CLASSIC DRIVER

Crewe factory gears up for Bentley Continental GT

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The Bentley factory at Crewe has been described as 'the largest showroom in the world'. For years, owners and prospective owners from all over the world have come to see the hand-crafted cars slowly taking shape and to enjoy the unique experience of talking to the very people who build their Bentleys.

But the launch of the Continental GT poses a new set of challenges for Crewe. The W12-engined, all-wheel drive Continental GT is itself one of the most complex and advanced machines on the road. The production team at Crewe had the task of producing this exceptional new British Grand Tourer to benchmark quality standards, in greatly increased numbers, without losing the human judgement, core skills and customer interaction which form such a large part of a Bentley's appeal.

The result is not so much a new production line as a new factory. Every element of the production process has been re-designed, in close consultation with team leaders among the 1200 Crewe associates who work in Bentley production. Being part of the Volkswagen Group, Bentley Motors has benefited from an overall £500m/Eu800m investment programme, with Eu91m being spent directly at the Crewe site. Although the largest-ever investment made at the Crewe factory, this was no 'blank cheque' approach. The manufacturing engineering team took as their mission the achievement of world-class quality levels, on time, at optimal cost and - crucially - in a socially responsible manner.

Hand built Bentley engines -

From the earliest days of Bentley in Cricklewood, under the critical eye of Walter Owen (WO) Bentley, the design and build of the Bentley engine has always been the heart of the marque, and the Continental GT is no exception. In WO's day, coachwork was outsourced to a number of specialist coachbuilders, whilst today the Continental GT's body is produced at VW group production facilities in Mosel, Germany, benefiting from economies of scale. But the twin-turbocharged W12 Bentley engine for the Continental GT is, quite properly, built up from the base casting on site at Crewe.

The engine's crankcase and an entire 'kit' of parts for each engine is mounted on an Automatic Guided Vehicle (AGV), which is self-powered and equipped with laser-guidance tracking that follows defined black lines painted on the floor. The AGV visits each of the 16 assembly workstations in strict sequence, and remains at each for exactly 17 minutes. It thus takes four and a half hours to process

and test a Bentley engine with a total assembly time of 15 hours per unit.

Each engine is hand-built and the judgement of the skilled craftsmen who assemble it is used to select matched parts that balance exactly: crankshaft to main bearing, crankshaft to conrod bearing and crankcase to pistons.

The DC electric power tools used to torque up the engine's fastening nuts and bolts are linked to the AGV and its on-board monitoring system. As each bolt is tightened in sequence by the engine craftsman, the DC power tool 'reports' back to the monitor that the correct torque has been achieved. There can be no possibility of 'missing' a fastener or failing to tighten it to the required torque - until the task is complete, the AGV will not move to the next station.

Every Continental GT engine is first turned during a cold test to check that all is well, before being connected to the hot test rig and fired up for the first time. When production is under way each engine will be tested for at least two hours, with 10% of engine production being run for up to 48 hours under full power to validate the integrity of the assembly process.

Assembly Line - from body shell to "marriage station" -

As a Continental GT proceeds along the line and through the various workstations, its panels protected by tailored covers with the famous winged 'B' Bentley emblem, it slowly takes shape as a finished Bentley. In the Chassis 1 area, the wiring, hydraulic pipes, lights and HVAC (heating, ventilation and air conditioning) systems are assembled to the body shell. From there the shell passes to the 'marriage station', where it meets up with the engine, subframes and wheels, and becomes recognisably a Bentley Continental GT. Within the engine bay of the Continental GT the compact but massively powerful W12 engine and transmission is an exact fit, with not a millimetre of excess space. Fluids for hydraulics, HVAC, brakes and coolant are then added, but not before each system in turn is tested for leaks, first under pressure, then under vacuum. If no leaks are detected, the vacuum is then used to draw the fluids through into its various reservoirs and pipes.

Wood - new techniques reinforces traditional skills -

The unbleached fine wood veneers of a Bentley's fascia, console and waistrails are an essential part of the character of the marque, and Crewe's expertise in wood makes it unique in world automotive production.

