

## Surface measurement online

Perfect colour matching and first-class appearance are two of the most decisive quality characteristics in the automobile industry.

That is why integrated quality control and constant quality management are indispensable. BMW now employs automated quality control that is setting new standards.

BMW's specifications on a new system for inspecting the surfaces were extensive: a robot-aided measuring cabin for continuous process monitoring shall monitor the colour tones, surface structures and coat thicknesses on painted car bodies. The measuring cabin must – according to the car maker's requirement – be integrated into every factory of the BMW Group, and deliver comparable values between the online and offline painted body parts. The data thus obtained shall help to systematically optimize and statistically record the painting process. From this, BMW expects a closed quality loop in production.

This is the first time a system of such extent has been implemented

by an automobile manufacturer. For the development and construction of the system, BMW employed the services of Asis GmbH of Landshut in Lower Bavaria.

Since the system was planned to be implemented in the Regensburg, Dingolfing, Oxford and Leipzig factories, a system had to be defined that met not only the car maker's specifications, but also those of the individual factories.

- Conformity to the respective factory standards.
- Continuous measurement for up to 30 percent of production.
- Uniform calibration concept.
- Comparable plant engineering and components.
- Same interface to the process databases.

### Triple measuring head saves time

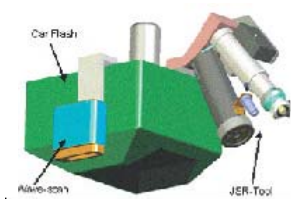
Asis supervised the design and layout phase and took on the planning of the system and interface engineering. The company also developed the system software and operation design as well as the data exchange to the main levels for measurement data transfer.

In the first step, the possible installation situations at the factories were analyzed according to the desired capacity requirements. Since the measuring cabins can have different cycle times depending on the desired number of measurement points per car body, it was decided to divert the bodies to be measured out of the production lines. That way, the plant operator can decide, depending on process requirements, whether more different bodies or more measuring points per body are necessary for his evaluation without influencing the flow in series production. Even fine measurement with several hundred measuring points per area are possible.

For this purpose, the control engineers integrated a selector by which a selection can be made type, colour or specific bodies. Also, the measurement systems and the areas to be worked on are freely definable for each body. The possi-



◀ Robots measure the painted car bodies, ensuring reproducible results



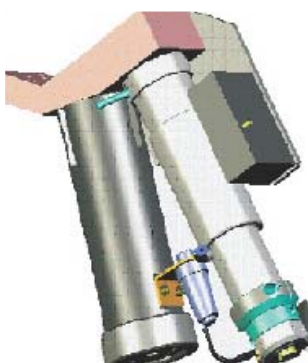
▲ The newly developed measuring head measures the surface structure, colour tone and coat thickness



◀ With laser technology, the wave-scan scans the car bodies without contact



◀ The colorimetric head can detect colour tone differences in online and offline painted body parts



◀ The coat thickness sensor detects up to five coats of paint

Automatic quality control is more efficient and cost-effective than manual measurement ▶



ble robot types, including axes and their ranges were determined by accessibility studies. The safety concept for the systems resulted from the respective hazard analyses of the robot station and instrumentation used.

The system manufacturer Asis, together with the instrumentation suppliers (Byk-Gardner, X-Rite and JSR Ultrasonics) designed a triple measuring head that achieves effective and efficient quality control at the same time as considerable time savings. In addition to the challenges that an industrial environment holds in store for

instrumentation, the conformity to the respective factory standards is also guaranteed.

### Measuring curve structures by wave-scan

A major factor in colour recognition is the orange-peel effect. For measuring the curve structures on the surface of car bodies, a wave-scan (by Byk-Gardner) is integrated on the robot.

The robot moves the wave-scan over the measured section without contact. A red laser, as point-light source, lights the paint surface with its divergent ray beam. The sides and radii of the paint surface augment or diminish the divergence of the reflected ray beam, and thus lead to local variations in intensity. During a scan motion, the light intensity at the sensor is recorded in dependence of the site, and the signal separated in its wavelength ranges by mathematical filters. The measured values are scaled from 0 to 100, where a plane and polished glass sheet that creates no variation is

rated 0. The values of the wave-scan correlate to the slope of the surface profile.

### Ensuring colour tone

Colour measurement is an important test process, in order to recognize variations and creeping trends in the paint application early on and thus ensure the colour tone stability. Even the slightest differences in colour parameters can result in the perception of a completely different colour.

For this reason, the Carflash colorimetric head by X-Rite has a multi-angle spectral photometer for colorimetric measurement. The spectral photometer measures the reflected spectral range in steps of 10 nm. The lighting, or measurement, is done at different angles, since the colorimetric head also has to measure metallic effect paints that produce different visual colour impressions depending on the angle of lighting and observation. In this case, surface radii in the range of -400 mm to 100 mm are realized.

## ASIS GMBH

Asis Automation Systems & Intelligent Solutions GmbH in Landshut has existed since 1998. As a specialist for innovative automation solutions, paint technology, control cabinet and plant construction as well as engineering, Asis provides solutions to clients from the automobile and supplier industry across the world.

What is essential for colour measurement are the correct alignment of the colorimetric head to the surface of the object being measured and the correct distance of the measuring head from medium. The ultrasound-positioning unit of the colorimetric head, together with the robot, performs the fine adjustment of the measuring head. It guides it towards the predefined measurement point down to a distance of 35 mm. In order to guarantee constant quality, the colorimetric head is freely parameterizable for calibration.

### Depicting paint coats

When choosing a suitable measuring system, the developers decided upon the coat thickness measuring system "RoboticPelt" by JSR Ultrasonics. With precise positioning, their ultrasonic sensor achieves a resolution of 10 µm to 250 µm, +/- 1 µm, for up to five coats. It can therefore depict the paint structure of the individual layers. By the fine measurements programmed into the system, variations in the paint application on the car body surface can be measured and displayed. That allows selective process optimization.

### Conclusion and outlook

The great advantages of the robot-aided measuring cells for carmakers and their suppliers are the enormous time savings of automated measurement in comparison to the former manual measurement. Also certain to be greatly pleasing is the reproducible measurement precision. This has been demonstrated by many measurements on the systems already built at Regensburg, Dingolfing and Oxford.

An identical system will be set up in the Leipzig factory in the second quarter this year, thus completing the integration of the automated quality control at the BMW factories.

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