



# The Novus Bike

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**State of the art composites technology and electric propulsion are enabling designers to rethink the fundamental concept of motorcycles.**

With 38.5 kg, it weighs only about as much as a power assisted bicycle. But with its 14 kW (peak) electric motor it has power comparable to a 125 cubic centimeter motorcycle, which would tip the scales at well over 100 kg. The Novus Bike, developed by German designers René Renger and Marcus Weidig, and unveiled at the Consumer Electronics Show 2019 in Las Vegas, is a new animal in the realm of two-wheeled private transport. Having this much power in a machine this light was achieved with an original concept that makes the most out of two cutting edge technologies: electric propulsion and fiber reinforced polymers.

Industrial designers René Renger and Marcus Weidig both grew up with a passion for motorcycles, discovering the world on two wheels as kids. So it should come as no surprise that when they decided to start their own design-studio Novus, based in Brunswick, Germany, their first prototype would be a motorcycle (<http://novusbike.com> [See Figure 1]). They set out to reimagine the whole concept of motorcycles, exploring all that modern technology has to offer. In doing so they found a niche that is unlike anything on the road today.

## 1. Complete freedom of expression

Weidig and Renger met while studying Industrial Design, which Weidig describes as “a lot of art, but also engineering, materials science and CAD-programming.”

Renger adds: “We always tried to incorporate technical aspects and functionality. It wasn’t just about styling, but about conceiving concepts that make a lasting statement. We have tried to realize that in this project as well.”

After gaining experience in design departments in the automotive industry, they wanted to have complete freedom of expression. Because working for others, they were not always able to implement the out of the box thinking they were striving for.

“In order to make this design, we had to free ourselves from all conventions,” Weidig says (See Figure 2). “If you start with a classic motorcycle in mind, you end up with a classic looking motorcycle. It was not easy to let go of everything we knew about motorcycles and start from scratch with just this new propulsion method and finding a design that does it justice. Electric scooters and motorcycles already existed, but they were conventional machines with the motor replaced with a battery block. We said: surely that cannot be all there is?”

## 2. Innovative carbon fiber monocoque frame

The university taught Weidig and Renger to question things instead of accepting the status quo, but for them it was not enough to be different solely for styling purposes. “In order to justify it, it has to provide added value,” Weidig says. “I think we have achieved that. Because a dry weight of less than 40 kg was only possible through this design: the carbon fiber reinforced epoxy monocoque shaped like a bicycle frame. It is a combination from many worlds. We have tried to select the best or fittest from all these worlds.” (See Fig. 3).

Where Weidig was always the guy with the fastest bike, Renger says he was more into personalizing his machine: “In Germany we are allowed to ride motorcycles of up to 125 cubic centimeters when we are sixteen. When I was that young, it was all about freedom and individualization for me: expressing your own personality. I took my bike completely apart and reassembled it so it looked different from anyone else’s bike. We have incorporated that feeling into our project as well: a bike that expresses the personality of the rider.” It is easy to see how Marcus and René combined their passions in the Novus Bike.

## 3. A battery instead of a tank

Where in a conventional motorbike, the tank is probably the dominant design element, in the Novus Bike it is the lithium

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FIGURE 1

Sleek, stylish, clean, fast, futuristic, fun, sporty, purposeful and cool: carbon fiber reinforced epoxy plays a large part in giving the innovative Novus Bike its looks and functionality (Photo courtesy of Novus).



FIGURE 2

Harley Davidson's electric bike, the LiveWire, was unveiled in November 2018 at the EICMA show in Milan. With even Harley Davidson getting into the game, electric motorcycles are surely going to take up a large share of the market. But although the LiveWire is all-electric, it still has most of the classic styling cues and technologies of petrol driven motorcycles (Photo: MaggioPH/Shutterstock.com).

ion battery, which gives the machine a 96 km range and which can be charged to 80% in one hour. "We did not want to replace the tank with a battery in the classical layout," Weidig says. Being the heaviest, biggest and most prominent part of the machine, the battery is placed as low as possible in order to achieve a low center of gravity. And it was incorporated into the frame structure instead of just mounted to it (See Figure 4).

"I do not think the dominant element is the area where the battery is," Renger notes. "The dominant element is the area where there is nothing at all. Design is not just where something is placed but also where it is deliberately not placed, and the way in which you surround this area. We wanted to reduce everything as much as possible: with every decision we looked for the simplest solution." (See Figure 5).

