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Accurate Colour Co-ordination For the Textile Components of Lingerie

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Introduction

The use of a liaison mechanism called a 'Teaching Company' in a technology transfer exercise from the University to the Business environment is described. The Teaching Company promotes detailed collaboration within a business and academic partnership and employs a full-time 'Teaching Company Associate' to enable the adoption of the novel technology, and maximize the potential benefits for the company's business.

The Worthington Project is a case study in the delivery of technological change and innovation in the field of colour, using new computer-based products and capabilities.

1. Electronic Colour Communication

The electronic colour communication system known as 'Imagemaster'™ is described. Imagemaster is a major suite of colour-related computer programs developed at UMIST (the University of Manchester Institute of Science and Technology). The software took six man-years to develop, and delivers an unprecedented level of accurate on-screen colour reproduction. The appropriate computer software and colour calibration methods were established in the Science Research Council (EPSRC) funded 'Imagemaster Project' at UMIST [1].

The key enabling technologies developed during the Imagemaster project include 'colour in context' simulations of full textile garments, garment components and materials in calibrated colour. The simulated colour is specified by the internationally agreed CIE Colour Co-ordinate method.

The CIE system of colour definition [2] is a complex model of the human visual response to visual stimuli. It uses a colorimetric model to predict all possible visual matches, even between samples of different materials. It also correctly predicts the changes of colour appearance that occur under different light sources. A full account of its development and widespread industrial uses is given in Billmeyer and Saltzman's 'Principles of Color Technology' [2].

A key factor in the success of the Imagemaster Project was the successful development of a dynamic calibration algorithm that converts local sensory colour definitions into objective CIE colour definitions.

Each CIE specification is linked to a spectral reflectance definition of the intrinsic colour that is correlated with texture and illumination effects. Colour is reproduced on-screen by real-time transformation of CIE colour co-ordinates into the locally variable RGB values indicated by the calibration algorithm. The transform achieves a visual reproduction accuracy of Delta E 0.6 (CMC 2:1) on average across the full 16.7 million-colour gamut of typical computer screens [3]. Dynamic feedback control is used to update the colour calibration as required [4]. The calibration process takes about three minutes to complete and requires minimal manual intervention.

A second key enabling technology is the link between on-screen visualization and dye recipe formulation. This allows the software to generate visually accurate 'virtual products' reducing the need for making laboratory dyeings or samples. Imagemaster uses photographic images to simulate the precise colour appearance under different light sources, and also the detailed textile texture.

The Software developed during the Imagemaster project enables the segmentation of each image into logical objects that can be adjusted independently for colour. It also automatically generates a single production colour-specification that is representative of the many thousands of image colour elements that represent the texture.

Imagemaster stores a production colour-specification for each identified object and object-colour in the image, and generates a new production specification for any altered colours that are developed by software manipulation on the computer screen. The entire object can be adjusted independently in Hue, Purity and Depth of colour without affecting the appearance of the detailed texture.

Digital colour images and manufacturing specifications are closely integrated in order to communicate both the visual appearance and the technical colour specification of the product across electronic networks worldwide. A close collaborative link is thus established between the creative development of new colour ranges, and the technical delivery of coloured products of all types. Close collaborative on-line networks involving all those contributing to product development and production are made possible by Imagemaster.

The payback for investing in this new technology comes from significant reductions in the lead-time needed to create new colour ranges, and the co-ordination of colour across the individual components that make up a garment. In effect, the garment specifier can construct a fully defined 'virtual product' and agree the production details with multiple component suppliers within days rather than weeks or even months. The use of electronic 'virtual sampling' makes the whole process much less dependent on postal delays, except perhaps where a final physical submission is regarded as essential. There is also a significant reduction in the cost of sample dyeing.

In one important demonstration at a leading UK retailer [5], a set of new fashion colours was developed one afternoon using Imagemaster by the designers. The specifications were then E-Mailed to a garment dyer, who delivered dyed and finished garments back to the designers for final approval of shade and appearance within 36 hours. After approval, the chosen shades were designated as electronic standards, and networked to bulk production manufacturers worldwide. The trial demonstrated that it was possible to achieve very significant reductions of lead-time from colour-range inception to the start of bulk production.

A major reduction in the complexity of achieving correct colour and technical specification has also been reported [6]. In its commercially developed form now supplied by the Colorite Division Datacolor [7] the Imagemaster system was awarded the Society of Dyers and Colourists Prize for Technical Innovation in 2000.

