

Carbon-roof, BMW, Germany Case study: Grinding



Trimming of structural elements from high-tech materials, such as carbon fibre, requires utmost care and highly automated processes to achieve reproducible results concerning quality and productivity. This is essential in grinding large surfaces of “Class A” parts of automobiles or visible components in aviation and yachting industry.

As so often, the impetus for developing and implementing new technologies and materials comes from companies of the space and aircraft industry as well as automotive manufacturers – especially from motor sport. Modern yacht and shipbuilding industry also contributes to the development. They all share the quest for a more favorable weight per

horsepower to save fuel and to achieve better driving dynamics as well as higher transport payloads – with no losses in security.

This requires materials fulfilling demanding criteria concerning stability, corrosion and weather resistance. High-tech materials typically require completely different manufacturing technologies. One example is the grinding of big structural parts as the striking carbon-fiber roof of the new BMW M3. KMT Robotic solutions developed the necessary technology in cooperation with BMW Landshut, Germany

Because of its extreme lightweight, a carbon roof reduces the mass of the vehicle about 5 kilos compared with a roof made of metal. These savings in weight achieved at the highest point of the vehicle lowers its mass center point and thus gives the car greater stability and greater driving dynamics. Furthermore, it results in remarkable lower fuel consumption due to the lower weight.

In addition to the technically relevant aspects the carbon roof is an unmistakable and exclusive eyecatcher due the fact that the coated fabric structure just got clear varnish. Thus the striking carbon fiber structure remains visible. To set this

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optical effect well in scene requires much expertise in surface treatment. An important step is the grinding, which made it necessary to develop an entirely new technology.

Benefits of automation

Manual grinding cannot guarantee the high level of uniformity and quality. The reasons are in the muscular fatigue of the worker as a result of physical effort and the decline in concentration because of the monotonous work. Exclusion of these weaknesses required the development of a new and totally automated grinding robot cell.

The automation specialist KMT Robotic Solutions (based at Wetzlar, Germany) got the contract for this challenging job. The experts in 3D jet cutting systems and mechanical processing of plastics developed a customized solution.

Intelligent processing

The manual grinding process was too time consuming and frequently led to deviations from the required quality. The goal was to reduce the processing time and to increase reproducible grinding qualities.

That is why KMT-engineers at first analyzed all relevant aspects of the grinding process itself. The result is convincing: With the new grinding robot cell it takes BMW just 50 % of the normal time for grinding the Carbon-roofs.

KMT paid particular attention to the development of the movements of the robot-guided grinding head, which had to adapt automatically to the curvature of the roof. A rigid mounted grinding head at the robot's wrist could hardly do the job, but the KMT developers found an innovative solution: A grinding head that allows automatic adaptive control of the pressing forces of the movable stockpiled grinding head. That guarantees consistent grinding conditions all over the treated surface and constant grinding quality.

The KMT-engineers had to face another challenging task. The conventional programming of robot paths via "teaching" proved too complicated and was practically not economically feasible.

To solve the problem, KMT developed their own programming tool. Within just two minutes it generates complex robot paths from 3D-CAD-data. And once programmed, the robot always moves the same way, while the grinding head simultaneously makes all necessary adaptive moves.

After the development of the complete process, KMT had to come clean. For this reason the robot had to grind 30 carbon-roofs as a representative sample. The result of this „field-testing“ convinced the principal along the line and led to a supply contract for the complete grinding system.

But there was still one problem more to solve: the complete system had to be dismantled for lifting to the first floor of the workshop with an elevator. There the KMT-mechanics should mount the single parts of the robot cell to a turn-key plant. In an extensive PC-Simulation the KMT engineers sliced the cell, optimized the individual components and also checked the assembly in a virtual reality surrounding.

Improved working environment

Besides all technical and economical aspects there is another point to recognize. One major reason for the development of a robot guided grinding system is the health of the workers. Monotonous physical burdens are among the main reasons for physiological long-term diseases.

Hand-guided grinding causes permanent vibrations to hand and arm. These vibrations cause irreparable degenerative diseases of bones, nerves and muscles. This is a serious issue in terms of safe work-places and to avoid long-term occupational diseases. Thanks to the robot grinding cell, these burdens for the workers ruled out.

Outlook

The new robot grinding system is technically a novelty in the market, because so far robots could not properly grind such varnish. The development of the grinding head with adaptive pressing-on-control opens entirely new perspectives. This technique is interesting outside of the automotive industry in all areas, where it comes to grinding of large and curved surfaces made from carbon or other hightech fiber materials.

FACTS

About KMT

KMT Robotic Solutions is a system integrator of and ABB partner with extensive expertise in three dimensional waterjet cutting and machining. The robot cell installed at BMW is based on the very robust foundry edition of the ABB-IRB 2400-16 F.

web site: www.kmt.com

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