**FIGURE 3**

The space where the cylinder block would be in regular motorcycles catches the eye in the Novus Bike because it is just empty and open like in a bicycle. It is as if the machine is boasting: “Nope, no internal combustion in here” (Photo courtesy Novus).

**FIGURE 4**

In conventional motorbikes, the energy storage (in the form of a gas tank) is on the top frame rail. In the Novus Bike it is in the form of a battery, integrated in the bottom of the monocoque frame (Photo courtesy Novus).

**FIGURE 5**

Why incorporate a display when virtually everyone these days carries around a smartphone, which can fulfill all of its tasks? It also acts as a digital key and controls for the bike (Photo courtesy Novus).

#### 4. In-wheel motor

Getting down to bare essentials meant doing away with the cumbersome and heavy chain drive, gearbox and clutch of normal

**FIGURE 6**

The in-wheel electric motor can be seen behind the brake disc (Photo courtesy Novus).

motorcycles altogether. The electric motor is simply fitted inside the rear wheel (See [Figure 6](#)).

This is feasible because electric motors have a wider usable rev range than combustion engines. An electric motor can deliver torque from standstill, rendering a conventional clutch obsolete. And because an electric motor tends to have ample torque already at low revs, it does not need as many gears as an internal combustion engine. In theory, you can even do away with the gearbox altogether.

In practice however, that is not so easy. You need to get the design and dimensioning of the whole machine and its parts absolutely right. Get it wrong and you can end up with a machine that is underpowered off the line or limited in top speed.

#### 5. Extreme diet

“We dimensioned everything in order to optimally use its torque and dynamics in city traffic conditions,” says Weidig. “It was not dimensioned for motorway driving.”



In order to get away with an in-wheel motor, lightness is key. Composites were essential in achieving that, but also a construction that makes full use of their potential. “It is not a metal frame clad with carbon fiber body parts as is so often the case in motor-



**FIGURE 7**

The rear swing arm is made of carbon fiber composite as well. The shock absorber is partially hidden in the frame (Photo courtesy Novus).



**FIGURE 8**

Even the front fork is made from carbon fiber composite on the Novus Bike (Photo courtesy Novus).

cycles,” Weidig says. “What you see is also the load-bearing structure. It is that integration that enables the low weight.” (See [Figure 9](#)). The carbon fiber reinforced epoxy monocoque was made of prepregs and baked in the autoclave. The prototype was laid up by hand.

The motor itself has to be light as well so as not to upset the unsprung weight of the rear wheel assembly (and thus the bike’s handling). A 14 kW (peak) brushless motor was chosen as the optimal compromise. It delivers a hefty 200 Nm of maximum torque, so the bike can propel a rider of average weight off the line at a satisfying rate of about half a g. The top speed is 96.5 km/h, which should be more than enough as well since the bike is not intended for motorway driving.

## 6. Carbon fiber composites all over

To compensate for the motor adding to the unsprung weight of the rear wheel assembly, the swing arms are made from a lightweight carbon fiber reinforced epoxy structure as well. A fully adjustable, progressive air damper sits neatly in an alcove in the frame (see [Figure 7](#)).

The front suspension was designed to match the frame design’s low weight and look (see [Figure 8](#)). It is a single strut (also with an adjustable damper) acting on a front fork made of carbon fiber reinforced epoxy. The weight-saving single strut design, which should be enough to cater for all inner-city traffic conditions, was possible because of the whole machine’s low weight. Adding more suspension travel, for example for off-road use, would have required a more conventional design with double front struts, adding width and weight to the sleek monocoque frame and thus the entire vehicle (see [Figure 9](#)).

The weight-saving philosophy was consistently carried out right down to the carbon fiber composite levers controlling monoblock calipers with 230 mm brake discs.



**FIGURE 9**

The single strut at the front should be man enough to handle all that inner-city traffic can throw at it. The LED-headlight is integrated in the handlebar assembly, making it nearly invisible when it is not lit (Photo courtesy Novus).

**FIGURE 10**

The carbon fiber composites give the Novus Bike its performance. They are also extremely beautiful when the sunlight catches its texture just right (Photo courtesy Novus).

## 7. Simultaneous engineering and design

Weidig and Renger do not think their design can be categorized as “form follows function”, because in their design, function does not completely define and dominate form. “I would say that function, engineering and form have to go hand in hand,” Weidig says. In some respects it is the original design in the first place that makes certain aspects of function and construction possible (see Figure 10).

