

Chapter 2

‘Colour, It’s Just a Constant Problem’: An Examination of Practice, Infrastructure and Workflow in Colour Printing

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2.1 Introduction

Two interrelated topics that have been of enduring interest to researchers in studying cooperative work practices and the design and use of technologies to support those practices are workflow and, to a slightly lesser extent, infrastructure. Workflow systems are a classic form of technology employed to coordinate cooperative work along a process of production where different workers (potentially in different companies and locations) complete different tasks along a ‘line’ of production. The workflow and the technologies that embody or enforce it are designed to maintain adherence to procedure and coordination across time and place. The central issues surrounding the treatment of workflow in Computer Supported Cooperative Work (CSCW) and related disciplines have been the problem of getting workflow systems to mesh with the particularities of local flows of work among people. Since Suchman (1983, 1987), at least, there has been a presiding concern with the ways in which workflow models fail to take into account the local, embodied, non-prescriptive and emergent manner (responding to dynamic local circumstances) in which people organise their work. Workflow systems have been criticised for being designed from ‘elsewhere’ – with an inadequate, overly idealistic or abstracted understanding of the work they are meant to assist. People end up having to organise or translate (potentially after-the-fact) their work, so it fits with the workflow system or workaround or ignore the technology completely (see Bowers et al. 1995) for an example from the print industry).

Consequent to such studies, there has been considerable work in looking at the possibility of adaptive workflow systems that could be altered to fit disrupted and evolving work patterns during a period of ‘domestication’ (see for example the Klein et al. (2000) special issue on such systems) and are informed by an awareness of the contingencies of work practice.

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However, it is now being more clearly acknowledged that while it may be easy to take the stance of ‘bad fit’ of system with existing practice, this ignores the fact that new systems are often specifically bought and deployed to transform work in some way – sometimes purely with the intention of making things more efficient, other times with notions like improving quality or conditions. A more sophisticated analysis of the situation, which also acknowledges the perspective of the software product developer, has developed. It is a complex task to provide generic products that can still be useful over a wide series of circumstances (Martin et al. 2005; Pollock et al. 2007), and part of the process for success in this area is to make apparent to customers the benefits of changing their organisation’s ways of working to fit the product, rather than vice versa. This may seem counter-intuitive, but when we witness the success of products such as enterprise resource planning (ERP) systems from companies such as SAP (see Section 5), we can understand that while some customers ‘lose’, and for some employees of customers the process of deployment and change is painful, many buyers of these systems are – in the long run at least – satisfied customers.

While the process of design or choice of system is clearly very important, more recent research has also focused on examining the process of system tailoring and the social process of ‘change management’. Deciding what practices need to be preserved, which may be transformed and how this is handled ‘politically’ may be crucial to the success of systems involving workflows. And, going further, new technology possibilities such as service-oriented architectures (SOAs), gradual, sensitive (to users and other impacts) roll-out and more tractable domains (like banking) may allow workflow systems to be a success (Brahe and Schmidt 2007). In some ways, the literature on infrastructure (Star and Ruhleder 1996; Star 1999; Lee et al. 2006; Olsen et al. 2006) presented in venues such as CSCW has a similar flavour to the literature on workflow. Although it deals with, for example, the technical structures that ‘sit behind’ the interface level and thus may be less visible to the user, these still impact on how their work is achieved. This literature has been concerned with infrastructure as a ‘relational concept’ – specifically with the relations between certain identified people, their work and the infrastructural technologies that serve as a ‘substrate’ for that work. In following this agenda the research has looked at the impacts and mismatches between people, their work and infrastructures and the work to produce and manage infrastructures. Interestingly it has predominantly also focused on infrastructures for global scientific communities to carry out *e-scientific* research and has been interested in the problems of community building, particularly concerning trust and the sharing of data as well as technical issues. More recent research has focused on the crucial role of people (‘the human infrastructure of cyberinfrastructure’ cf. Lee et al. (2006) in promoting, supporting and maintaining infrastructures.

