How to control Color Appearance within the Interior Automotive Supply Chains

Walter Franz
Datacolor, Inc.
Zurich, Switzerland

Improving further the appearance harmony of a car interior is an increasing demand in today's automotive industry. Appearance harmony means that, when color and gloss components in a finished car are matched to a standard, there is a high correlation with visual assessment independent of material and texture. The standards now used are physical standards which are distributed to everybody who is involved in this process. The interior supply chain is very fragmented; the number of samples needed is high and the logistics is complex. In addition physical standards are not stable over time and are afflicted with a certain production tolerance. On the other hand, today's requested production tolerances of a car interior are very tight; this includes also the gloss readings of all visible components. The requested colorimetric specifications for a spectrophotometer are regarding inter-instrument agreement DEab < 0.1 (CERAM Tiles) and regarding gloss +/- < 0.1 GU.

To control the color of a car interior, one can avoid logistical problems by replacing material standards with digital standards, but only if the spectrophotometers in the process measure consistently over time and have good inter-instrument agreement. They also must be portable if the measurements are to be performed *in situ*. Also, the industry preference for spectrophotometer geometry is 45/0. Why 45/0? The German Association of Car Makers (VDA) proved that this geometry delivers better correlation with visual assessment than sphere instruments. [The referring recommendation is called VDA 280/1.] The advantage is conferred by eliminating the gloss component of reflection, which is not completely absent from any form of integrating sphere measurement.

A new 45/0 handheld spectrophotometer was developed to overcome the barrier to digital standards, so now such standards can be used to achieve the requested interior quality. A description of the instrument will further reveal the components of good color quality control in automobile interiors.

Measuring Head (US Patent 8,130,377): To optimize the signal/noise ratio and for a long lifetime, LED illumination was chosen. In addition LEDs can be well managed regarding their emission behavior. A set of 18 LEDs are placed on a circle illuminating a circumferential concave mirror above this circle. The mirror is then illuminating the sample under 45°; its design guarantees well mixed white light with continuous power distribution in the visible wavelengths range from 400 to 700nm. The sample is observed under 0°. Important: the LEDs are used for illumination only; the spectral dispersion is done by a dual-beam spectrometer.

The inter-instrument agreement of this device is enhanced by in-factory correlation of each unit with a master instrument (which may be virtual). Once a unit is correlated and

leaves the factory, one can use it in conjunction with digital standards for QC of color in the field.

To benefit from high interinstrument agreement it is important to realize high reproducibility especially for textured samples. Rotational sensitivity must be minimized. This is achieved by well-balanced emission characteristics of the diodes. Every diode group (a group having a given spectrum of emission) is controlled separately so that the directional sensitivity of the device is not significant for automotive interior samples.

Spectrometer: a dual-beam spectrometer was chosen reading every 2nm within 400nm and 700nm for both measurement and reference channel. Reporting interval is 10nm; the optical bandwidth is < 10nm. The reference channel detects the light emission of all the diodes so that a very high repeatability is achieved.

Gloss Measurement: For efficient work flow, the automotive industry requested to measure reflectance and gloss in parallel. A separate optical set-up is integrated in the measuring head to realize true 60° gloss readings which are used in the car industry. Although correlated in the factory using 6 different gloss standards it appeared that in grainy samples the requested inter-instrument agreement of +/- 0.1 GU could not be achieved. Therefore an in-field correlation algorithm was developed to overcome this problem. This means that every unit can be correlated to a given master instrument.

Tests in the automotive supply chain have demonstrated success in the goal of using digital standards to achieve color communication. The optical design is robust enough to ensure inter-instrument agreement and reproducibility even for textured materials.

In summary, here is how to control color appearance in automotive interiors: Design a workflow that uses digital rather than material standards, use a fleet of 45/0 handheld spectrophotometers that have good illuminant stability and azimuthal symmetry, correlate the units to each other to ensure inter-instrument agreement, and make sure that a calibrated gloss-meter is included in the spectrophotometer to enhance the efficiency of the workflow.

Author biography

Walter Franz is the Director of Global Business Development at Datacolor. His education included studies at the University of Ulm (FH), Germany, with the Faculty of Physics and Micromechanics, leading to certification as a Graduate Engineer (Dipl. Ing.). He first worked for the Carl Zeiss company in Oberkochen, Germany, as a regional sales manager for analytical instruments. Then, in 1984, he transitioned to Datacolor International, and has held various positions of sales and management since then. Since 1994, Mr. Franz has been the Seminar Chairman at the German Plastics Center in Würzburg, focusing on color science in plastics. He has also taught Color Science at the Institute for Pigments and Paints in Stuttgart. Finally, he has been a continuing member of committees in DIN (German Industrial Standard) and VDA (German Association of Car Makers).