to slow down, the drive kicks in and delivers power to the wheel. Most of the time the front is only free-wheeling. But to steal a phrase from Christini's book, "When the rear wheel slips, the front wheel grips."

2WD is going to change off-road motorcycles in the very near future.

2WD WR450F is available in some foreign markets (see story on page 67). That system is very similar to ones seen on KTM test mules. The Christini model differs significantly because it is a mechanical-drive mechanism using a number of chains and gears to transfer power from the countershaft sprocket to the front wheel.

The key to this design lies in the ability to get the power through the steering without having adverse effects. Christini began with mountain bikes. He developed and patented a method of transferring the power through the steering stem. With 1 "human-power," torque-steer wasn't much of an issue, but it could be

The system is complicated to some degree and scary to some engineers, but that's enough tech. How does it work? Plain and simple, 2WD is going to change off-road motorcycles in the very near future. On this CRF450R, the feel is subtle but at the same time astonishing. This bike was, for testing purposes, what I'd call a working concept bike. It wasn't near a prototype level, as there is plenty of ongoing testing, and every ride reveals areas in which some improvements could be made. I've never been a fan of the CRF450R as a trailbike, but this revision is far from a standard Honda, and an awesome trail machine. The first thing you notice is that you notice very little. It rides and

feels just like any other bike you've ridden. Then you start to test it. Pushing the front end, sticking it in sand, riding up to a log and not lifting the front wheel ... all of a sudden, this bike is very different from anything you have ever ridden. That front-wheel-drive begins to kick in and make the tire stick, crawl, bite or climb out of whatever situation into which you put it.

The biggest benefit is in turning. In a typical low-speed turn, you don't notice anything. Push the limit of traction on any surface, and the farther you push or spin the rear, the more responsive the steering gets. Instead of just continuing to push, it really tries to pull the bike in the direction in which you are pointing the front wheel. And the more you get used to it, the more you can trust and control your turns. In really low-speed turns—at or near full lock—the bike actually cuts in more tightly than you'd ever expect it to, especially in loose conditions. Power slides

take on a whole new dimension. Think World Rally here, just to a lesser extent, and you'll get the picture. While turning you can get a sensation of torque-steer, but you have to wag the handlebar back and forth to feel it. In the real world you wouldn't try to do that. But even so, it is a very minimal drag, and no different from a steering damper set a little too tightly.

So what about climbing hills? First, don't forget that once you start climbing, the front wheel becomes lighter as the incline gets steeper. So if you are moving at a good clip, unless the traction is very low, 2WD doesn't make a huge difference. But if the hill slows the bike down, the 2WD effect becomes more dramatic. And if you stop on a steep hill then attempt to get going again, the front drive really kicks in. Typically, a bike wants to bury the rear, but the 2WD has an initial

lunge that is generally good enough to get you moving. One small side effect, or something that you'd have to get used to, is that when you are wheeling and the rear wheel loses traction on a climb, if the front wheel comes down pointed in any direction other than straight ahead, it will pull in that direction.

Mud is another environment in which the 2WD shines. Instead of having to push the bike and the front wheel through the muck, we found the Christini machine floats much better than what we're accustomed to. It's as dramatic as, if not more so than, the difference between a two-stroke and a four-stroke in deep mud. Sand yields the same results. In slick or loose conditions, you can put more trust in the front wheel, but you don't really

Interview

We got background on why 2WD. Steve Christini's education, bicycles and where they are going and his plans for motorcycles.



Interview by Steve Christini

DR: What is your background?

SC: I have a mechanical engineering degree and a minor in business. I worked as a project engineer/manager at Air Products before I started Christini.

What made you think of 2WD?

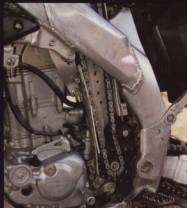
I was riding on a trail in the summer of 1994 near Villanova, Pennsylvania (near the university), after a rainstorm and was unable to climb a hill that I normally could crest without a problem. The mud was slippery, and I basically got pissed I couldn't make it up. Then I thought about having the front wheel pull and began the design process from there.

How did it progress to motorcycles?