In this study we are clearly moving into a domain quite different from these other studies. However, Star and Ruhleder (1996) identified several features of infrastructures that are useful for this study. Infrastructures tend to be *embedded* (sunk into other structures, technologies and social arrangements), *transparent* (not noticed), *linked with conventions of practice*, and they *become visible upon breakdown*. They are seen as relational in that what constitutes one person’s infrastructure is not the

same for another depending on such things as their relative jobs. In this paper we examine the relation between the work of graphic designers and print workers, the workflows and technologies they employ, and the technical infrastructure embedded in their software and devices. This infrastructure is placed there for the purpose of managing colour (communicating and translating it from device to device and application to application).¹

We believe that this study is interesting and important in both a specific and general way: specifically because managing colour across a distributed workflow is a complex cooperative problem and generally because this work builds upon classic topics concerning practice, workflow and infrastructure. We believe it builds on these topics in a manner that illuminates them in a different way, mainly because: (1) other studies of infrastructure have not looked at infrastructure in relation to a *product production workflow*, instead in relation to *data sharing when conducting scientific research*. Thus this research is novel in that it specifically looks at an interrelation between infrastructure, workflow and practice; (2) the different parties involved are not equal partners but service providers and clients; (3) the different parties had little or no input in the infrastructure's design or development and have no ownership; (4) while this infrastructure is problematic it is difficult to imagine any reasonable alternative; and (5) the ways in which it impinges on work and is misunderstood by practitioners are, of themselves, interesting.

2.2 The Problem of Colour Print Production

Producing colour prints is complex and when problems occur, understanding their root causes, where they are located (in the workflow, in the file, or at the printing device and just where exactly within any of these) and how to solve them is very difficult even for domain experts. Putting aside problems with print devices – how they are calibrated and maintained, and issues to do with humidity, temperature, and how inks and toners react – one of the main problems of producing colour is achieving the 'correct' or at least a 'good' mapping between what is created and observed on screen and what is produced in print.

The technologies involved in colour work – input (e.g. scanners and cameras), display (e.g. monitors) and output (e.g. printers) devices – have device-centric ways of producing and encoding colour (i.e. different colour spaces). Colour is produced differently on screen, by combining red, green and blue (RGB) light sources, than in print, made of cyan, magenta, yellow and black (CMYK) ink or toner pigments which are applied to some substrate (e.g. paper). On top of this, different devices (even different devices of the same order, e.g. two printers) have

¹ As an example of the relational (rather than absolute) features of infrastructure one can see how the CM infrastructure for graphic designers' work is the topic of research and development for colour scientists rather than being an infrastructure that supports their work.

different gamuts² (ranges of colours) they can produce. Furthermore, design choices, technical constraints and manufacturer preferences also create differential colour production. This clearly sets up an issue for how files or documents, passed between devices, are represented. There needs to be some method of translating between these different colour spaces, particularly for deciding how colour definitions within one gamut should map on to those in a different gamut.

Colour management (CM) was developed by The International Colour Consortium (ICC).³ CM is an industry-standard technical system designed to enable translation between different colour spaces and colour devices (monitors, printers, etc.). Essentially this means that when a file is transferred from one device to the other, it should come with a profile that indicates how to interpret its colour information. This profile is then translated into a device independent colour space defined by the ICC before it can be re-interpreted correctly in terms of the new device. CM is a technically correct solution, in that the system, when used properly, can translate colours between say a screen and a print device such that colours seen on screen should correlate as highly as possible with those printed out.

Over the last 2 years we have been studying the work involved in creating and producing graphic designs, with a focus on colour printing. Our studies show that the successful implementation of properly colour managed workflows is rare in the print industry, and that achieving printed results that satisfy the customer is often a complicated business involving a number of print-proof-adjust-reprint cycles. Practitioners mostly do not have any kind of systematic understanding of what it is, in particular, about a certain document that when printed on a certain machine will cause a particular type of problem. It is not that they do not have any knowledge of problems, their causes, and potential solutions; it is just that this knowledge maps in complicated (not always accurate) ways to what is actually going on.

2.3 The Prospect of New Markets

It might seem strange to talk about the prospect of new markets after discussing the problems of current colour printing practices. However, some points are worth making that explain why this is relevant. Firstly, colour printing is a multi-billion dollar industry and is likely to remain so for some time. Secondly, the problems of colour do not curtail the industry; they just make achieving the desired output more costly, or compromises must be made on quality. That is, it takes more print-proof-and-adjust cycles in order to get the desired product or the accepted product

²The range of colours – gamut – a device can produce are defined mathematically in a multi-dimensional space. Colour spaces both overlap and diverge. Translating colours from one space to another involves mapping colours in one space to the other according to various algorithms. Various compromises are made for mapping colours that occur in one space but are outside the gamut of the other.

³<http://www.color.org/index.xalter>

is of lesser quality than it might be. Thirdly, there is an ongoing competition between offset printing where a printing plate has to be produced for each individual page, versus digital printing, which requires no plate, meaning every different page is produced at the same cost. Because of the need to produce plates, offset printing is more expensive for short runs (i.e. numbers of copies), but is generally understood (by designers and printers) to produce more aesthetically pleasing prints. This is generally seen as a feature of having a higher resolution and wider colour range of richer inks, but is also probably a product of technology maturity and greater practitioner experience. So, offset is widely understood as having the edge on quality. Due to this many printing decisions are made on quality-amount-cost calculations with a number of copies threshold⁴ below which offset is not economically viable unless there are specific quality requirements the client is prepared to pay for.

