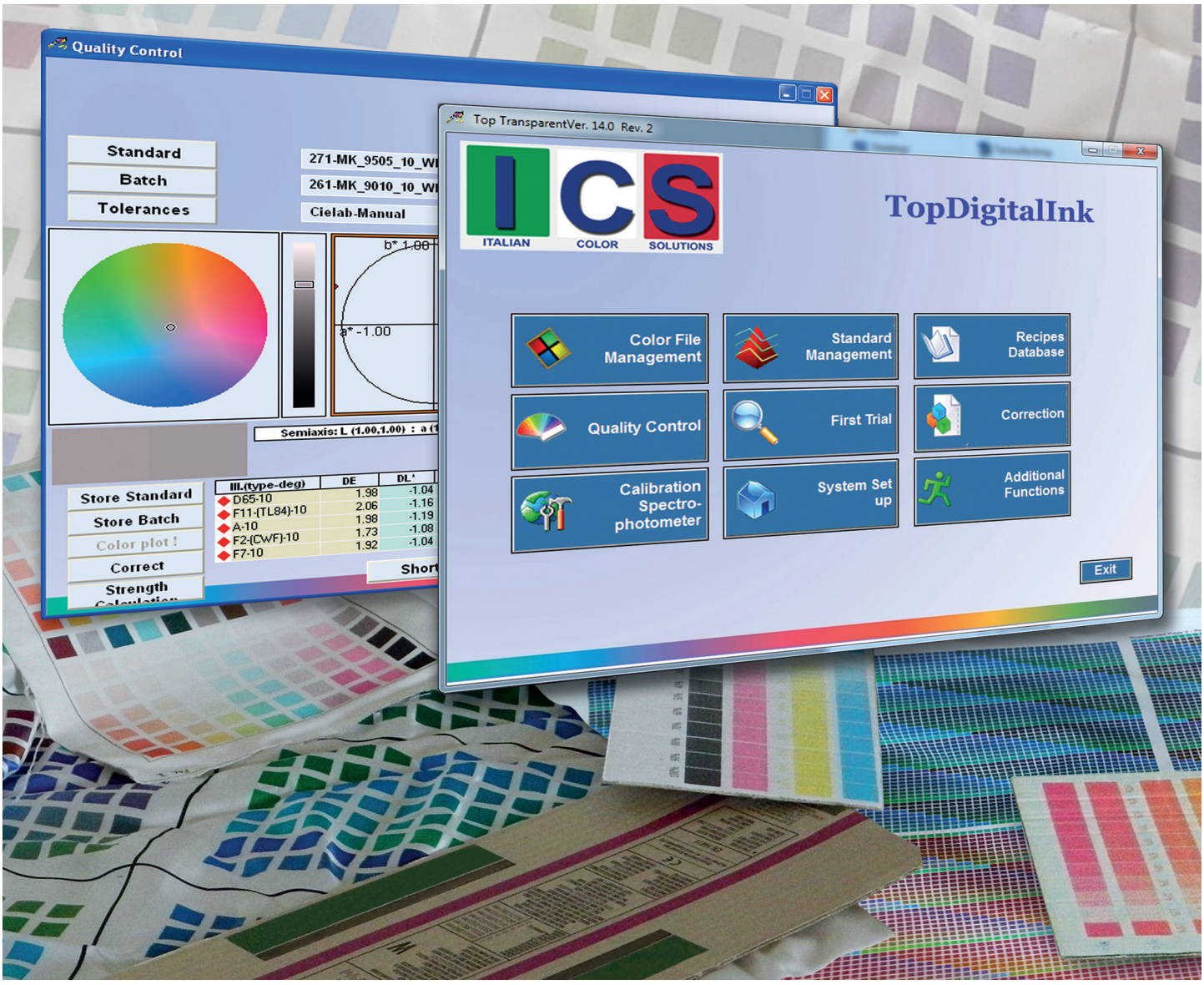
TOPDIGITALINK

ITALIAN COLOR SOLUTIONS

Colormatching Software
for Digital Ink-Jet Printing Technology
for the Industrial Packaging Application



Accurate prediction of color over every kind of natural substrate for industrial packaging application.

Every kind of digital ink-jet printer is accurately calibrated.

Minimal set of laboratory trials are required for the printing system calibration.

Dithering of the printing system is properly parameterized together with physical dot and optical gains.

Semi-transparency of ink coating is taken into account with a two-constant physical model of light propagation.

TOPDGITALINK

COLORMATCHING SOFTWARE FOR DIGITAL INK-JET PRINTING TECHNOLOGY IN THE INDUSTRIAL PACKAGING SECTOR.

