Ricardo Motorcycle
Conference 7.0

Smart, urban – and every inch a BMW

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Building on more than a decade of co-operation with BMW Motorrad, Ricardo Motorcycle has partnered with the premium bikemaker to develop a new generation of mid-sized scooters that distil the qualities of the highly successful C650 range of maxi-scooters into a smaller and more accessible format. **Jesse Crosse** reports on the creative processes behind the new and innovative C400 series scooters aimed at the expanding urban and touring markets

BMW's C650 range of luxury maxi-scooters, co-developed with Ricardo Motorcycle, has been a major critical and commercial success, prompting an initiative to extend the premium concept into the heart of the sector.

However, the global market for smaller scooters in the 400 cc category is already well served by a number of established manufacturers, and to enter it and succeed is a daunting task – even for a company of BMW's stature and standing. Yet, with the help of Ricardo, that is precisely what BMW Motorrad is aiming to do with its new C400 scooters.

The challenge, put simply, was to design and manufacture a scooter that could not only achieve a competitive price point in this tightly fought market segment, but also gain best-in-class status for refinement, performance, handling and premium design values. For Ricardo, it was to be the most daunting task yet in a relationship with the German motorcycle manufacturer that has already spanned more than a decade.

Successful partnership with BMW since 2006

Ricardo first began work on BMW Motorrad products back in 2006 when it took on the upgrade programme for the four-cylinder K1200 superbike engine to produce a new range of K1300 motorcycles to be launched in 2009. The programme drew on Ricardo's extensive resources in Shoreham and Leamington Spa in the UK, Prague in the Czech Republic and Schwäbisch Gmünd in Germany, making for a truly multinational project.

The result was a resounding success and since then the relationship has gone from strength to strength. Ricardo's engineering of the six-cylinder K1600 touring bike engine led to this new BMW earning rave reviews in the motorcycle press. The first luxury maxi-scooters, again developed with substantial Ricardo input, arrived in 2012 and continue to be available as the C650 Sport and C650 GT

BMW C400 series

- and since 2017 there has also been an electric version, the C Evolution.

Mid-size market: a logical step

With approximately 30,000 units worldwide annually, the mid-size scooter sector is about two-thirds of the size of the maxi-scooter market, explains BMW's project manager Dr Joerg Reissing. "Yet over the years it has proved very stable, so it was a logical step to downsize our maxi scooters, so we can attract new and different target groups - there is a healthy market demand."

Nevertheless, the pressure was on to produce a premium machine that met customer expectations for the BMW brand. "This mid-size segment is more competitive, with many more people competing in that space," observes Ricardo's head of motorcycle strategy and business development Paul Etheridge. "The price point is much more competitive too, so the product has got to be the best in its class and it's got to be correctly priced. Overall, it's a lot more challenging to make a successful product in this segment."

"BMW's aim is to expand the offer on the market," adds Ricardo's Massimo Lotti, responsible for the project's styling team. "The big scooter segment is limited, mainly because of the cost comparison with 650 cc motorcycles: a big scooter can cost substantially more than a Japanese naked 650 cc motorcycle."

Careful thought went into the positioning of the two C400 models, adds Reissing. "Firstly, we wanted an attractive sport version that competes with our competitors' offerings, and secondly we needed a smaller version of our big C650 GT tourer, but in this lower displacement category."

The concept for the C400 was very similar to that of the larger scooter. "So, starting from the same base, we aimed to produce a sport version and a GT version," explains Lotti. These became the C400 X (sport) and C400 GT (touring). Yet even though the 400 parallels the thinking of the 650, the

Innovative engine mount gives smooth ride, quick handling

A scooter differs from a motorcycle in that the engine assembly also doubles as the rear swinging arm and is continually moving when the scooter is being ridden. "This kind of application," says chief chassis engineer Massimo Lambertini, "is difficult to do well because you have to decouple the vibration coming to the rider and passenger from the engine via the frame.

"To do this, the pivot would normally have a rubber-mounted hinge point with two degrees of freedom. The rubber mounting introduces flexibility between the engine and the frame, and this gives riders a feeling that the rear wheel is steering while they are cornering. You get the feeling that the rear of the scooter is not following you," he explains.

Ricardo was able to channel its considerable simulation skills into developing a coupling system that provides a very high pivot point for the engine. "This gave us riding characteristics similar to that of a motorcycle," continues Lambertini. "There are some rubber elements but compared to all the competitors with the same kind of engine and rear wheel design, this is widely acknowledged as being best-in-class."

two platforms are completely different and there is no similarity or carry-over between the maxi-scooter and the mid-size one. Interestingly, the idea of producing a sport and GT version from a single platform originally came from Ricardo at the beginning of the maxi-scooter project.

