YAMAHA
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4th Challenge Exhibition

WGP500 最高峰への挑戦

YZR500 30年の進化

"Challenge to the Top" — The 30-year Evolution of the YZR500

Dates: June 24 (Tue.) ~ Nov. 28 (Fri.), 2003
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J. Saarinen on the first YZR500 (OW20) winning its debut race in the France GP (Paul Ricard Circuit), round one of the 1973 GP series

In 2002, the pinnacle of international motorcycle racing, the Road Race World Championships (WGP), underwent the biggest change in its more than 50-year history. This was the year that the regulation for the top class was changed from the 500cc format, which works machines from around the world had been competing in since the class's launch in 1949, to the MotoGP class competed by 990cc 4-stroke machines. This marked the start of a new era.

During the period from 1961, when Yamaha first took up the WGP challenge, until 1968, when it suspended works participation temporarily because it had accomplished its initial aims, Yamaha won the manufacturers championship of the WGP five times. Then, after five years of supplying production road racers to privateers around the world, Yamaha once again resumed works activities in 1973. This time Yamaha took on the new challenge of the top category, the 500cc class. To this challenge, Yamaha brought a 2-stroke machine to face the 4-stroke machines of makers like MV Agusta that dominated the 500cc class at the time.

In the 30 ensuing years, the Yamaha works machine "YZR500" became the platform for a succession of new technologies born of Yamaha research and development that would become the standard technologies of today's motorcycles. In the process, famous riders like Giacomo Agostini, Kenny Roberts, Eddie Lawson and Wayne Rainey would be among the 20 riders who piloted the YZR500 to a grand total of 115 victories, while claiming 10 rider championship titles and nine manufacturer titles.

For this year's "4th Challenge Exhibition" we turn the spotlight on the challenge of WGP racing that Yamaha has continued since the 1960s, in particular the 30-year history of the YZR500 factory racer that competed in the WGP's top class and the pursuit of the new technologies to push back the limits of 2-stroke machine potential that it represents. This history is a manifestation of the "spirit of challenge" that lies at the heart of Yamaha Motor's corporate culture and a record of the race activities that have always been the testing ground for that spirit.

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The OW20 upsets the "common sense" of GP racing with its overall performance

April 22, 1973

At the opening round of the World GP series at the Paul Ricard circuit in France, a Yamaha factory team had returned to the paddock for the first time in five years. Behind the scenes, Yamaha had been developing its first 500cc factory racer, the YZR500 (code name OW20) to make its GP comeback with.

The riders for this new challenge were J. Saarinen of Finland and Japan's ace H. Kanaya, and this race would mark the first step in a glorious history of YZR500 development that would continue for the next 30 years.

At the time, a variety some 20 different makes of machines could be seen on the starting grid of the 500cc class, including Harley-Davidson, Husquvarna, Konig, Ducati, Bultaco, Norton, BMW and Triumph. But in fact the competition was almost completely dominated by the 4-stroke machines of MV Agusta, which had won the manufacturers title every year except one in the 15 years between 1958 and 1972. It was the common sense of the day that no one could win the 500cc class with a 2-stroke machine.

But, that day Saarinen would ride the Yamaha YZR500 to victory in its debut race, beating the 2nd-place MV Agusta 4-stroke machine by a full 16-second margin. What's more, Kanaya would follow in 3rd place, prompting the European press to hail the start of a new era of 2-stroke potential.

In the 2nd round of the series at the rainy Salzburg circuit in Austria, Saarinen and Kanaya would finish one-two, and in doing so prove that Yamaha's 1st round win had not been a fluke. By ending the domination of the 4-stroke machines, The YZR quickly became the main attraction of the "Continental Circus," as the GP was known. "At the time, we were told that the 3-cylinder 4-stroke engines of the rival makers put out about 102 hp, while our OW20 put out just around 95 hp. So, the reason we were able to win right from our debut race was surely because we didn't depend on maximum power output for our competitiveness but rather built a machine with outstanding overall balance." In other words, even at that time Yamaha had a development philosophy of pursuing overall performance, which includes handling," recalls Mr. Masakazu Shiobara, who worker on the development team at the time.

