

## Manufactory 4.0

At "Böllinger Höfe," quattro GmbH's new production facility, man and machine work hand in hand. Here, the Audi R8 is brought to life step by step in a precision mix of manual and automated operations.

Eva Bolhoefer (copy), Myrzik & Jarisch (photos)



With meticulous precision, workers delicately apply the finishing touches to the body during surface inspection.



**01** The innovative tilting lift allows safe working on the vehicle's underbody. **02** With the aid of a profile gauge, irregularities in the aluminum surface are identified and subsequently smoothed. **03** Using a gap gauge, workers measure the dimensional accuracy of doors and other add-on parts to within hundreds of a millimeter.

01

As part of an inconspicuous industrial park surrounded by fields and greenery, a futuristic building complex rises into the Baden-Württemberg sky on 230,000 square meters of space. A diamond-shaped glass cabin bearing the legend "Audi Sport" in big red letters serves as a worthy showroom for the high-performance Audi R8. This is quattro GmbH's new production facility Audi "Böllinger Höfe" in Heilbronn, where the super sports car is hand-built. Unlike in high-volume production, where most work processes are automated, the 492 employees here still perform many tasks by hand. It begins in the body shop, where experienced welders join individual aluminum beams step by step into frame parts that will ultimately form the basic chassis of the new Audi R8. Once all the parts are joined together, they make up the enhanced Audi Space Frame which, thanks to a combination of aluminum and carbon-fiber-reinforced plastic (CFRP), makes the new Audi R8 up to 50 kilograms lighter than its predecessor.

"The workers in the body shop have to be able to weld aluminum precisely by hand. That demands a great deal of skill and concentration," explains manufactory manager Jochen Wagner. One of those workers is fusion welder Dimitri Thyssen, who is currently busy with his colleagues attaching the roof of the new Audi R8 to the Audi Space Frame. The ice-blue flashes and star-shaped sparks reflected in the visor of his welding helmet bring to mind an oversized sparkler. "I've been working in R8 production for eight years now. I know exactly what to look out for," explains Dimitri, his voice raised to carry above the metallic background din. "We are a seasoned team, every movement is practiced to a tee," he adds.

### The Internet of Things for the factory of the future

The hand is an important tool also in the finishing shop. Here, workers apply the finishing touches to the body, smoothing out minor imperfections to micro-millimeter accuracy. A wooden profile gauge they run over the surface identifies defects in the aluminum. But even the gauge can't reveal every blemish, and that's when sensitive fingertips are called for. Body shop worker Jan Koprivnik has them: "Sensitivity can be learned to a certain degree, but you also need talent," he explains. As well as tactile faculties, precision filing skills are also required in the sanding area. "Some of our workers are trained carpenters and have a great deal of experience in this area. And the contours of the new Audi R8 are much sharper compared to the previous model, so this poses another special challenge," says Koprivnik, pulling a pair of white gloves over his sensitive fingers.

Workers like Dimitri Thyssen and Jan Koprivnik are central to the manufactory, where man and machine operate as a team. This is particularly evident in the assembly area. Here, workers are assisted by a "driverless transport system," or DTS. Its extremely flat, compact vehicles carry car bodies into and around the shop completely autonomously. You meet them on the shop floor as you would a colleague fetching coffee. Once it arrives in the assembly shop, the DTS vehicle automatically takes up the correct position in the production sequence. In the specified cycle time of 41 minutes, it travels autonomously on to the next of 15 assembly stations. "Thanks to the innovative navigation system, which is guided dynamically by features in its surroundings and can be reprogrammed when required, the DTS always finds the right way, ensuring a high degree of flexibility in the production process," says Wagner. "Plus, the DTS is height-adjustable, so our people can work at just the right ergonomic position. This is a big step toward the smart factory and Industry 4.0." >>



03



Preparation of the body for adhesive bonding of CFRP parts.

The smart factory of the future harnesses the Internet of Things to optimize flexibility, resource efficiency and ergonomics. The term "Industry 4.0" stands for the fourth industrial revolution, after mechanization with water and steam power, mass production using electrical energy, and the use of electronics and IT. Worker health and safety plays a central role. Innovations in the assembly shop such as the ergonomic tilting lift that can pivot 90 degrees in both directions enable employees to carry out assembly tasks on the underbody without strenuous overhead work.

In the assembly shop, the body is brought to life step by step.

The people who work in the Audi R8 assembly shop need a good memory. The cycle time here is 41.5 minutes, as compared with the mere five minutes in volume production. "The workers have to fit up to 50 parts in a predefined sequence and master up to twelve different tools," explains Wagner, describing the complex work steps. Installing fittings, wire harnesses, inner panels, engine and transmission, the workers bring the body to life step by step until its metamorphosis into the Audi R8 super sports car is complete. But before leaving the factory on their way to customers around the world, the cars first undergo stringent quality controls. These include analysis in the light tunnel. Here, not even the tiniest scratch or inconspicuous bump escapes the attention of inspector Bianca Kreis. Aided by special inspection lights, her trained eyes and sensitive fingers and palms pick up even minute blemishes on the outside and inside of the car. "What I like particularly about my work is the variety—plus, I love sports cars," says the trained master mechanic who has worked at Audi for 25 years. "I look at every little detail to make sure the Audi R8 is defect-free when it leaves the manufactory." >>

Ten Audi R8 a day are built at the "Böllinger Höfe" manufactory, mainly by hand.



The devil is in the detail: Welders need concentration, experience and a steady hand.



The Audi R8 undergoes leak testing in the spray chamber. Within six minutes, around 1,200 liters of water rain down on the vehicle. The car is then dried and inspected for water ingress.

Just as Bianca Kreis is responsible for visual quality control, test driver Sadik Morina ensures that everything inside the Audi R8 works as it should. He drives the vehicle over a vibration test track in order to pinpoint unusual noises or other irregularities. "During the subsequent road drive, we test the Audi R8—also at higher speeds—to make sure everything's OK," explains Morina. "Then it goes through a final inspection. When it finally leaves the factory, it's really something special."

They are all proud to work at a place like this, where hand-built and high-tech go together to create one of the most impressive cars the auto industry has to offer. //

*Audi Audi R8 V10 plus Coupé fuel consumption urban/extra-urban/combined (in l/100 km): 17.5/9.3/12.3. CO<sub>2</sub> emissions combined (in g/km): 287. Audi R8 V10 Coupé urban/extra-urban/combined (in l/100 km): 16.7/8.4/11.4. CO<sub>2</sub> emissions combined (in g/km): 272. Where stated in ranges, fuel consumption, CO<sub>2</sub> emissions and efficiency classes depend on tires/wheels used.*

#### More information:

The "Audi Böllinger Höfe" site covers 23 hectares, around a quarter of the area of the plant in nearby Neckarsulm. It gives Audi leeway to further optimize structures at the Neckarsulm site and consolidate central units of quattro GmbH. At the same time, it has created additional jobs in the region.

Unlike in volume production, welding here is still carried out by hand. It calls for great skill and precision, which is why it is carried out exclusively by experienced craftsmen.