Naturally, Bentley's woodshop still uses only the finest sheets of hand-selected veneer, but in cutting the veneer to shape, new technology has helped to cut waste and improve quality. Laser cutters, accurate to 0.25mm, cut the veneer sheets to shape - Bentley still insists upon veneer that is a full 0.6mm thick, rather than the industry norm of 0.4mm.

Bentley's fascia panels have always displayed 'mirror-matched' veneer patterns, with one side exactly reflecting the other; only possible when two adjacent wafer thin leaves have been taken from the same tree. The Continental GT is no exception, and the signature join of mirror-matched leaves is 'stitched' together at the rear with a zigzag glue weld.

Between the substrate panel and fine wood veneer comes a sandwich of two cross-grained constructional veneers interspersed with three paper glue sheets, with a base sheet of Mylar to adhere to the substrate and the final leaf of fine veneer on top. This is pressed and bonded for 4 minutes at 135°C before being hand-sanded using belt-driven mops, a process called soft form sanding. A 'fladder mop' - fingers of fine grain abrasive in a revolving mop - almost caresses the surface of the veneered panel, enabling the Bentley craftsperson to see that even the contours and apertures for dials and switches are correctly sanded before PU lacquering.

But first the veneered panels are carefully inspected by woodshop craftsmen, who use a 'wet mop' to bring out the veneer colour. This highlights any area of minor discolouration, so that the panel can be touched in by hand before the colour is sealed in by PU lacquer in sealed, dust-free spray chambers. The lacquering of the veneered panels is one of the few areas of Crewe where robotics are used. Bar-coded carriers identify the panels, so that the robotised spray arm can read the code by laser, 'recognise' the component and follow its shape precisely. A 50,000 gallon water backdrop catches all overspray and separates it out so efficiently that it needs only two top-ups a year: for the most part the water is recycled to be used over and over again.

A minimum of 72 hours is required to cure the lacquered panels before the final flatting, after which the panel is machined around the edge to achieve the final exact panel size. Even here Crewe's attention to detail ensures that the panel edge of aluminium and its veneered surface is edge-painted to match the chosen veneer, so that no telltale flash of aluminium can ever be seen around the edge once the fascia or console is in place within the finished cockpit.

All told, a full set of 15 separate veneered panels for each Continental GT takes between 16 ½ and 18 ½ man-hours to create, considerably shorter than the 58 hours required to create a Bentley wood set for the previous generation of Crewe-built cars.

However, wood is a natural material and cannot be hurried: including the time taken to stabilise the humidity of the veneer sheets, and the 72 hours for curing after lacquer spraying, the total time required to make a set of panels for the Continental GT comes to 10-12 days, making the wood set the sub-assembly with the longest lead time in the entire factory.

Upholstery and trim traditional - Bentley skills and human judgement oversee laser-accurate execution -

Much of the character of a Bentley comes from the ambience of the interior. A keynote of this is the tactile and olfactory delight of hand-stitched full leather trim covering every surface, made using the finest grade leather. But even on the best quality hides there are tiny flaws and minor imperfections, and the judgement of the men and women in the Crewe upholstery shop is critical to ensure that each matched set of hide is as consistent and smooth as possible.

Previously at Crewe, the individual panels were cut out of the complete hide using a press and cutting forms, which were positioned by hand to make best use of the material. In contrast, for the Continental GT the hides are cut using a computer-guided laser cutter. However, human judgement is still critical to the process; craftsmen and women use fluorescent tape to mark the areas of the hide that contain flaws or graining imperfections, and the laser cutter automatically computes the optimum use of the hide to cut out the differently-shaped and dimensioned panels whilst avoiding the marked areas.

The result is that whereas the previous system required up to 15 hides to create a set of hide trim and upholstery for just one car, the new technology enables the same quality to be achieved for just 11 hides per Continental GT.