However, intriguingly, digital opens up a variety of different business propositions whereby printing multiple variations of the same document on-the-fly, or single documents for mass populations, or tailored products becomes possible for the same *printing* price per page as printing a longer run. This offers possibilities for capturing a mass consumer 'long tail' market (Anderson 2006) previously untapped in high-quality printing, for example, where many consumers construct various semi-bespoke products (e.g. calendars) out of their own photographs. It also opens up a market for software products and applications that make the production of variable tailored printing products easier and dependable, and crucially, cheap enough. These printing products are very attractive to businesses who wish to employ personalised 1–1 marketing (specific products and services are targeted to individuals, rather than in a blanket fashion to all customers). This type of marketing is thought to be much more effective in getting customers to 'bite'.

In both of these markets web 2.0 is important, as is the notion of 'mass customisation' (Piller and Stotko 2002) Mass customisation is the idea of providing tailored or personalised products to customers for around the same cost as mass produced. Being tailored, these products or services should necessarily have higher value to the customer. The Internet can help to achieve this in a number of ways – through digitisation, quicker, more efficient customer interactions, and the ability to collect and analyse customer data. If the product is entirely digital (e.g. music) the entire process of selection, tailoring and delivery, and the ongoing customer relationship can be managed on-line. If the product is material, e.g. clothes (or as in this case printing), while it still needs to be delivered, many aspects of the customisation (giving exact measurements, choosing colours, emblems, etc.) and the relationship can be achieved through the Internet. Other products like specialised advice can be done completely on-line. Mass customisation has become an important topic for printing; firstly, for allowing print shops to offer web submission and web-based products that can be personalised and tailored, and for reaching mass market customers. Secondly, this opens up the market

⁴This number can vary considerably depending on the specific technology in question and the nature of the print job, but is generally considered to be around 2,500 copies.

for new technologies that make it easy to implement and manage workflows for producing 1–1 marketing, that manage and assess digital printing assets (images, photographs), that provide templates for tailorable documents and so forth. In this way, high-quality production printing is moving into web 2.0 and related technologies territory. But the question of assuring quality – particularly in colour – remains.

2.4 Method and Settings

The paper describes the findings of a series of ethnographic studies undertaken at a number of print shops and graphic design agencies in the UK and Europe over a 2-year period (cf. Randall et al. (2007) for a guide and exposition of this work in CSCW and Bowers et al. (1995) for a pertinent study in the print industry). We carried out this work in conjunction with colleagues working at another research laboratory within our organisation in North America. During this time we also consulted market research carried out internally and externally to our company. Having compared our results with the North American work and the market research, and having found that they were repeated, this allows us to make reasonable claims about the generalisability of our findings.

Observation is our primary method, supplemented by in situ interviewing, with site visits varying between 2 days and 3 weeks. Our fieldwork data were audio and video recordings, photographs, notes and artefacts from the sites. Our materials were gathered and analysed with an ethnomethodological orientation (Garfinkel 1967; Sharrock and Anderson 1986) which emphasises how work is organised as a recognisable social accomplishment. To achieve this we observed and analysed the real-time details of work, interaction between participants, and interactions with technologies and artefacts. From this analysis we were able to uncover how practitioners understood, oriented to, reasoned about and managed colour, and this is presented below.

It is also worth explaining how our materials are presented here, and for what reasons, as some readers may be looking for transcripts of audio or video, or detailed notes on unfolding action, none of which they will find here. The purpose of our project was to find out how colour was being managed and why CM technology was not being properly exploited. As we discovered how design work unfolds by studying our materials we also found the ad hoc methods used to manage colour and that the way in which practitioners reasoned about colour was radically different to that which would be required to use CM workflows. It is these methods, that reasoning and the schism between these and what would be required to use CM workflows that we present here.

2.5 Infrastructures and Workflows

CM is a technical ‘infrastructure’ upon which CM workflows can be built to achieve consistent colour reproduction (most faithful to the original source, most consonant with what is seen on screen, etc.). Every screen-to-print workflow uses

some CM technology components whether, and this as we shall see, is crucial, this is the knowing intention of designers and print workers or not. Although CM is not in itself a workflow system, to use it successfully, necessarily implies a workflow where a specific instantiation is *rigorously followed* and *understood* (at least in a functional sense, by following a strict set of procedures, making the correct selections, etc.) *by all* of those involved in the process.

