Yamaha Motor Monthly Newsletter

The "PAS Ami" Electrically Power Assisted Bicycle

Spotlight: Electrically Power Assisted Bicycles

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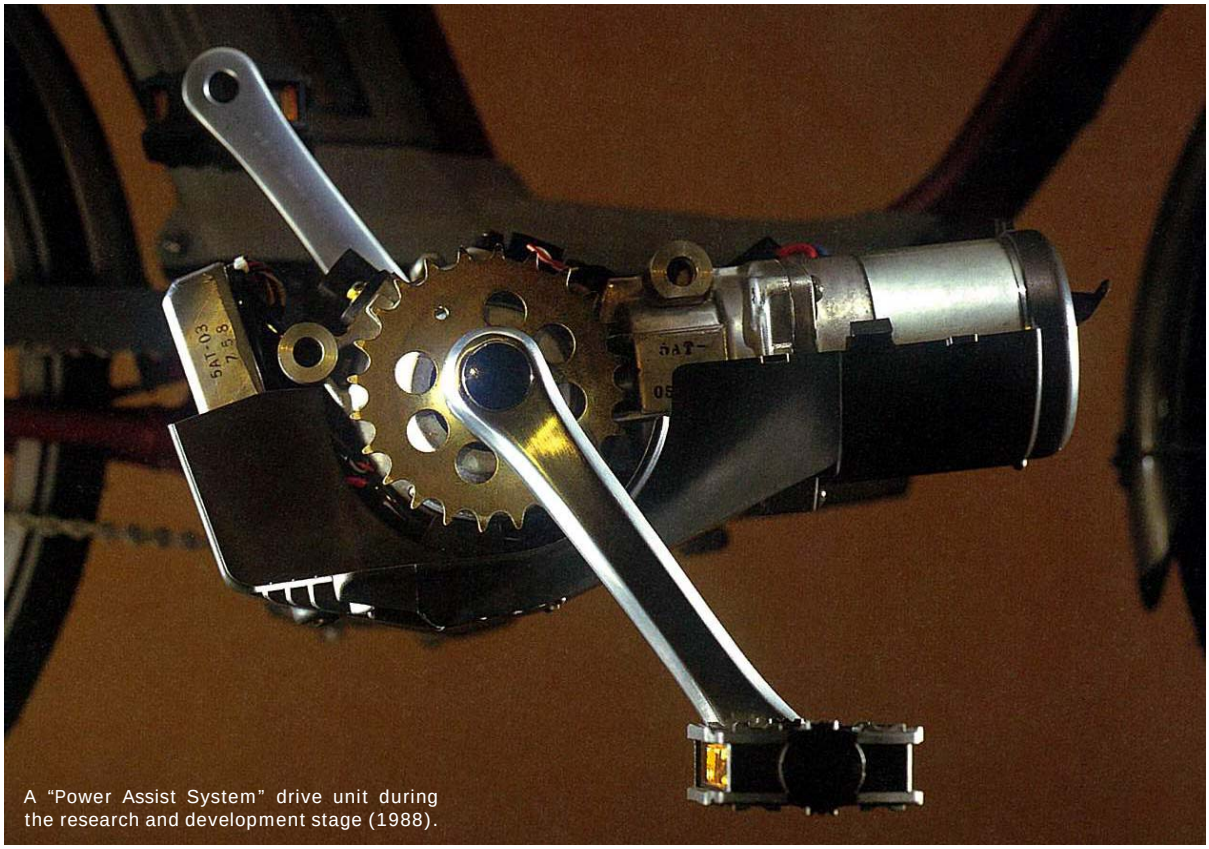
Electrically Power Assisted Bicycles

Performance tuned to “human sensibilities”



A “Power Assist System” drive unit during the research and development stage (1988).

Two decades ago, Yamaha Motor developed and launched a world-first product born of a simple but challenging question: What if there was some kind of power source to help someone pedaling a bicycle uphill or into the wind?
An electrically power assisted bicycle, the Yamaha “PAS” has tackled one of the biggest weaknesses of the bicycle and created a more people-friendly form of personal mobility that has found a welcome place in the lives of a growing number of people, as Yamaha has continued to evolve and refine the Power Assist System (PAS) technology and introduce an increasing variety of models. Now, the special value of these electrically power assisted bicycles is spreading from Japan to Europe and worldwide. This month we look at the development and spread of our PAS electrically power assisted bicycles as an environmentally friendly personal commuter vehicle designed and engineered with top priority on performance tuned to “human sensibilities.”