In 1979, Yamaha riders K. Roberts, J. Ceccoto and C. Sarron took on the challenge of the Suzuki machines ridden by F. Uncini and others. On the OW45 with its matured YPVS device, "King" Kenney Roberts would win his second straight season title this year

2-stroke potential expands with the OW35K

After its sensational debut in 1973, the YZR continued to win victory cup after cup in the hands of riders like Italian hero G. Agostini. But Yamaha was not alone. Suzuki had also developed a potent 2-stroke machine in its RG500 and was threatening to become the new class leader. By this time the old adage that "no one could win the 500cc class with a 2-stroke" was long forgotten.

In the Finnish GP in July of 1977, J. Cecotto rode the YZR to its 11th victory. This victory and the machine that brought it would mark another milestone in the development of the 2-stroke machine's potential.

"We had fitted Cecotto's machine with a new exhaust system device we called the YPVS for Yamaha Power Valve System. In fact, the YPVS system itself was first developed on single-cylinder models like Yamaha's motocrossers, but the first 4-cylinder machine to mount it was Cecotto's OW35K," says another development staff member from the time, Mr. Taichi Ito.

The YPVS technology actually went back to know-how developed for emissions measures. Compared to a normal 4-stroke, a 2-stroke only emits about 1/10th the amount of NOx (nitorogen oxides). On the other hand, a 2-stroke emits larger amounts of HC (hydrocarbons) than a 4-stroke, and reducing these HC emissions was an important development theme for 2-strokes. What's more, the 2-stroke blow-by phenomenon that caused these increased HC emissions also caused a torque valley that was undesirable weak point for a performance race machine. The YPVS device was one that solved this problem by employing a valve that enabled variable exhaust timing and linking its function to the changes in engine rpm in order to optimize exhaust timing at each speed range. The exhaust pattern on a 2-stroke engine is a cyclical one that corresponds to the combustion in the cylinders, and there are certain rpm zones where the pressure in the exhaust pipes is subject to either a canceling out or augmentation of the pulse due to the overlapping of the successive exhausts.

If the late 70s was the era of "King" Kenny Roberts and Eddie Lawson was Yam Wayne Rainey. Winning three straight world titles form 1990, Rainey would be

History of the development 1973-2002 YZR500

OW20 (1973 ~ 1974)

Yamaha's first 500cc factory machine

This machine mounted a liquid-cooled 2-stroke in-line-4 piston reed valve engine on a chromium molybdenum steel frame with disc brakes front and rear. It captured a victory in its debut at the France GP in France April, 1973.

OW23 (1974 ~ 1975)

First machine developed specifically for 500cc compe-tition featuring a cassette type transmission

Debuting at the Belgian GP of 1974 and used through the 75 GP season, this was Yamaha's first machine developed specifically for the 500cc class.

It won its first GP500 season title in only its third year competing in the 500cc class.

OW35 (1977)

New engine with revised bore x stroke

The piston reed valve intake was replaced by a piston valve system. Also, the bore x stroke was changed to 56mm x 50.6mm and a power jet type carburetor was adopted.

OW54 (1981)

Featuring the square-4 rotary valve engine format

This model was Yamaha's first square-4 engine mounted on an aluminum frame. For long-time fans, this model brings back memories of B. Sheen taking his first championship on a YRZ500.

OW60 (1982)

Second model with the square-4 Crosby finishes 2nd

This model was designed to be 6 kg lighter than the OW54, which was slightly handicapped due to its weight. At its debut race, Kenny Roberts and B. Sheen finished first and second, respectively, and G. Crosby took second for the year on it.

OW61 (1982)

First V-4 engine powered 500cc GP machine

This was the first 2-stroke 500cc GP machine powered by a V-4 engine. This bike featured the frame that would become the forerunner of Yamaha's famous Deltabox frame, and this model would eventually create the new standard in GP500 racing.

OW70 (1983)

Appearance of the Deltabox Frame

This was the first machine to adopt Yamaha's new aluminum Deltabox frame and the first to be designed for a 17-inch front wheel. This year Kenny Roberts on the OW70 and Freddie Spencer (USA) on the 3-cylinder Honda NS500 staged one of the greatest title battles in GP history that went right down to the last round.