Unfortunately developing a correctly operating workflow and adhering to it is not simple. Different devices offer different settings for handling (e.g. recording, producing) colour. Different design applications offer various settings for working with documents and encoding colour data in files, including differing default settings. Successfully managing colour across a screen-to-print workflow requires that the users ensure that 'appropriate' profiles are always attached to files and that these are translated in the 'correct' places. Users must be able to understand the separation between how an image is displayed and how it is encoded, as well as potentially taking into account the capabilities of the print device. Defining the appropriate workflow requires a degree of technical knowledge not normally found among design and print professionals. Ordinarily, or at least as an aspiration, in the realms of computing, the complexity 'going on behind the scenes' is hidden from the user, often with a 'graspable' workflow sitting on top of a complex infrastructure. Here, implementing a good workflow requires a sophisticated understanding of just how the CM infrastructure works.

In our studies of print shops (firstly) and graphic designers (secondly) the most obvious finding was that properly colour-managed workflows were not implemented anywhere, even in a fine art museum. In our studies of print shops (O'Neill et al. 2007) we became aware that most files reaching the print shops contained no colour profiles (attachments indicating the CM information), and that those that did, had the profiles discarded by the print workers as untrustworthy. We also became aware that tools on print devices, designed to be used with colour-managed files were being used 'inappropriately' or 'creatively' to try and effect aesthetic changes. Our initial belief was that the problem might lie with the graphic designers and it certainly seemed to originate in their work. This led us to look upstream in the process, to graphic designers, to try and understand why CM was not being used by them. Our research indicates that because CM is very complex – both in itself and in the way it is presented in tools and technologies – practitioners all along the process have varying knowledge and understanding of it but do not have the understanding, desire or resources to implement a properly colour-managed workflow. In many cases this applies to print-shop workers just as much as graphic designers. When it comes to the customers who commission graphic designers, they are often initially even more in the dark, about the problems associated with colour translation and production.

The situation is made even more difficult due to the fact that different people in different organisations using different technologies work to produce and print designs with elements from different sources (e.g. graphics, photos, text). Indeed, such a finding is reinforced by the fact that it is photographers who are the people who are most likely to colour manage. They can exercise more direct control over their workflow as it involves fewer people and they are often interested in *preserving* the colour data from camera to print. In our interviews with them we have realised that

they orient to trying to keep what they capture with the camera, whereas graphic design is much more about *creation* and *production* that involves the assembly and transformation of material from several sources.

2.6 Non-CM Workflows in Graphic Design and Printing

Our studies of graphic designers added strength to the idea that CM was proving too technically complex to understand and implement across the print workflow. Graphic designers showed variable levels of understanding of CM and it was seen as too complex to implement properly. There was, also, a degree of confusion about elements of CM; few had anything approaching an in-depth knowledge.

In the absence of CM workflows, designers and print shops strive to control colour in more local and practical ways. Practitioners were found to have developed several related techniques and practices for achieving the colour results they required, or at least reducing the inconsistencies and uncertainties between screen and print. And most obviously graphic designers develop relationships with print shops that they trust; who help them achieve good prints, without necessarily inquiring into what it is about the print shop (their set-up, staff, equipment) that enables this.

Indeed, this is a very interesting question, since the industry-scientific and best-practice view on producing quality prints resides with the notion of being able to design and implement a CM workflow. Whereas, configurations of people and technologies that can still produce quality in the absence of a properly colour-managed workflow – and what that quality consists in – are poorly understood. In the following section we detail various ad hoc practices used to control colour and note that the interesting thing that unifies them is their *tangibility* and *comprehensibility*; they deal with samples and more straightforward, everyday ways of viewing and encoding colours such that the reproduction is close to something they have previously seen. This stands opposed to the mathematical models of colour encoding embodied in CM.

2.7 Examples of Ad Hoc CM

In our previous paper (O'Neill et al. 2007) we noted that CM did not seem to be used at all in print shops and discussed the ways in which print workers tried to correct problematic colour in prints by adjusting several controls. We also described how print shops worked with customers to set up colour libraries for important colours like brand colours and that they tried to educate customers both about the potential problems with files and colours and about how they might be improved. Looking at graphic designers has reinforced our understanding of the importance of relationships in printing; graphic designers often have favoured print shops that help them to produce a quality product. Although print shops often do more of the correctional work, graphic designers orient towards problems with colour and try and control colour

in ways in which they are able. They may also spend considerable time managing customer expectations, e.g., making them aware of colour differences between screen and print. Designers' basic advice on colour is that offset is better than digital, if one has strict colour requirements; spending time (and more money) proofing with the print shop is crucial; and Pantone inks (proprietary ink formulas used in offset printing) are the most dependable ways of getting colour right. It should be noted that the advice of both printers and graphic designers for customers is experientially based rather than grounded in a scientific perspective and understanding.