“That was the only way in which to realize the low weight,” Weidig explains. “Maximum function integration in order to have the least amount of parts and bolts, and having it all look as if it was cast in one piece. That requires simultaneous engineering and design. So, no bouncing back and forth between engineer and designer. While designing you always have to have in the back of your mind how it is all going to be made.”

## 8. Freer than a classical motorcycle

If you have grown up with a love for motorcycles and cars, you tend to love the sound of an internal combustion engine. “Riding electric is certainly a different experience,” Marcus says. “I find it feels even more free than on a classical motorcycle: it is quieter. But you definitely still hear a sound of strength exuding from the motor. And you especially feel the incredible torque from a standstill. You do not have to manipulate a clutch and gearshift lever, making the ride much more carefree. I love racing bikes and their sound. But for the environment for which we designed the Novus, starting at a café for example, it is strenuous to have all those loud vehicles going by. It feels like a blessing rolling along noiseless.”

Maybe generations to come are going to acquire a taste for the soft whine of powerful electric motors and speed control elec-

tronics. As for the silent running decreasing road safety because it is impossible in traffic to hear electric vehicles coming, Marcus feels that this problem is going to decrease over time as overall road noise levels are going to decrease when more electric vehicles are on the road.

The low weight and low center of gravity make the motorcycle extremely agile in traffic. “Its maneuverability is comparable to a power assisted bicycle,” Weidig says. “The rider’s weight and center of gravity are more pivotal than on a conventional motorcycle. So it requires less effort from the rider.” Combined with 14 kW of peak power, it makes for a unique driving experience. “It looks light, and riding it is also light,” Weidig says. “The experience matches the optics.” (see Figure 11).

## 9. New niche

Why did they choose this market segment of a superfast city runabout: a new niche, more up-market and faster than power-assisted bicycles and electric scooters, more agile and maneuverable than current motorcycles, but with a top speed too low for motorway cruising?

“We did not want to build a racing machine,” Marcus says. “But you cannot be underpowered either: you always have to have enough power to feel sovereign in traffic, as well as towards your vehicle. We thought electric drive made the most sense in an urban environment with lots of stop and go traffic, especially with a very light vehicle. That makes it suitable for daily use. It is possible to make an electric motorcycle with 100 kW. But that would require a very big, heavy battery and it would be just like everything that is already out there.”

We wanted it to be like nothing else on the road,” Renger adds. “There are big bikes, which are comfortable and fast, and



FIGURE 11

A machine this light, powerful and agile gives the rider even more a feeling of freedom than regular motorcycles. Just like the headlight, the taillight is LED and integrated, so it is hardly visible when it is not lit (Photo courtesy Novus).

there are e-bikes, which are good for short distances. But on longer stretches you will arrive all sweaty. And they are not really cool. We wanted to make a two-wheeler that would be light and electric, that you can take into an elevator if need be, and that has a cool, positive image that sets it apart from unwieldy motorcycles and less agile bicycles. That space in-between had to be catered for. This combination of extremely low weight and high power was not on the market yet. Currently the economic perception in the western world for small, lightweight two-wheelers is: a necessary compromise for people who maybe cannot afford a car or a proper motorcycle. We wanted to shatter that perception and make a product that arouses desire. Something people want to have and can be proud to have."

## 10. Future

The machine also has a pretty proud price. The production model is expected to go for \$39,500 plus VAT. "Tooling and handcrafting are very expensive on the Novus Bike," Weidig explains. "And we want to achieve a high level of quality."

With a pioneering concept, unique looks and a production run limited to 1000 units, buyers should get a timeless machine for their money. With the Novus Bike being the first of its breed, it will be interesting to see if other manufacturers are going to jump into this niche as well.

And will the concept of the in-wheel motor, the carbon fiber monocoque and the battery in the bottom of the frame become the standard layout for future electric motorcycles? "That is difficult to say," Marcus says. "That concept was tailored to this horsepower class. We did not consider big bikes that can do 250 km/h."