OW76 (1984)

Lawson takes his first title

For this model, a crankcase reed valve intake system replaced the rotary disc valve system. Eddie Lawson, the new ace on the circuit, won a total of 4 races on this bike on his way to his first title.

aha's face of the 80s, the 90s belonged to the man they called the "Prince," he last Yamaha rider to compete with the No. 1 on his machine.

(Top) The YZR propelled many riders to stardom. Their nationalities were British, French, German, Italian, Finnish, American and Australian, and also Japanese. One we will never forget is the French hero Christian Sarron. (Lower) After winning three consecutive All Japan championships on the YZR500, Tadahiko Taira also took part in the WGP.

Yamaha's engineers realized that negative pressure resulting from the mutual canceling out of pulses that occurs in the area of the exhaust pipe at the moment of exhaust could also function to increase exhaust efficiency and thus engine power output.
"Improving this unique 2-stroke characteristic, called the Kadenacy effect, was something that had the capability to vastly improve the performance potential. You might call it a critical step in the history to 2-stroke engine development. And, in the long history of Yamaha's development of the YZR500, no single improvement has led to a bigger improvement in its lap times at the Yamaha Test Course than the adoption of YPVS," says Mr. Shiohara.

The V-4 engine, a format that would lead the GP for 20 years

Over a three-year period from 1978 to 1980, "King" Kenny Roberts was nearly invincible as he rode Yamaha YZR machines to three consecutive WGP titles.
But time and progress don't stand still for long in the competitive world of GP racing. Soon Suzuki came out with its "square-4 cylinder machine, the RGΓ500, followed by Kawasaki with its KR500 and Honda with its 3-cylinder NS500 model that debuted in 1982.
Amidst these dramatic changes, Yamaha introduced its first square-4 machine, the OW54, in 1981, followed by the 2nd-generation Yamaha square-4, the OW60, and finally its first V-4 engine model, the OW61, made its debut. In fact, Yamaha had begun development of a V-4 as its next-generation racer some time earlier. But realizing there was a lot of risk involved in suddenly jumping in to the races with a V-4, Yamaha adopted a strategy of first developing the same kind of square-4 as the competition and feeding back the race data gained with it to the V-4 development project.

In the V-4 development project, reducing engine weight and size to a level comparable to a 250cc engine was a primary objective.
Since a 2-stroke engine has a separate crankcase for each cylinder, the width of a single-axis (shaft) V-4 ends up being about the same with as a parallel four. However, adopting a 2-axis layout enabled a design with less right-left width. It also theoretically offered the advantage of easier adjustment of the ignition angle. But the problem became where to position the intake system.
"One day, one of our engineers was mumbling to himself, 'If only the disc could be made to turn within the "V" bank between the cylinders.' At that minute the whole picture became clear," recalls Mr. Shiobara.
These simple words gave birth to a highly original concept of throwing out the side-mounted rotary disc with its inherently limited forward projection area, positioning the carburetors in the "V" of the block and having one rotary disc service two cylinders.
This led to the birth of the OW61, the first YZR500 to mount a V-4 engine, which was eventually unveiled at the Salzburg GP in 1982. Two years later, and now equipped with a crankcase reed valve, E. Lawson rode the V-4 YZR to win his first World GP title in 1984, after which the V-4 engine continued to dominate the GP scene for the next 20 years.

The Deltabox frame, a winner on the track and production models too

One of the defining features of the YZR machines after 1983 was the Deltabox frame, which would also find use on numerous Yamaha production models like the TZR250. The first YZR to adopt this frame was the OW70 that "King" Kenny rode in his legendary battles with Freddie Spencer on the Honda NSR500.
The original aim of the Deltabox configuration was not simply increased frame rigidity. It is more correct to say that it was born of the

OW35K (1977 ~ 1978)
The YPVS-equipped model Kenny Roberts rode to his first title
This model featured Yamaha's exclusive YPVS (Yamaha Power Valve System) technology.
Kenny Roberts rode this model to the series title in 1978, the first of three consecutive GP500 titles he would win.

OW45 (1979)
The epitome of the in-line-4 piston valve machine
This model utilized the revolutionary honing relief processing method which allows for micron level accuracy around the exhaust port to provide improved reliability. This model provided the base for the TZ500 Road Racer production model sold from 1980.

