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Factor 001 in-depth: Highest spec Formula One approach to design, materials and components

Factor 001 road bike advances design, materials and electronics applications to create the first truly modern training aid for the serious athlete.

Factor 001 is the result of a creative project by BERU f1systems to explore the transfer of design approaches, technology and materials from Formula One (where the company is a supplier of various components such as electronics and composites to every team) to mankind's most enduring invention. The result is the most advanced bicycle in the world, complete with a fully integrated, multi-channel ergonomic data recording system; a breakthrough development in non-automotive sports performance analysis.

Philosophy

Factor 001 has been designed from the ground up as an integrated, cohesive device. The priority is the rider; from ensuring maximum levels of comfort and safety, to enabling the enjoyment of outdoor training while collecting and analysing laboratory-quality data. Absent from the brief was a need to comply with the restrictive design regulations set out by the UCI – the governing body for world cycle sport – to avoid jeopardising the engineering-led design and training tool function. Factor 001 had to match other top end road bikes in terms of overall weight, while carrying additional equipment for its data recording system, and providing the lateral stiffness that deems many competition bicycles impractical for everyday training on the road.

Finally, to truly showcase BERU f1systems' motorsport prowess, the bike had to comprise as many original parts as possible; component technologies never before seen on a road bike.

Only the front and rear mechs, chain, saddle, and tyres, are off-the-shelf items. The pinnacle of the technology transfer from Formula One to cycling, and indeed other sports, is the bike's integrated data logging software.

Robust carbon-fibre monocoque chassis created from clean sheet

Highlights:

- Formula One modelling approach
- Lightweight carbon fibre monocoque structure
- Twin-spar made-to-measure frame
- Fully integrated structure using BERU f1systems' Wire-in-Composite patented technology

Factor 001 was designed using the same powerful modelling and analysis software used to build Formula One cars. The latest finite element analysis (FEA) codes were used to investigate and simulate the athlete's inputs over a broad range of road and riding conditions. Only when a full understanding of the structural forces had been gained, were any decisions made as to materials, form or manufacturing methods. The end result is a unique structure that is light, comfortable and capable of turning every last part of the rider's effort into efficient forward motion.

The bike is a lightweight (under 7 kg) carbon fibre monocoque structure. Representing a considerable feat in composites design and manufacture resulting from BERU f1systems' in-house expertise in variable geometry tooling, the bike's dimensions can be adjusted to the exact physical requirements of the rider. Customers will undergo a Formula One driver-style seat fit experience prior to their Factor 001 being built. The single piece frame avoids the use of structural joints which can typically reduce rigidity by approximately 15 percent; its M55J carbon fibre being the stiffest uni-directional material on the market.

While the machine retains the classic and structurally efficient diamond form, the major frame members split into two as they approach the extra-wide reinforced bottom bracket area. This places the maximum amount of material right at the edges of the frame's structure, allowing it to better resist the sideways frame flex caused by pedalling effort, and managing to avoid unnecessary reinforcement in the vertical direction.

Eliminating the heavy, structurally inefficient fork crown and carrying the fork blades all the way up to the top of the head tube has produced a design that is stiffer and more efficient than conventional designs. The twin-spar approach also reduces the peak loads on the steering bearings, for substantially longer maintenance free life. They are tuned to work perfectly with the carbon disc brake system, delivering maximum deceleration without chatter, even at high speeds on difficult road surfaces.

The frame performs an important aesthetic role in enabling the load sensors, batteries, wiring, control cables and lines for the hydraulic braking system to be fully integrated into the composite using BERU f1 systems' Wire-In-Composites technology. This gives unparalleled efficiency and durability with a clean, uncluttered appearance.

Ultra-strong lightweight monocoque wheels

The Factor 001 wheelset uses a unique composite construction to produce a light, strong and stiff 8-spoke wheel, capable of delivering a long service life in tough conditions. Unlike existing composite designs, which are fragile and limited only to track or smooth-road applications, the Factor 001 wheels are designed to cope with real world, everyday training.

The high strength composite skins, using BERU's proprietary fibre construction, are bonded to an ultra lightweight, durable RohaCell foam core. This core helps the wheels resist lateral forces, keeping them true through pothole strikes and energetic sprints.

Breakthrough carbon ceramic braking system

Factor 001's brakes were one of the project's most critical challenges, given the road cyclist's braking requirements over repeated rapid decelerations with highly unpredictable performance. In seeking to eliminate every possible variable, engineers chose a hydraulic disc design using a carbon-ceramic composite. The motorsport-grade material offers total consistency at any temperature and a braking surface that will deliver the same performance wet or dry, at the beginning of mountain pass or in the final hairpin of a 20km descent.