Urban agility and GT cruiser off one platform

The challenge, says Massimo Lotti, is to use scooters based on a single platform to compete against the best seller in each of the sports and tourer categories: "We were up against two different models from two of the world's top manufacturers, Yamaha and Suzuki, and now Honda is in the market too," he explains.

This would be tough enough as it was, but to mount that dual challenge from a single platform would be tougher still, particularly as the underlying chassis and suspension design would have to deliver two distinctly different sets of vehicle dynamics. By contrast, the competitors' machines were designed from scratch to deliver those respective attributes. But the outcome, Lotti recounts with some satisfaction, is that independent reviews rate the C400 X as the best in class in the 'Sport' category, while the GT version has received very positive feedback as a 'tourer scooter' – a very good result.

As the brief evolved, the decision was taken to dial back the sporting attributes of the C400 X to retain an urban focus, creating a scooter with a lighter and more agile feel than the grand tourer. The approach is what the designers call 'cross-city.' In that urban segment a true sports scooter makes less sense because it does not need to be uncompromisingly sporty, and it must appeal to a city-based customer. The idea was to make a vehicle that felt light and agile to the touch – one that could easily take on the cut and thrust of urban traffic and allow the rider the freedom to make rapid progress through the most crowded streets.

The feeling of agility riders get from the nimble C400 X is engineered into the chassis, and the scooter is also 8 kg lighter than its GT sister. "That is mainly due to differences in the body parts," explains Massimo Lambertini, who was responsible for chassis design and development.

Design cues from legendary GS BMWs

On both the C400 X and C400 GT, the BMW styling department team introduced some of the styling language from the BMW GS off-road touring motorcycle. "The GS is not an overt sports bike, it's a cross-tourer, so we had the opportunity to provide a similar feeling on a scooter," explains Lotti. "The GT was a different proposition. We wanted to create a true GT focusing on fuel economy, comfort, riding position and all the attributes a true GT should have."

One concept introduced on the bigger scooter was a Ricardo idea: the patented Flexcase system, originally launched on the C650. The storage system can drop down to allow a full-face helmet to be locked away securely while the scooter is stationary and in the normal position, and can be used for general stowage when the scooter is being ridden. While the Flexcase system is not new to the market as a whole, the BMW machines are the only scooters available with anything like it.

The main target for the chassis design was to create an extremely rigid engine mounting and achieve the highest standards of handling feel. "One of the weak points of other scooter designs is that the engine is completely rubber-mounted, so the engine and rear wheel unit is not so rigid. This is to avoid noise and vibration from being transmitted to the rider and passenger, but it's not great for rideability," explains Lambertini.

At the front there is a 15-inch wheel to ease the shock of urban potholes, and telescopic forks aim to give the best ride possible. A small subframe, moulded in plastic, supports the instrument panel and front lights. The C400s incorporate some carry-over design features from other BMW bikes, such as the handlebar

"It was a logical step to downsize our maxi scooters, so we can attract new and different target groups – there is a healthy market demand" Dr Joerg Reissing, BMW project manager

switches, headlights and instrument cluster, to provide a strong link with the rest of BMW's two-wheeled family. The design goes one step further than competitors with the addition of a twin (rather than single) front disc brake set up with four-piston calipers to improve safety and give the rider a greater feeling of security.

Engine and transmission design

A water-cooled, port-injected 350 cc single-cylinder four-valve engine with a single overhead camshaft and roller finger followers provides the power. Output is 34 PS at 7500 rev/min and torque is 35 Nm at 6000 rev/min; both the C400 X and C400 GT conform to the latest motorcycle EU4 emissions standards.

Engine design work started in 2013 with some initial information from BMW, and Ricardo was also involved in initial benchmarking and defining the specification. That involved reviewing existing products to establish the optimum engine capacity, and BMW's desire for some similarity with other Motorrad engines meant the bore size was initially set at 80 mm. "We hoped to use some carry-over parts like the valve train components and the piston but in the end the parts were all made in China specifically for our project," says Ricardo's Nikola Fiket, who was in charge of powertrain design and development.

The engine incorporates a CVT transmission, with the front pulley mounted on the crankshaft. The second pulley is connected to the first by a rubber belt and drives a fixed-ratio secondary drive with a small centrifugal clutch. "These components account for more than half the weight of the swing arm," says Fiket. "We also had responsibility for the airbox and complete air intake, which is also assembled through the swing arm. The exhaust system is connected to the right-hand side of the swing arm."

Balancer shaft: yes or no?