## 11. Finding a new DNA

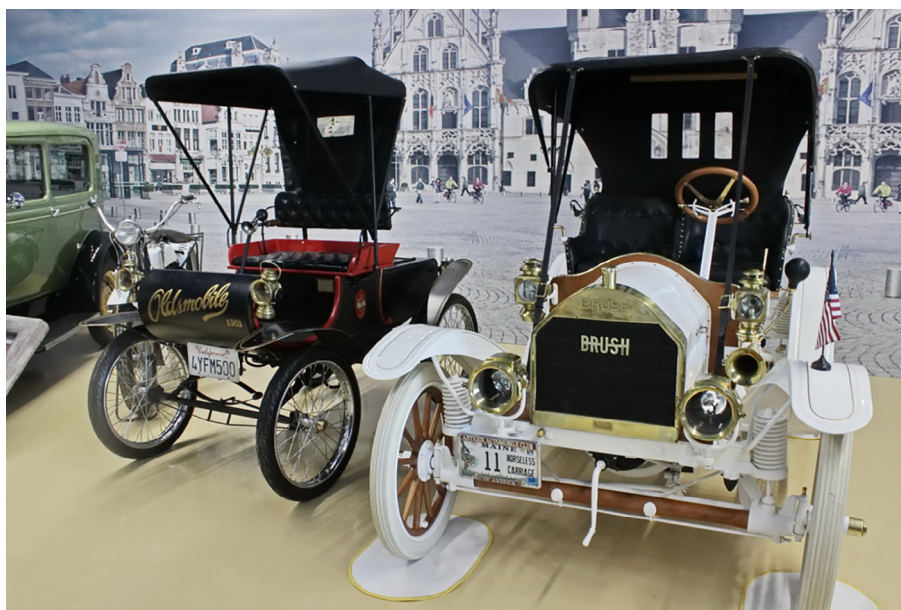
When motorcars started replacing horse-drawn vehicles in the late nineteenth century, for a long time they were engineered and designed like horseless carriages (See Fig. 12). It took a while for the automobile to find its own, unique engineering and esthetic DNA, exuding confidence about its innovative technology instead of trying to downplay that it does not have the traditional means of propulsion the consumer of the time loved and trusted because he had grown up with it. With its largely exposed propulsion technology, it seems inevitable that the motorcycle is now on the verge of a comparable revolution, having to completely reinvent its engineering and esthetic DNA.

Most electric motorcycles currently on the market still look like conventional bikes trying to hide their non-petrol-burning bits as if they are ashamed for them. That is why projects like the Novus Bike are a big step forward in the search for an electric motorcycle DNA, blending shape and technology in a confident way, fully embracing and even flaunting its propulsion and materials technology.

Chances are of course that future electric motorcycles will differ as much from the Novus Bike as modern cars differ from a Rolls Royce Silver Ghost or Ford's model T. More powerful motors and batteries may require different layouts and packaging. And maybe hydrogen is going to replace batteries, leading for example to a fiber reinforced polymer monocoque frame to double as the hydrogen tank.

But the Novus Bike shows what can already be achieved with current state of the art technology, providing you start with a blank slate. It – and the new class of vehicle it represents – would not have been possible without electric propulsion and advanced reinforced plastics engineering.



**FIGURE 12**

Initially, motorcars looked like “horseless carriages”, as can be seen in the Oldsmobile from 1901 on the left. In the 1911 Brush model E-26 roadster on the right, we can already see the automobile shedding its horseless image and starting to find its own unique engineering and esthetic DNA (Photo EhayDy/Shutterstock.com).

As carbon fiber reinforced polymers become more mainstream and as in-wheel motors and batteries become lighter and more powerful, this will open up a whole range of possibilities, maybe even as exotic as low-slung recumbents (as seen in the 1988 cult anime science fiction movie “Akira”) with motors in front and rear wheels.

Maybe the Novus Bike is laying the foundation for the motorcycle’s future DNA, greatly expanding the market for composites in motorcycles. Surely, its design philosophy and attitude should be the way forward for the motorcycle world: exciting times are ahead for two-wheeler enthusiasts.

## 12. Changing perceptions

Weidig and Renger are not willing to divulge yet what their next project is going to be. “This was a product of passion for us,”

Weidig says. “But we do not want to limit ourselves to motorcycles.” Renger adds that they are interested in a lot of other themes as well: “Novus as a brand represents generating and implementing ideas that stand out from what is already out there: waking people up and breaking with convention.”

They are looking into maybe using natural fibers and bio resins. And they are available for innovative projects, providing they match their philosophy. “The reason why we do it, is not just to make another luxury product,” Renger says, “but to change perceptions, and maybe in the end even influence societal conventions.”