OW48 (1980)
First model featuring an aluminum frame
This model featured a dramatically reduced body weight thanks to the introduction of the square-section aluminum frame. Kenny Roberts rode the OW48 in 5 out of the 8 rounds in 1980 on the way to his 3rd consecutive championship.

OW48R (1980)
Dual rear exhaust, in-line-4 piston valve model
This model, raced from the Dutch GP, 4th round of the 1980 series, mounted a rear exhaust engine on the steel frame of the previous year's model to boost power output.

OW53 (1981)
Last model with the in-line-4 piston valve engine format
The OW53 debuted in 1980 and featured the last outside dual rear exhaust layout which had been introduced the previous year.
It was also the last in-line-4 model with the piston valve format.

OW81 (1985 ~ 1986)
Taira gets his third title in All Japan Championships
The OW81 adopted a completely redesigned V-4 engine and, in addition to Lawson winning his second world championship two years after his first, Tadahiko Taira won his third straight title in the All Japan Championships.

OW86 (1987)
Important contribution to Yamaha's fourth maker title
This model incorporated changes to the exhaust system such as a longer tailpipe implemented to comply with new noise regulations. R. Mamola rode this model to a decisive victory at the Japan GP on a rainy day at Suzuka.

OW98 (1988)
Right-side twin mufflers, left-right asymmetrical rear arm
On this model the two front exhaust pipes were crossed once under the engine and then both brought out on the right rear side. To accommodate this, a left-right asymmetrical rear arm with a large curve on the upper right side was also adopted as one of the model's distinguishing features.

OWA8 (1989)
Introduction of the data recording function
This model featured a data recording function to record setting data and monitor the condition of the bike at all stages of the race. Norihiko Fujiwara rode this machine to his third All Japan championship title.

OWC1 (1990)
Taking Rainey to his world title
This is the machine on which W. Rainey won 7 races on his way to his first world title. This bike served as a base model when Yamaha later sold the engine to European manufacturers and released the model's technical data.

Eddie Lawson helped build a golden age for Yamaha in the WGP in the 1980s. His cool and unrelenting racing style won him the nickname "Steady Eddie."

quest and research for a frame on which the new V-4 engine could be mounted most efficiently.

It is also a little-known fact that some unique ideas were tried in the development process. At first there was an idea of using the interior of the main frame for the fuel tank in order to achieve a greater concentration of mass at the center of gravity. Yamaha's engineers even tested a special coating used in aircraft on the inside of the frame sections. But, eventually there were regulation-related problems that prevented the use of the in-frame tank in actual GP racing and the world would never see the "tank-in-frame" concept realized.

The Deltabox frame would continue to evolve through a number of changes like the structure of the main tube (reinforcing studs added inside the squared cross-section tube), optimizing of alloy types and rigidity balance, etc.

For example, for the OWF2 of '93 that Wayne Rainey rode to three season victories used extruded aluminum parts. Extruded aluminum is made by a process of heating up the aluminum stock to an appropriate temperature and then forcing it through a die to produce tube stock of the desired shape. Because the extrusion process enables more complex shapes and also a higher degree of precision in shape and dimensions, it also brought dramatic improvements in rigidity.

However, Yamaha's engineers were soon to learn that rigidity alone was not the answer. Although the new frame achieved much higher rigidity figures than they had ever hoped for, they also observed that there was not a very good harmony between the torsion characteristics of the frame itself and the functioning range of the suspension. And, the handling character at super-high speeds also left something to be desired. Having learned these lessons, the next spec, the OWF9, once again returned to the previous panel-stock frame. This was a period when the focus of Yamaha's frame design turned to the problem of how to best use the torsion characteristics of an aluminum frame to contribute to handling performance.

Contributing to the Promotion of GP Racing

With W. Rainey's successive titles in 1990 and '91, Yamaha won both the GP500 manufacturer and rider titles two consecutive years. At the same time, however, the WGP, which had for so many years been the pinnacle of road racing, was facing problems in another area. The number of machines competing in the GP500 was decreasing steadily, and some were even beginning to worry about whether or not the championships would survive.

In answer to this need to stimulate the GP race scene, Yamaha announced in September of '91 that it would provide its YZR500 engine to European constructors, and actual sales were begun in '92.