A new idea - “assisting human power”

As you can see from the cover photo, Yamaha’s PAS electrically power assisted bicycles essentially look the same as a regular bicycle. But, the big difference lies in the Power Assist System drive unit it mounts, consisting of an electric motor and control components like torque and speed sensors. The system on this personal commuter vehicle adds a power assist from the motor in proportion to the force applied to the pedals by the rider. It integrates the two forces so naturally that it feels as if someone is giving you a gentle push from behind.

An early prototype electrically power assisted bicycle.

The idea of a bicycle capable of adding a power assist to the force of the rider's pedaling is actually one that had been around at Yamaha Motor for quite some time. Before the start of development on the electrically power assisted bicycle, there had been prototypes like the "OU11" in 1973 that mounted a small gasoline engine on a bicycle, and the "OU99" in 1982 that also mounted a small gasoline engine, but on a mountain bike. However, the mechanisms used on these prototypes were rather unwieldy because they involved complex operations like shifting the power source over to the engine each time the rider wanted it for going up hills and the like. In this way they were far from Yamaha's ideal of "a vehicle that is easy for anyone to use" or "a commuter vehicle that puts top priority on performance tuned to human sensibilities." However, the turning point came in the second half of the 1980s. Around this time, revolutionary advances were being made in the field of electronics around the world. These new technologies led to a completely new idea of using an electric motor to assist the rider's pedaling. Applying Yamaha Motor's core competence in electronic control technology to this new concept led to the successful development of the "Power Assist System" power unit from which the "PAS" product name was eventually born. In 1989, the first Yamaha prototype of an electrically power assisted bicycle, dubbed the "OU91" was completed, and went on to become the root of the first-generation PAS bicycle.

The surprising, delightful ride creates an instant hit

The lead-acid battery pack on the original PAS (top, 1993) could provide a power assist for 20 km on a single charge. Today's latest PAS Natura L (bottom, 2013) uses a lithium-ion battery that assists for double the distance at 39 km (45 km in Auto-Eco Plus Mode) along with big strides in both performance and functionality.

When nationwide sales of the PAS began in 1994, Japan had a population of about 120 million. And, the fact that an estimated 70 million bicycles were owned at the time shows just how much they are an integral part of life in Japan and that they can surely be considered the country's most popular way to get around. When Yamaha set out to mount the Power Assist System on this familiar and ubiquitous personal commuter vehicle, several ideals were laid down as goals to achieve. They included making a vehicle that would "help society by making people's lives more convenient," "help solve local environmental and energy problems" and "alleviate traffic problems" such as the lack of parking spaces and chronic traffic congestion. The PAS dealt positively with these issues as well as ones that addressed the key issues in Japan of improving and maintaining health through physical activity and providing solutions for the challenges of an aging society. Upon its limited regional release in 1993 and nationwide release the following year, the PAS was such a hit that production was boosted to three times the initial first-year sales plan of 10,000 units.

Yamaha Motor's founding president, Genichi Kawakami had always said, you "create demand through your own efforts," and that principle became the foundation of the company's "pioneering spirit." With its first electrically power assisted bicycle, Yamaha Motor had created a product that had not existed anywhere else in the world. To get as many people as possible to experience its smooth riding performance and the new value it offered, a large-scale "100,000-Person Test-ride Campaign" was swiftly put

into action. Test-ride events were held all over the country and when people got the chance to experience the PAS electrically power assisted bicycle for the first time, the reaction was almost universal: a big smile of surprise and delight. For the people at Yamaha who worked to develop the PAS, there could not have been anything more rewarding.
Twenty years have passed since then with ongoing development work centered on making the product even more convenient, comfortable and enjoyable to ride. The technological evolution of the drive unit has focused on giving an even more natural feeling to the power assist, while the addition of running mode selections to get the most intelligent use of the battery's energy, the Shift Position Electric Control (S.P.E.C.) system to provide the optimum assist force at all times and a convenient remaining battery charge indicator, have all contributed to great advances and maturation of the product's performance and functions alike.

PAS technology put to use in the Olympics as well

Over the years, the Power Assist System mounted on the Yamaha PAS has drawn attention in some rather unexpected places. One is the Olympics, where the born-in-Japan style of bicycle racing, *Keirin*, has become an Olympic event. In *Keirin*, the competitors follow behind a pacer in the early stage of the race. Since the pacer must run in front of highly trained competitors, a set pace at a high speed is required. In the past, the pacer rode a motorized 2-wheeler that inevitably had an undesirable effect on the race with its exhaust and noise.