Complete upholstery sets are still made the traditional way using sewing machines, and some of the

most intricate parts of the hide trim are still created by hand. A Bentley steering wheel's immaculate hide cover, for example, is double-stitched by hand using two needles simultaneously, and the craftsmen and women who perform this task have their own specially designed stations for this exacting and detailed work.

The Continental GT reaches completion -

Back on the production line, the sub-assemblies such as seats, fascias, trim and doors are all prepared in areas alongside the production line, another aspect of the re-designed factory that helps to ensure that lines of communication are kept short and effective. Throughout the assembly hall, overhead illuminated displays provide line managers with an instant readout of any areas of concern. Each Crewe associate working on the assembly line can stop its progress by a pull cord next to his or her station; this will automatically show on the display to identify the exact point of hold-up. But the reporting system is also programmed into the power tools themselves. In the unlikely event, for instance, that a bolt has a piece of swarf in its thread, the DC electric power tool will be unable to tighten the fixing to the correct torque setting, and this information will automatically stop the line, ensuring that the Bentley in question proceeds no further until every fixing is perfectly tightened.

In addition to built in process controls, production have established an ethos in the workplace that promotes "right first time" and a way of working where each associate will carry out "buddy" checks to ensure each and everybody in the team are working together to achieve this target.

Close by the production line is the quality area, where there is a Continental GT bodyshell, machined out of solid aluminium to the master dimensions of the car. This 'full-size functional checking fixture', known as CUBE, means that any fitting or compatibility issues with components or sub-assemblies can be taken straight to the master and the cause swiftly identified.

The finishing touches -

As the Continental GT proceeds towards the end of the assembly line, it passes into a rheostatically controlled lighting booth where bodywork and finish can be examined under perfect lighting conditions. From here it is driven onto the hydropulse shake rig - simulating a brisk drive over uneven road surfaces - which give the suspension the opportunity to 'settle' to their normal ride height.

Once the drivetrain and suspension has reached its normal road-going state the Continental GT passes to the next station where castor and camber are checked and set using laser guided technology. Only then can the headlight alignment be set once it is certain that all aspects of the chassis and ride height are to their correct specifications.

From here the Continental GT passes into a rolling road cabin where it is run at varying speeds for a minimum of 12 minutes in order to check all functions and measure acoustic performance. The finished car is then driven down the test track to check for rattles and squeaks before passing to the 'monsoon test' - an intense shower test lasting a full 17 minutes - to ensure than not a drop of water makes its way into the cabin. Every Continental GT is checked, and every Continental GT is drive tested on the road, before it is considered to have passed Checkpoint 8: the final point in the production process, after which it is passed over to become the responsibility of the Sales division, en route to one of the 140 Bentley Dealers throughout the world.

Site logistics - Traffic flow of key importance and deliveries -

The commitment to Continental GT and its increased production volumes requires a lean manufacturing 'Just In Time' supply system. As a result, traffic flow is of key importance, and by clearing unused parts of the site around 15% more space has been won so that deliveries can be smoothly processed via two receiving areas under large new weatherproof canopies.

Crewe will keep on site up to three days' supply of bodyshells, which arrive already painted from the Volkswagen Group's production facility at Sachsen in Mosel, Germany. The shells are stored on automated storage racking, so that the correct shell and body finish can be called off for its journey down the assembly lines in due order.

Just one day's supply - two shifts'-worth - of other components will be stored at Crewe. Thus the smooth flow of components onto the production line as they are used - the KANBAN system - is a key element of the new Continental GT production line, and a fleet of tow trolleys will circulate throughout the assembly lines, constantly replenishing component bins.

Transit packaging of components and sub-assemblies poses its own set of challenges. Removing and compacting large amounts of packaging can take up time, cost and space, whilst its disposal creates environmental impact. The solution for Bentley Motors has been to invest in heavy-duty re-usable crates and packaging, and provide them to each of its suppliers, so that as each truck arrives with a fresh delivery of components, it is first unloaded and then refilled with the previous day's empty cartons, ready for re-use.