In fact, Europe had a long tradition of GP teams that used engines by the makers mounted on fine-tuned frames built by the constructors to produce competition machines. It was Yamaha's belief that the racing scene would be stimulated by a brace of new teams on the starting grid using machines constructed in Europe according to this tradition. But selling its state-of-the-art racing engines also meant that Yamaha was releasing vital technical information. Still this bold move would bring unexpected results that would change the sport forever.

The success of Yamaha's gamble was clear the next year when 23 machines, a full two-thirds of the bikes on the starting grid for the 500cc class final in the '92 GP series' opening round at Suzuka, were powered by the Yamaha YZR500 engine. As Yamaha had hoped, the GP500 class was rejuvenated all at once.

During this period of engine supply, Yamaha would also release vital chassis development data to the constructors ROC and Harris using the Yamaha engines. Never before in the history of the GP had a factory provided constructors with design blueprints and full instructions on the full details of maintenance and setting methods like this.

Thanks to these effort ROC and Harris placed 4th and 5th respectively in the constructors' ranking in the 1992 to '94 seasons, and not only because the competitiveness of their Yamaha engines. It was also proof of the versatility and all-round quality of these engines including things like ease of set-up. Furthermore, the fact that competitive chassis could be constructed without special aluminum alloys but just commercially available aluminum stock was also a testament to the basic soundness of the Yamaha chassis designs.

In 2002, the GP500 class which had long been the pinnacle of motorcycle racing, was reborn as the MotoGP. And the YZR name was destined to live on in the new generation of 4-stroke MotoGP machines, as Yamaha named its new entry the YZR-M1.

Now a new challenge is already underway to win this new world title, and to continue to build a motorcycle culture. The Yamaha Racing Spirit that was born and nurtured over thirty years of unending challenge of YZR development lives on and continues to grow today. We hope that everyone will find the chance to experience that passion at the race track and discover the thrill of motorcycle racing at its best.

OWD3 (1991)
The seventh manufacturers title
With a new electronic-control rear suspension (CES), this bike took Rainey to six victories and his second World title. It also gave Yamaha its seventh manufacturers title

OWE0 (1992)
Rainey's "V3" model
This machine featured a boosted power output of 160PS, up from 155PS the year before and was the bike on which Rainey won his third World title in as many years, a record to equal that of "King" Kenny.

OWF2 (1993)
Introduction of an extruded aluminum frame
The aluminum main frame of this model was made of extruded aluminum with a segmented box cross-section. This design helped Yamaha win its eighth manufacturers title.

OWF9 (1994 ~ 1995)
Forced-air type air box boosts intake performance
On this machine, L. Cadalora ranked second overall for the season. In the 1995 model, an air type air box was introduced to boost intake performance.

OWJ1 (1996)
Adoption of a powder-metal piston
This model featured the powder-metal piston with enhanced heat resistance as well as a new frame design that eliminated the seat rail. Norick Abe rode this machine in the Japan GP and scored his first GP win.

OWH0 (1997)
V-bank angle 75-degree drive axis position altered
The V-bank angle of this model was altered to 75 degrees in order to enable larger air box capacity. It was developed concurrently with the OWJ1, and although the year designation has the OWH0 one year later, it was actually raced one year earlier than the OWJ1.

OWK1 (1998-1999)
Course records one after another despite non-Leaded spec
This model was a non-leaded gasoline spec in line with the revised GP regulation. Despite the non-leaded spec, this machine produced new course records on many of the GP courses. The OWK1 continued to mature and S.Crafar picked up his first victory at the British GP.

OWK6 (2000)
Contributing to Yamaha's ninth manufacturers title
This model was a further developed version of the previous year's OWK1, and resulted in 3 wins for Garry McCoy, 2 for Max Biaggi, as well as 1 for Abe. This machine thus contributed to Yamaha's 9th 500cc Manufacturer's Title after a seven-year hiatus.

OWL6 (2001)
Biaggi grabs 2nd in season ranking
This model featured spec revisions relating to engine performance and drive-ability that contributed to increased acceleration and top speed performance as well as long and short type rear arm options to fit the characteristics of the different riders.

OWL9 (2002)
The 28th and last generation YZR500
In this year's GP regulation that had 2-stroke and 4-stroke machines competing together, the great competitive potential of the YZR500 was proven once again when O. Jacque won the pole position at the German GP on this machine and Abe finished the season ranked 6th.