2. Multi-Component Lingerie Assemblies

Imagemaster has been exploited in the technically challenging environment of the Lingerie Industry. Lingerie garments and co-ordinated garment-sets typically consist of assemblies with twenty or more distinct components, which are often made by many different suppliers. Many of the components are of high intrinsic added value, and are made by specialist firms worldwide. The problem of colour-specification and co-ordination is made more difficult by the fact that the relevant suppliers are often widely distributed geographically, and may even be located on different continents. Because of this highly complex construction process, it is common practice to restrict the shade ranges to classic colours such as white black and red. This avoids the need for developing individual fashion shades, and allows the production of cheaper mass produced products.

The challenge for the project reported here was to gain commercial advantage by delivering fashion colour with a similar cost and lead time to that expected for the less demanding colours.

The potential advantages of on-line electronic colour specification and communication are clear. The enabling technologies of on-line colour, appearance visualization, and virtual sampling were identified as a significant Business opportunity by Worthington Manufacturing Ltd who make and supply lingerie components. After purchasing Imagemaster a Teaching Company was set up as a collaborative project with UMIST to develop the detailed techniques and business opportunities.

A Teaching Company is established as a semi-independent corporate group of individuals drawn from the personnel of both the commercial and academic partners. Its mission is technology transfer from the Academic to the Business environment. The Teaching Company is assisted by a Consultant

from the Teaching Company Directorate (TCS) and funded jointly by the commercial partner and the government. The Teaching Company employs one or more Associates to work full-time on the project [8].

3. On-Line Colour Communication in Support of Existing Business

The main cost advantage when using on-line colour systems is the replacement of physical lab dyed samples with electronic virtual samples. Worthington Manufacturing typically produces in excess of four hundred dyed samples per week in the laboratory and up to eighty physical submissions are sent by post for approval mainly to international destinations. A major objective of the project reported here was to reduce the number of both lab-dyes and physical submissions. The target is a reduction of at least fifty percent.

The dye lab at Worthington already uses the latest Smartmatch [™] software by Datacolor to formulate trial recipes. The developed recipes are then applied to a very wide range of substrates including the nylon-covered hook and eye assemblies used in brassieres, as well as the lace and plain fabrics used in the garment body and other components. A key factor in this process is that it is very difficult to make an objective measurement of the colour of a lace fabric, and impossible to measure the colour of a bra hook using conventional spectro-photometers. The generation of numeric colour specifications from on-screen images using Imagemaster thus becomes a critical factor in delivering successful recipes to the dye house.

Considerable progress has already been made in improving the quality of recipe prediction. It has also been found possible to open on-line links to the dye manufacturers. This has proved valuable for generating specialist dye recipes that work well on assemblies containing several chemically and physically distinct types of nylon such as hook and eye assemblies.

Early on in the project, a key task was to establish electronic approval links with the specifiers for whom the various components were being dyed. Using physical submissions, it is not uncommon to make up to five submissions in order to gain approval, and each such submission is subject to postal delays. In a global market, the specifier is often a retailer in the USA or a manufacturer in the Middle or Far East. It was demonstrated early on in the project that once the specifier has become familiar with the use of virtual samples, only a single sample for final approval is generally necessary.

A major reason for multiple submissions is the need to establish the precise visual appearance on each component substrate in an assembly. In traditional practice this is achieved in a sequential series of approval exercises. The colour specifier typically only makes a firm judgement of co-ordinating appearance when a physical sample can be made available. The process often starts with approval of the body fabric, and the trim, strap, fastener and minor components are specified and approved later as secondary standards. As product launch rapidly approaches, the follow-on deadlines get tighter and tighter due the inevitable delays of approval earlier in the sequence.

Imagemaster allows large libraries of images and fabric specifications to be stored. These can subsequently be retrieved and re-coloured in order to generate new fashion colours and co-ordinated colour ranges. This means that initial judgements of appearance can be made without waiting for the new colours to be physically applied to the chosen materials.

Colour appearance varies significantly from one textile texture to another. A given dye recipe looks different when applied to different fabrics. These relative differences can also be quantified and recorded in Imagemaster libraries. This allows the trim, strap and fastener specifications to be generated simultaneously with the body fabric specification, with the key advantage of avoiding sequential delays.