Accurate color reproduction with digital ink-jet printing technology is troublesome since many factors may affect the color assessment. Ink viscosity, optical properties of the ink, absorption property of the natural substrate, roughness of the substrate, dithering of the printing system, all these elements must be properly taken into account by a suitable prediction model of color. Semi-transparency of inks currently utilised in the digital printing technology makes the color assessment much more complicate.

Moreover, the limited number of primary colors provides the printing system with a coarse color gamut.

Finally, no colorimetric approach has been adopted for color prediction but only interpolation techniques based on Look-Up-Table (LUT) definition that yield inaccurate outcomes. Interpolation techniques in fact require the preliminary acquisition of a huge amount of data in order to reconstruct the ICC profile of the printer, and it makes the system calibration a time-consuming process.

Traditional spectrophotometers are utilised to digitally sample the color space of the printing system.

In some cases visual inspection by skilled technicians remains the only viable approach for the color quality control.

OPERATION MODE AND TECHNICAL FEATURES

TopDigitalInk is a new colormatching software specifically developed for handling color reproduction over carton and natural surfaces that are commonly used in the industrial packaging sector.

It adopts a true colormatching approach and it is based on the deep experience of I.C.S. in colorimetric applications.

TopDigitalInk utilises a limited set of printed color palette in order to calibrate the digital printing system. The palette is made of 20x20 mm squares for each primary ink at the concentration of 100%. Each primary ink is printed by varying the dithering at the constant step of 10%.

Color of the printed palette can be measured with traditional spectrophotometers that adopt small measurement mask (SAV) and SPEX/SPIN viewing geometry. Spectrophotometers equipped with integrating sphere that yields an uniform and homogeneous illumination radiation filed are recommended.

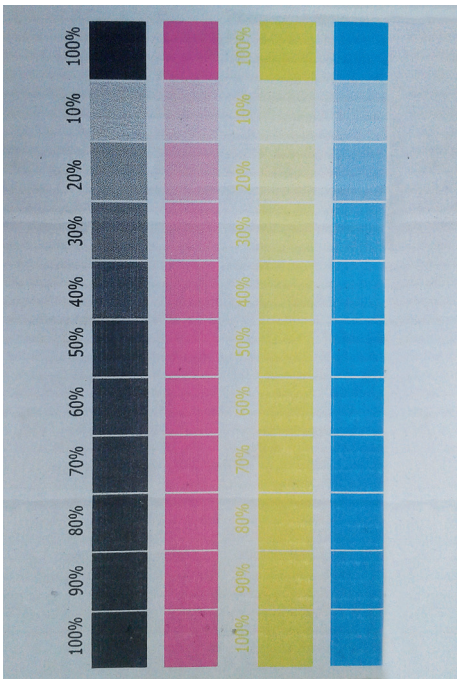


Figure 1: Typical set of printed palette as required by the TopDigitalnk for calibrating the printing system.

TopDigitalInk is based on a two-constant and two-fluxes (Kubelka-Munk) physical model that takes into account the semi-transparency of the ink coating printed on a natural substrate (carton or paper). A particular effort has devoted to the analysis of the optical dot gain or Yule-Nielsen phenomenon: some illuminating photons can emerge in the viewing direction far from the impinging area due to scattering occurring inside the ink and substrate.

Another typical effect of ink-jet printing technology is the physical dot gain. i.e the circumstance that the ink dot can expand and penetrate on the substrate widening the effective printed area.

The software allows the user to read the reflectance spectrum of substrate without repeating the colorifle measurement. The spectral characterisation of ink in terms of absorption and scattering coefficients is automatically updated.

An original feature of the predictive model is the chance to include in the spectral characterisation of ink some recipes with known concentration. This additional information is aimed at improving the predictive capability of the model in order to assess the relative strengths of different inks.

This software allows the user to choose different options for new color formulation:

- fractional area of printing (dithering or halftone technique);
- formula of chromatic difference DE computation (CIELab, CMC, CIE2000);
- number of inks composing the final recipe;
- colorant data-base selection;
- reflectance spectrum of the natural substrate.

Differently from the color interpolation techniques, the predictive mathematical model yields the practical advantage to take into account the substrate's reflectance. When the substrate is changed, it suffices to insert the reflectance of the new substrate, and the theoretical prediction of a standard is automatically updated. There is no need to acquire back the full set of printed palette with the spectrophotometer.

