Mastering the shade... a CAD system for colour

Since the introduction of computer-aided design technology into the textile industry, imprecise on-screen colour has become a recognised weak link in the production chain. Colour mismatch between the different media has led to costly modifications, as well as reaffirming many a designer's technophobia. However, a new system has been developed which is user-friendly, versatile and which communicates colour accurately.

The emergence of computer-aided design (CAD) technology over recent years has enabled textile designers to create new and exciting ideas more quickly, and therefore more cost-effectively, than ever before. Improved graphics software packages have led to the introduction of new and impressive design tools, such as 3-D image effects and the ability to create images of garments which simulate drape and crease characteristics as well as the texture of the fabric itself.

Unfortunately, this technology – advanced as it is – has been hindered by the problem of poor colour reproduction on the screen, a significant limitation indeed given that colour is probably the central consideration when designing textile products. On the one hand, many of the CAD systems that have been developed for the industry over the last ten years have only offered a limited gamut of available shades (perhaps 2000 at the most) which has certainly not encouraged many designers to throw away the traditional pen and paper. In addition to this, the success of these systems has been inhibited by the problem of poor colour communication, with a shade displayed on a designer’s computer monitor being different to the ‘same’ shade on paper or even on another screen. There are numerous reasons why colour monitors should represent colour inconsistently, but the most frequent factors are the age and condition of the cathode ray tubes inside the unit, and the amount of time that the monitor has been switched on. Whatever the reason, the common result is that designers become suspicious of the colour representation on screen and tend to revert back to his or her frehand copy when developing colour themes.

Developing a CAD system for colour

It was against this background that a research team based at UMIST in Manchester, UK, started work on a new CAD system in 1988. The team included Chris Hawkyard, David Oulton and Isaac Porat, and set as its agenda the aim of developing a system that included the following key features:

- the ability to visualise the full gamut of possible colours
- the ability to specify and define the colours seen unambiguously
- the ability to communicate colour rapidly and precisely between decision makers and into production
- the ability to navigate easily and rapidly on screen through all possible colours
- the ability to manipulate colours singly and in groups for content, balance, harmony and theme.

The UMIST team had access to a wide range of designers, colour specifiers and colour range managers, and tapped into their special knowledge and experience to examine the process by which colour ranges are developed, balanced, modified and tested. The next objectives were to develop the necessary components which would support the required features, followed by the assembly and demonstration of the final system.

The result is the ShadeMaster which specifies colours according to CIE XYZ, L*a*b* and LCH colour coordinates, and also generates synthetic reflectance curves for the vital interface with surface colours via computer match prediction. Incorporated into the ShadeMaster system is a self adapting driver for colour graphics monitors. It uses screen...
measurement and feedback to adapt drive characteristics so that screen colour can be maintained constant over a full gamut of colours, and combinations of monitors can be calibrated to give the same colour appearance. The adaptive driver achieves this by constructing and maintaining a non-linear three-dimensional mapping function between XYZ and monitor red, green, blue (RGB) inputs. This mapping function can be modified by reference to the current state of the monitor, which is sent back to the driver from a Minolta CA100 tristimulus colorimeter. The result is that any given CIE XYZ colour specification can be reproduced on the screen to a tolerance of ± 0.003 in xy chromaticity, and ± 5% in Y lightness. As a result, any two systems which have been calibrated in this way will have consistent colour and will look exactly the same. For best results, it is advised that users calibrate their monitors every couple of hours, which is quite feasible given that the whole process only takes several minutes.

With colour manipulation seen as one of the most important requirements of designers, a wide variety of user-friendly tools have been developed which can be accessed via a Windows-based system using a 'mouse'. Graphics software based on a so-called colour-context system is used to create a complex scene that simulates a standard colour matching cabinet on the screen. The scene has a number of elements which cause the human brain to accept the simulation: a perspective layout with a set of coloured tiles, a 'virtual illuminant' corresponding to D65 standard artificial daylight, reference white and black tiles, and standard neutral surroundings keyed to those of a real matching cabinet.

Not only does the ShadeMaster enable the user to handle, move and alter coloured samples freely, but it also provides a range of computer-aided tools with no equivalent in the manual process. These tools have been designed to allow greater control over individual colours, groups of colours and colour relationships. Some of the facilities included are: a set of coloured samples on screen arranged in single colours, ranges and colourways; tools to create, delete, move, enlarge, decrease and compare samples; a facility to alter sets of colours while maintaining their internal balance (useful for creating new colour-ways); and a facility to select and change the colours of any sample on the screen using easy to understand intuitive parameters such as hue purity/chroma and lightness.

Oh, by the way, you also have 16 million different shades to choose from!

Benefits of the system

It is clear that the development team at UMIST has not only addressed a very real problem, but that the potential market for the ShadeMaster is wide. Possible application of the system is said to include almost any area where colour needs to be visualised, manipulated and specified (such as textile garment and print design, textile dyeing and colour management, or colour and fashion forecasting), and any activity where accuracy and speed of colour communication is of paramount importance (notably coordination of multi-source and multi-component colour production, or scaling up from colour idea to prototype to full-scale production).

Estimates suggest that the ShadeMaster is able to reduce the time it takes to generate colour ranges – usually about six months – down to somewhere in the region of two months. In particular, the system is potentially of most benefit to those involved in the earliest stages of the production process. Information detailing colour trends, seasonal influences, house style and colour library material can be introduced into the system quickly, and a profile design which includes the necessary technical data for the dyer can be produced at ease. Moreover, because hard copy print-outs, either onto paper or fabric, are an accurate presentation of how the design will look on the final product, time-consuming modifications are kept to a minimum.

Looking to the future, variants of the ShadeMaster are being developed for new areas such as interior and exterior design. For example, a 'spectral response engineering system' is at the demonstration stage. This synthesises a family of reflectance curves and lighting specifications, and, by combining lighting and surface colour characteristics, a total colour appearance can be engineered for retail, office, hotel and similar environments. In addition, adaptive driver screen calibration is expected to be valuable in medical imaging from camera probes, particularly because medical training could benefit from accurate screen and print-out colour. Elsewhere, research is underway into non-contact colour measurement in industrial and hazardous environments, with a principal aim being the development of feedback and control of industrial colour application processes.

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