Attention to detail - a Bentley priority -

One of the first things the visitor will notice upon entering the assembly areas is the cleanliness of the factory, an obsession that extends down to the smallest detail. Rubbish sacks are made of clear plastic, so that team leaders and managers can see at a glance that the correct waste has been put into the proper place. Cupboards are glass-fronted so that their contents are visible - the philosophy is not to have any unnecessary clutter anywhere in the workshops. Around £750,000 (Eu 1.1m) has been spent on the floor finish alone. It is a metallised acrylic coating, originally designed for hospital and laboratory use, which can be buffed spotlessly clean at the end of every double-shift. By every workstation there is a 'shadow board' with stencilled spaces for dustpan and brush, and each workgroup is responsible for sweeping up any litter or debris in its area.

Even the tool chests, component bins, cupboards and workstations are mounted on large rubber-tyred castors, so that the entire line can be cleared for cleaning once a day.

Bentley Motors' greatest asset - its people -

In planning the new Continental GT production facilities, the directors of Bentley Motors were adamant that they did not want to change the special character and individuality of a Bentley, which strongly derives from the people who design, engineer and build it. Despite the considerable increase in production volumes, automation throughout the Continental GT line at Crewe is only ever used as a means of achieving higher levels of quality, rather than a way of 'de-skilling' the human input. Thus there are only two areas of the Continental GT line where robotised machinery substitutes for human being: the lacquer spraying of the veneered wood sets, where both consistency of spray path and health and safety issues make the machine an intelligent alternative; and the robotised application of glazing adhesive in a continuous bead around the window and windscreen apertures of the bodyshell, a monotonous task requiring utter consistency of bead size and nozzle path. Other than these two areas, every assembly operation is guided and controlled by the skilled men and women of the Bentley Crewe factory.

In stark contrast to the Crewe of yesteryear, each working area has a rest area close by the line, where associates can take their tea and lunch breaks and relax. Each area has comfortable seating, a fridge and a microwave oven, so that associates do not have far to walk when the break bell sounds.

Crewe has added to its production staff in preparation for the launch of Continental GT, and those directly employed in production now number 1200. Before any new recruit can work on a Bentley, he or she will spend five weeks in a combination of classroom and practical training. Being Bentley, and committed to unique standards and working methods, the production team elected to create their own specific training programmes staffed entirely from within Crewe, rather than buying an 'off the shelf' training solution.

Once within the factory, new associates are allocated to work groups, each with its own team leader. The ratio of team leaders to associates throughout Crewe is 1:6, and the team leader for each area is qualified to perform every task within that group. Daily briefings before each shift flag up any areas of concern, that in turn are reported upwards if the team leader is unable to resolve them. This way, not only are any potential bottlenecks identified swiftly, but every associate is empowered to make

suggestions that will improve either quality, productivity or both, as well as being able to develop their own preferred work patterns. Every associate is also recorded on video performing their work, so that the team can study them to find areas of improvement.

A new Crewe - a new generation of hand-crafted Bentleys -

In comparison with the highly bespoke Bentley Arnage R and Arnage T, which typically require around 500 man-hours to create, each Continental GT to leave the site at Crewe will have taken some 250 man-hours to build. But it is worth putting these figures in context: for example, a typical high-volume family saloon or hatchback will require somewhere between 20 and 30 man-hours to assemble from start to finish.

The Continental GT is therefore a highly individual and hand-crafted car, whose performance, quality of materials and design represent exceptional value at its pricing level. More importantly, the very factors that make owning a Bentley such a unique experience - the sense that one is driving a hand-made performance machine, made to one's own preferences and specification - are both retained and safeguarded by the investment, both human and financial, that has been made in Crewe.

To visit Crewe and to see a Bentley being crafted is one of the wonders of the automotive world. In creating the Continental GT production facility, Bentley Motors has ensured that this pleasure will be experienced by a new generation of Bentley drivers, enjoying the sense of personal involvement and commitment that only Crewe and its craftspeople can generate.

Text/Photos: Bentley

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