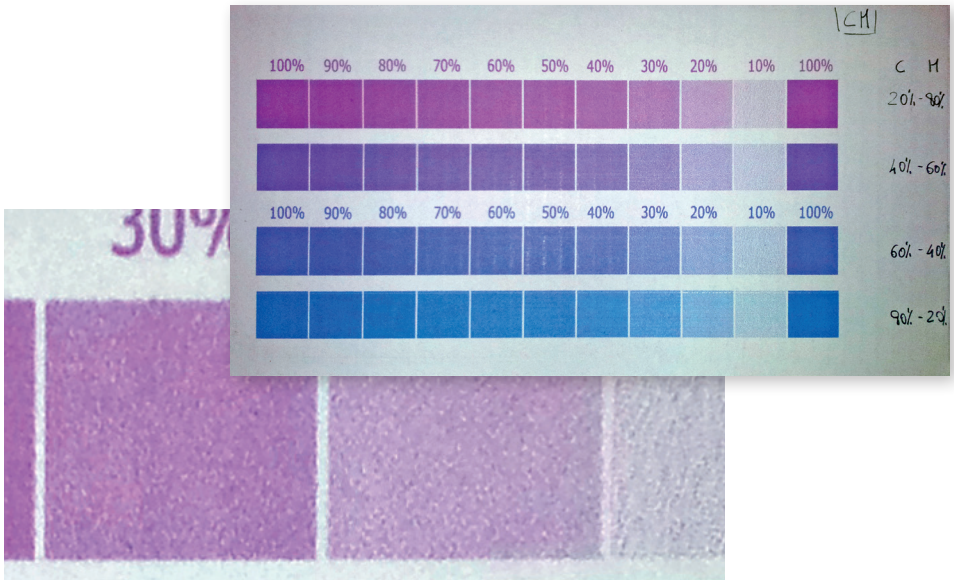


Figure 2: Additional set of printed colors of known composition for improving the predictive capability of the software.

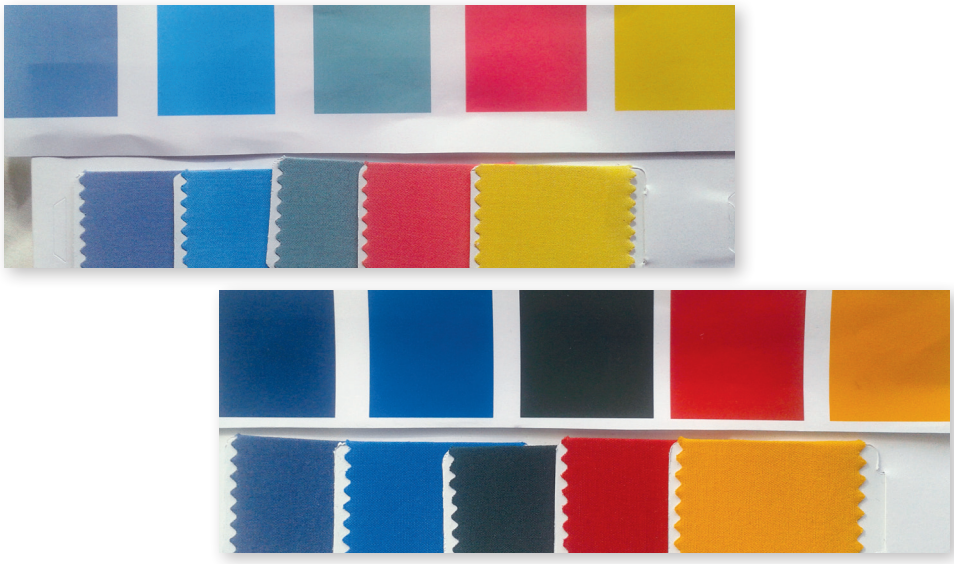


Figure 3: Examples of first imitation of new colors outputted by TopDigitalInk. Samples have been printed with a standard ink-jet printer for office application. The printed samples are compared with the original standard targets.

An important feature of **TopDigitalInk** pertains its original capability to predict those colors that are outside the printer gamut. As well known, the colorimetric range of printing systems is limited and is affected by many factors such as number of primary ink, optical properties of ink, dithering, optical properties of the natural substrate, and so forth.

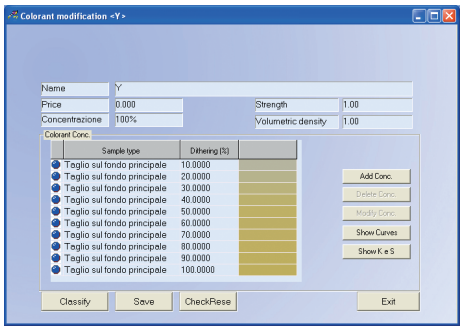
A special function has been implemented in order to predict accurate formulation of out-of-gamut colors. Practically, the predictive model attempts to reproduce mainly the hue of the color and reduces the reproduction accuracy of the luminosity. In this way out-of-gamut color recipes reproduce the color shade and saturation with the exception of its luminosity.