As the rider's control of a braking system depends on the feedback received at the lever, and the efficiency of power transfer from there to the braking surface, every point along that transmission path was analysed to eliminate sources of loss. Rather than soft, braided hydraulic hose, lightweight but rigid stainless steel pipes were built right into the structure of the Factor 001 chassis. Protected from damage by layers of carbon composite, these lines give the rider unprecedented braking power, with all the feedback needed to use that power wisely.

Multi-channel electronics package pioneers performance measurement in non-motorsport applications

It is the fully integrated performance monitoring system that transforms the Factor 001 from highly efficient road transport into scientific training tool.

Highlights:

- Unique ergonomic data collection, logging and analysis capabilities
- Biometric, physical force and environmental data harvested simultaneously
- Huge technology transfer potential to other sporting environments

Factor 001's electronics system provides unique performance data collection, logging and analysis capabilities that will enable athletes and their trainers to locate and calculate performance gaps, and access multiple sources of previously unavailable information. Developed with feedback from professional athletes, the technology has the potential to provide step changes in performance and competitiveness in cycling and beyond.

Biometric data

The physiological data collection package uses hardware from medical applications for the diagnosis of cardio-vascular problems, and works by transmitting information via Bluetooth from the rider to the bike's head unit, situated on the handlebars. It is able to measure ECG data, respiration rate, skin temperature, respiratory impedance and core body temperature, as well as the rider's vertical, lateral and longitudinal acceleration.

Physical force data

Information on the power generated by the rider is extracted via sensors in the cranks, which utilise BERU f1 systems' Formula One torque measurement system, that wirelessly connects to the bike's head unit. For the first time, the power output from the left and right leg can be measured independently throughout the whole pedal rotation, to an accuracy of one degree. This is measured as torque (Nm) at a sample speed of up to 350Hz. Athletes can then analyse this data in a graphical format using the supplied analysis software to maximise the efficiency of their pedal stroke.

Accelerometers measure the bike's left and right lean, incline and the rate of climb when ascending and descending. Other data gathered includes rear wheel speed, minimum, maximum and average torque levels for each crank, useful power generated by each leg and crank cadence. Offered as an optional extra will be Factor 001's infrared beacon kit, which comprises a bike mounted infrared receiver, and a free-standing infrared transmitter. The kit enables the bike's logged data to be automatically segmented, enabling direct data performance comparison over a series of laps.

Environmental data

Sensors monitor and allow storage of information pertaining to atmospheric pressure, altitude, ambient temperature and humidity. This provides a vital record for subsequent analysis and correlation when united with the physical force and physiological outputs. Factor 001 also comes complete with an on-board GPS system.

Combining these three sets of outputs allows athletes and their trainers to build a real time picture of road conditions, rider state and effort, and performance.

Factor 001's sensor network is built into the structure of the bicycle and connected by an integrated wiring harness that is protected by the composite chassis. The system is powered by a state of the art lithium polymer battery. The bike's 76mm x 57mm LCD touch screen display gives the rider customised feedback in real time, while hours of data can be recorded for later review. On-the-move, riders can choose the parameters displayed to them from over 100 channels, or easily select between one of eight screens they have pre-configured.

Notes

About BERU f1systems





BERU f1systems offers advanced design and manufacturing facilities for vehicle wiring harness systems, tyre pressure monitoring, stress measurement and composites. Supplied to world championship winning cars in every major formula and every Formula 1 team, components from BERU f1systems are now available in military, road car, aerospace and nautical applications.

Follow Factor 001 on Twitter (FACTOR001), Facebook (Factor 001) or via the website (www.factor001.com)

Pictures

High resolution copies of these images are available on

www.autopresspoint.com. Alternatively please contact Claire Dumbreck.

	<p>The Factor 001 – the world’s most advanced bicycle – was unveiled today (March 11th) at the Science Museum’s free exhibition, <i>“Fast Forward: 20 ways F1™ is changing our world.”</i></p>
	<p>Factor 001 – the definitive version of the innovative new road training bike – was launched today, and is now on public view</p>
	<p>Factor 001’s monocoque wheel is light, strong, stiff and capable of delivering a long service life in tough conditions</p>
	<p>Factor 001’s physical force measuring system can monitor riders’ leaning from left to right via sensors in the crank</p>

PR Contact

Claire Dumbreck at Market Engineering

claire.dumbreck@m-eng.com

Tel: 01295 277050 / Mob: 07768 773857

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