Once I realized it worked as well as it did on the mountain bike, I thought a little horsepower would make it even better. The only barrier with the bike is it still uses human legs. But a motorcycle has the obvious advantage of HP. So it was a natural progression. We actually made a split in the company in 2000 and created Christini MotoCross, Inc., which is a wholly owned subsidiary of Christini Technologies, Inc. (www.christini.com).

Where do you see the technology going?

I think it will become a staple for off-road recreational riding and eventually (within 10 years) become an important safety option on many road bikes. I also see a whole new category of trail riding/two-wheel bikes showing up for summer/winter fun riding [like four-wheel-drive ATVs]. Traditionally, wider balloon tires have had crummy traction, but add the second wheel and you could have an incredibly fun, agile, Rokon-type bike. Just another category to play with.



The first step is getting the power off the second smaller countershaft sprocket and up to the first gearbox. The chain is tensioned and adjustable.



Not to be goony but to show off the product, Christini runs no front number plate to let you see the oversize head tube/gearbox. It and the lower triple clamp are the key components to the patent.



Trick fork lowers house a gear set and transfer power to a Talon hub with a one-way clutch. The wheel is only slightly harder to remove from the bike.



The left-side frame rail is pushed out a bit to make room for the chain. The bike scaled in at nearly 30 pounds more than a CRF450R, but more than one experienced test rider guessed it was only 15 pounds heavier—a testament to the way 2WD makes a bike feel more active and lighter.



Spinning the front requires a lot of spinning on the part of the rear, which we did for photos. The bike really likes to hook up and go.

TEST CHRISTINI ALL-WHEEL-DRIVE CRF450R

have to modify any riding techniques. Then you let it steer instead of pushing. If you stop in sand, the bike makes an initial lunge to resume acceleration and gets on top of the sand more quickly and at lower speeds.

You can choose to ride over a log by lofting the front wheel, or you can just ride into it and the front wheel will pull itself up. So if you mistime the log, you're much more likely to have the front wheel attempt to climb up than to see it slip down. Ditto for rock ledges. Ruts are also much easier to escape from. In fact, when the bike gets cross-rutted, it's much easier to get both wheels back in line because the steering is so much more active.

What else does it do? Well, it doesn't roll backward. Unloading it out of a truck is tricky! And at this time there isn't an easy way to shut off the front drive, a feature the Christini 2WD bicycle has that might make rolling backward possible.

Then there is the weight. The added drive system isn't as noticeable as the scale says it should be, even with the weight as high as it is. Christini claims his system has about

5 pounds more unsprung weight than a stock CRF450R but less unsprung weight than a hydraulic drive. It's possible that number could be reduced if the parts were produced in quantity for this specific application. The Christini CRF's stability is impressive when compared with that of a standard CRF, yet turning didn't appear to be compromised. The reduction in stability and turning was readily apparent when we broke the front-wheel-drive system.

Braking is another area that benefits. Since the rear drives the front, in most cases it prevents the front from locking up, which leads us to one of the most-interesting findings of Christini's group. They claim novice riders become much better riders on a 2WD bike, since it gets them out of unexpected situations. I think an advanced rider would learn how to exploit the advantages and be able to ride faster. I'm sure there will be a lot of skeptics out there, as there always are with new technology (two-strokes, disc brakes, single shocks, liquid-cooling, four-strokes, electric starters), but 2WD should be the next big thing!

In the end, we slapped the bike back together and got the photos before we broke it again. Most likely one of the parts we welded or screwed (there wasn't much metal to connect some pieces back together) failed. But I spent a good day riding the 2WD and testing what it could do. I'm sold. Right after I rode it for the first time, the bike had a full week of evaluation by different R&D departments where it didn't miss a beat, so Christini wasn't surprised we finally broke it.

The evolution of dirt bikes has been steady but with a drops-in-the-bucket pace before the recent four-stroke boom. Yet here is a technology that stands to change high-end dirt bikes forever.

For now, the Christini bike is off for another round of evaluation by everyone from military contractors to motorcycle manufacturers. And Christini likes us so much for showing him what breaks, he said he'd bring it back for more abuse. We'll take him up on that. Then we'll be ready when 2WD comes on production dirt bikes here in the States. Someone will bite on the concept. **DR**