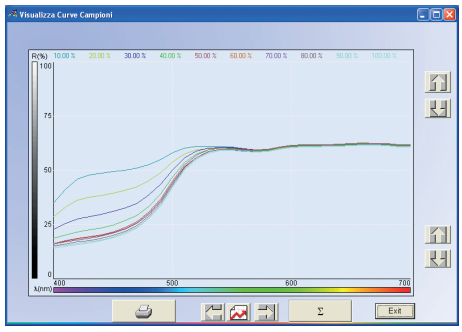
MAIN ADVANTAGES OF THE PREDICTIVE MODEL

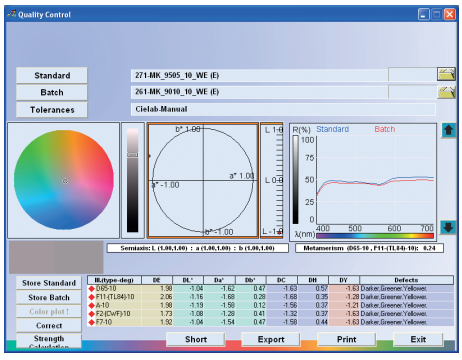
- **Optimization of the production chain**: the printer calibration requires only a minimal set of spectral measurements.
- **Improvement of quality product**: the spectral characterization of ink in terms of absorption and scattering coefficient ensures the high accuracy of color reproduction.
- **Novel capability**: only TopDigitalInk can predict accurate formulation of out-of-gamut colors.

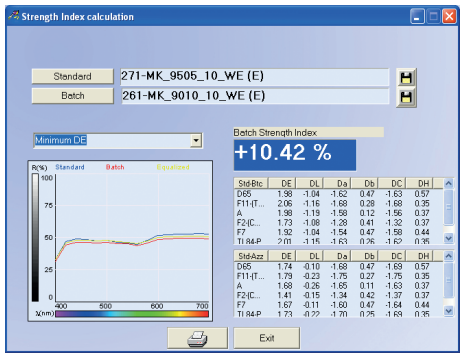
TopDigitalInk offers smart interface for quality control assessment. Different color space (L, a, b; L, C, h) can be selected together with several illuminant sources (D-series, F-series, etc.) and observer functions (2° and 10°).

The software can communicate with all kind of spectrophotometers that are commonly utilised in the industrial colormatching application.



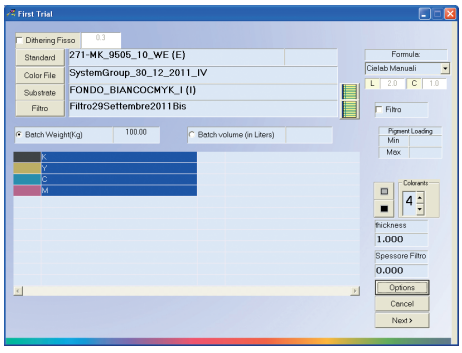






TopDigitalInk offers the smart solution to the color reproduction in the industrial packaging application.

Printing systems are efficiently calibrated and the time-to-market is shortened.



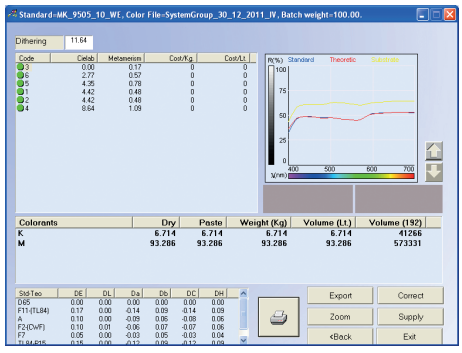


Figure 4: Examples of windows of the TopDigitalInk software package for industrial packaging applications.

APPLICATION FIELDS

TEXTILE

PACKAGING

PLASTIC

CERAMICS

MAIN FEATURES

- Quantitative assessment of the color instead of unsatisfactory visual inspection over printed natural surface.
- Calibration of the printing system with a limited number of laboratory trials.
- Spectral characterization of natural substrates.
- Spectral characterization of inks.
- Chance to predict standards outside the gamut of the printing system.
- Option to include into the colorfile a list of recipes with known concentration.
- Option to formulate a standard as viewed through an optical filter (e.g. copal finishing).

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