The "Keirin PAS" was officially used at the 2000 Sydney Summer Olympics.

As a solution for that problem, Yamaha Motor was commissioned by the Bicycling Popularization Association of Japan to conduct research and development of an electrically power assisted pacer bicycle. In 1997, a Yamaha development team set out to create a specialized high-speed bicycle that could reach speeds of 60 km/h. To get that kind of performance, the bicycle was mounted with two electric motors instead of one and the assist ratio was raised to 1:3 (compared to the under 1:1 ratio of production models at the time) along with other high-performance tuning. Named the "KEIRIN PAS," this high-spec model was used as the official pacer vehicle in the Sydney Olympics (2000) and various other *Keirin* events.


This Yamaha-built bicycle taxi gained much attention in its use as a transporter at the 2005 World Exposition, Aichi, Japan. It used a PAS drive unit and the body was made of the same fiber reinforced plastic Yamaha successfully employs in manufacturing its boats and golf cars.

The world of sports was not the only area attracted to the outstanding performance potential of the Power Assist System. When the 2005 World Exposition, Aichi, Japan was held with an event theme of "Nature's Wisdom," Yamaha was commissioned by the Japan Bicycle Promotion Institute to develop and create a bicycle taxi mounting the PAS drive unit. This taxi became a popular way to get around the huge expo grounds and is just one more example of the numerous fields where the technology behind electrically power assisted bicycles and their environmentally friendly performance have been put to use.

OEM business in Europe's growing "e-bike" market

Two decades after the birth of the Yamaha PAS, numerous other makers have joined Japan's electrically power assisted bicycle market, and today it has grown in size to an annual demand of approximately 400,000 units. At the time of the PAS' launch, senior

citizens were the first group to show a strong need for its benefits, but today, new variations such as sports models and models designed to carry two seats for child passengers have made these bicycles a familiar vehicle of choice for young families and other groups like high school students.

Recently, another milestone was reached with the 2011 signing of an agreement with Giant Electric Vehicle (Kunshan) Co., Ltd., a subsidiary of Giant Manufacturing Co., Ltd., (Taiwan), for OEM supply of electrically power assisted bicycle drive units and joint development of electrically power assisted bicycles. Then, at the end of 2012, Yamaha's OEM business in Europe continued to grow with contracts signed for the supply of electrically power assisted bicycle drive units to two more companies, the German bicycle maker WINORA of the Netherlands-based Accell Group and CycleVision A/S, a subsidiary of the Danish bicycle maker H.F. Christiansen A/S. In Europe, where electrically power assisted bicycles are popularly called "e-bikes," the market has grown rapidly, particularly in the countries of Germany and the Netherlands, to a present scale of more than 800,000 units in annual demand. In conditions like this, Yamaha Motor is aiming to expand its OEM drive unit business to a scale of 100,000 units by 2015.

The precursor of today's bicycle was the kick-propelled *Laufmaschine* ("running machine"), a two-wheeler invented by Baron Karl von Drais of Germany in 1813. Now, 200 years later, we can only wonder what the Baron would think if he were to see bicycles made so delightful to ride by the electric drive unit pioneered by Yamaha Motor gliding along on the streets of Germany.

Message from the Editor

Yamaha Motor pioneered a world-first product by developing and launching the PAS electrically power assisted bicycle. This year marks the 20th anniversary since its release, and this month, we took the opportunity to briefly introduce how this product was conceived and how it has grown over the years.

Electrically power assisted bicycles are primarily found in Japan and Europe so there may be many of you who have never seen one before. But, as you read earlier, many people who try these bicycles for the first time break out in surprised smiles after they experience what it's like to ride one (myself included!). If a chance arises, I hope you'll try out an electrically power assisted bicycle and experience the great joy it brings to riding.

Our next issue will talk about the Yamaha motorcycles you all know so well and the early days of the business. Please look forward to it!

Yuriko Senga

*The figures for running distance shown in the text for the first PAS model (1993) are the values measured with a "General Road Pattern" in Standard Mode. Figures for the PAS Natura L model (2013) are measured over the "Standard Pattern" designated by the Bicycle Association (Japan) Approved Electrically Power Assisted Bicycle Safety Standards.

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