The business with existing customers was the first area to be targeted, and approximately fifty percent of existing customers are now at various stages of implementing on-line colour communication with Worthington. A key advantage to the Business is that this is a pioneering

development, and Worthington is a world-leading ambassador for the new colour communication technology in the lingerie industry.

Both the design process itself, and the subsequent processes leading to a developed product must undergo significant changes when adopting on-line specification and approval of colour. The Teaching Company between Worthington and UMIST recognises and supports the need for familiarisation and training in the key techniques used to generate on-screen product simulations. It also provides the calibrated images and physical samples that are necessary to convince those involved of the visual accuracy of the simulated products.

The processes of familiarisation and training are already well developed with some of the key existing customers of Worthington Manufacturing. The Company recently hosted a major seminar of customer-personnel from three continents to set this activity in motion. An on-going series of trials and parallel-specification exercises was a major outcome of this seminar. The trials are being used specifically to establish the validity of on-screen virtual products and quantify the lead-time gains achieved.

Tara Young the Teaching Company Associate, has travelled to several customer sites overseas to help with developing appropriate images. She has also been active in the in-house training of Worthington personnel. The need to integrate the new technology into the process of selling the company's products has also been identified as an important factor. In consequence, members of the sales staff have been involved from the earliest stages of the project.

Since the Teaching Company Project started, it has become evident that the new technology is a vital factor in retaining and developing the relationship with existing business partners. This is particularly true in the rapidly changing global market in which the company operates.

4. Generating New Business

On-line communication using calibrated colour is an ideal value-added component of electronic networking. The analogy has been made with the early days of telephone versus telegraph communication. The messages are different (colour rather than speech) but the problem is the same. You will not get the maximum possible benefit until everyone you need to communicate with has a unit, knows how to use it properly, and is connected to the network. There is currently something like 200 Imagemaster installations worldwide. The majority of them are used in textiles or textile-related manufacturing businesses, and a significant number of them are at existing or potential customers of Worthington.

The overall aim is mutual benefit to both Worthington and their customers. The benefit will come from product ranges with many more interesting and attractive fashion colours and colour changes. It is also likely that anyone producing and delivering the exciting new shades will also get the business in the stock shades as a welcome collateral. This interesting supplier / buyer synergy is very difficult to deliver without using the type of innovative technology described.

Several key potential and existing customers are participating in the effort to deliver the expected advantages. Once a true colour-communication network has been established, all the relevant colour standards can be developed simultaneously using virtual submissions. This avoids the delays and inconsistencies associated with serial standard development, and sequential production.

Both existing and new business is being developed by establishing close collaboration over the electronic network. All those concerned interact to produce better co-ordinated products more efficiently. The aim is to establish close supplier / buyer collaboration as a matter of course during range planning and product development. Improved collaboration is generally an expected outcome of electronic networking but colour is a special case, and needs specialist computer software to realize the potential benefits.

The investment in both expertise and trials generates a capability for rapid and flexible response to customer requirements. Once a working network is in place it represents an important service to the

customers of the company. The company that can offer such electronic colour-communication services attracts new business. It also makes repeat business more likely, and less dependent on price.

Significant networks have already been established and several new networks are at the trial stage. The project is providing valuable insights into the challenges and difficulties associated with delivering a novel technical capability. Progress to date is very encouraging, and the new technology is expected to establish Worthington as a major and expanding supplier of coloured lingerie components.

5. Conclusions

The Worthington Project is a case study in the delivery of technological change and innovation in the field of colour, using new computer-based products and capabilities. The critical factors in achieving successful technology transfer are identified as winning the full collaboration of those affected, and the allocation of sufficient additional resource to establish, trial, and monitor the effects of the desired changes. In the current exercise it was necessary to achieve changes in working methods, not only in-house at Worthington Manufacturing, but also at the customer sites as well. The key to achieving broad-scale changes of this type was found to be concentration on monitored and quantified gains in productivity and ease of communication.

It has been demonstrated that visually accurate fabric and garment simulations can be generated from measured colour specifications. It has also been demonstrated that the reverse process is also possible. Correct colour specifications can be generated from visual images whose colour has been altered to generate a new fashion colour. This method has been used to generate accurate colour specifications for items such as nylon-covered hooks and eyes that are impossible to measure by conventional methods, thereby taking much of the guesswork out of colour co-ordination.

A 'critical mass' of on-line collaborators is now in place, and a bright future for colour-specification networking is predicted. From the end-users viewpoint the improved range of lingerie shades to choose from is expected to make life a little more seductively colourful.

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