Some scooter engines have a balancer shaft for smoothness, while some others that do not still score well on vibration and refinement. "The big question was do we need one, and what would be the best position for it?" remembers Fiket. BMW looked at its two main competitors – one which had the most rapid performance and wasn't equipped with a balancer shaft, and the other, rated highest for refinement, which did. The objective was to achieve the best of both and become the new benchmark for others to follow, so the decision was taken to include the shaft.

"We chose the best position for the shaft to quell vibration and also take into account the swing arm pivot point we wanted. Intake gas flow was also the subject of considerable simulation work: as the cylinder lies almost horizontally so the air intake has to turn 180 degrees through the swing arm."

And although relatively conventional in its approach compared to others in the market, the detailed design of the BMW combustion system in terms of combustion stability, tumble ratio and airflow generally is at the cutting edge of what is technically possible.

Production: technology transfer to China

The chassis and fairings for the familiar C650 series are manufactured in Europe, and were designed in collaboration with Italian scooter specialist EXNOVO (now part of Ricardo Motorcycle), while the C650's engine is produced by Taiwanese manufacturer KYMCO. In contrast, for the new C400 the manufacturing is carried out entirely in China, by LONCIN at its plant in Chongqing.

Quite apart from the design and engineering of the vehicle itself, the management of this remote manufacturing process was a demanding task and needed careful handling, as

BMW C 400 X product highlights

"We took much more responsibility for the design and development as well as helping the new supplier base to deliver components meeting BMW's stringent quality requirements" Paul Etheridge, Ricardo head of motorcycle strategy

BMW's Dr. Joerg Reissing explains: "One of the main challenges was to ensure fast and efficient communications between all the parties involved, including suppliers. Considerable effort went into establishing standard processes to ensure excellent levels of quality."

The final result, a scooter which would be sold in Europe as well across global markets, had to be 100 percent BMW not just in quality, but in look and feel too. Overall, the engineering team had to work within the technical capabilities of the suppliers, and one of the issues was the fact that component volumes were being measured in the thousands rather than the millions that many Chinese suppliers are used to.

"This is a substantial step further than before," explains Ricardo's Paul Etheridge. "We took much more responsibility for the design and development as well as helping the new supplier base to deliver components meeting BMW's stringent quality requirements. This alone represented an entire area of work, and of course it went without saying that the manufacture of the final vehicle also had to meet BMW requirements of quality and refinement."

One of the ways this was managed was to perfect the various assembly techniques in Europe, then transfer and demonstrate them in China. At that point the processes were adjusted to suit the Chinese workforce. All testing is carried out in China and the scooters are assembled on two production lines, the first for the powertrain and the second for the entire scooter, which at the end of the process is ready to ride away.

Excellent outcome – and the media agree

The end result was exactly as expected: a scooter that is well designed, well specified and with great handling. "Our focus was on typical BMW styling, market-leading innovations like connectivity with a large TFT display, and a riding experience that is closer to a motorcycle than a scooter to deliver our brand-core 'Joy'," says Reissing.

Like their bigger predecessors, the new BMW scooters have proved as popular with the world's press as BMW hoped. "In town an excellent turning circle allows the C400 X to easily be U-turned in a road and its light feel and narrowness means you can zip through gaps, while the riding position means your feet are always close to the ground…" said *Motor Cycle News*. "The C400 X looks and feels a premium scooter…"

Visor Down agreed. "The C400 X was a delight to ride – it felt agile, and far lighter than its 204 kg wet weight. The torque of 35 Nm peaks at 6000 rev/min, but there's plenty of grunt throughout and the compact 400 easily hits the ton with a bit more to give."

The leading website went on to say: "thanks to a 'vibration-decoupled engine mount' – rubber bushings damping the engine vibration – the bike is remarkably smooth, and there's very little shake through the bars and mirrors. In fact, even at higher speeds you could still get a clear view of what's behind you."

Mannheimer Morgen was deeply impressed with the C400's new navigation system, finding that the simple interface didn't distract or mislead the rider, and in a three-hour test ride around Milan was "absolutely perfect."

The competitively priced C400 scooters are now on sale, with features such as automatic stability control (ASC) and ABS as well as BMW Motorrad Connectivity which allows the rider to access phone, music and navigation via a multi-function controller on the handlebars.

A satisfied Reissing notes that "Ricardo made important contributions for the success of the project due to comprehensive knowledge of complete vehicles, the interactions between development and production and quick and flexible workflows."

All in all, the new C400s are compelling new products of which both BMW and Ricardo are rightly proud, marking another milestone in what has proven to be a hugely successful relationship between the two companies.

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