2.7.1 *Pantone Swatch Books*

The Pantone Inc. Corporation produces a range of inks, swatch books and charts (see Fig. 2.1) of their proprietary colour space, that show the colours that can be reproduced, given the substrate (coated or uncoated paper), print technology (e.g. between offset printing and different types of digital press), and ink formulas (proprietary Pantone inks, or four colour combinations) that are used. The colours themselves, their 'intensity' and general look and feel vary across the range. When used properly – i.e. the correct book for the correct print device technology and for the correct substrate – Pantone technology can be used to specify and print individual colours with good accuracy. The designer can select the desired colour from the guide book or chart and then can encode the colour as a Pantone in the image file and it will be interpreted as such by the print device (Fig. 2.2 shows a leaflet



Fig. 2.1 Digital Pantone swatch chart



Fig. 2.2 Deli flyer (produced from the swatch chart)

produced by using the chart in Fig. 2.1). We observed a widespread use of Pantone swatch books and charts for selecting and controlling colour in all the design houses we visited. In the best cases, the designers were using print device and substrate (e.g. coated/uncoated) appropriate Pantone swatch books bought by them or provided to them by their print shop.

For example, one of the UK agencies had just invested in a full set of Pantone swatch books and the designers showed us that they now had an offset process colour swatch book that had been giving them particularly good results. However, some design houses used Pantone swatch books that were not ‘correct’ for the printing press or substrate they were going to print on. Instead, they had one Pantone book and believed that this was relevant to all presses and substrates. In these cases, the relationship between the chosen Pantones or CMYK process colours and what the print device could produce was more variable. A key problem from the perspective of designers is that the Pantone system is confusing. Pantones are stipulated as a set of equidistant numbered colours within the range (gamut) that can be produced by a machine. This means that a specific Pantone number may well be a different colour when produced on different machines. Unfortunately this is not widely known and many people labour under the misapprehension that choosing a specific Pantone (e.g. for a brand) will ensure consistent reproduction across print devices and substrates.

Furthermore, the differentiation between Pantones and their CMYK process versions was, again, understood differently in different locations. A number of designers that we have observed choose a palette with reference to a Pantone guide in their design, simply as this seems a sensible way to stipulate a palette. Later on in the process it may well turn out that either the customer does not want to pay for specifically

mixed Pantone inks, or the design will be printed on digital (which in most cases means that special inks cannot be provided). At this point the designer will either get their software package to convert the Pantones into CMYK versions or will leave this to the printer. Either way, the CMYK versions may vary in the extent to which they match the original Pantones often leading to confusing results. It was during the course of our studies that we found out that even different releases of the same software package can have different conversions!

This problem is often exacerbated in situations where a design with the same palette is printed on both offset and digital, as differing results would be likely. For many designers and – it would surely seem the default expectation – the belief is that Pantones are a system of absolute value, but that reality is that, although in the 'same ball-park' they are actually relative to one another across formats.

A great advantage of using Pantone swatches is that it allows the matching of colours by eye, which unsurprisingly, given its simplicity and tangibility, is one of the designers' preferred methods. Although, they are aware that matching colours individually between screen and swatch book is somewhat imperfect due to the different media of instantiation. Importantly, Pantones can only be used for specifying spot colours in vector graphics objects (graphic blocks of colour) and not for bitmap regions within the page (such as photographs or elements of a photograph).

2.7.2 Work in Default CMYK Colour Space to Help with Gamut Issues

Two design houses we observed work by default in a CMYK 'emulation' space (see Fig. 2.3) on screen when they are producing a printed product. By working in CMYK they believe the discrepancy between what they see on screen and what will eventually be printed is minimised (i.e. in comparison with working in RGB). Working in CMYK means that designers are showing some orientation to printing in their work. In general the effect of this is that they are less likely to choose colours for their designs that are out of gamut; there will be generally a greater consonance between what is seen on screen and what will be printed. However, understanding just how what appears on screen will relate to a print is still complicated, especially if using an un-calibrated⁵ monitor, as different colours will be closer or differ more from their on-screen equivalents.

This is exacerbated when the user does not know which settings they have and their impacts, e.g. in one of the settings CM tools were turned off, while in the other they were set at a North American default setting (it was in the UK). In both cases

⁵Calibration is a process where the colorimetric response of a device (the way the device reproduces specific colours) is measured using a spectrophotometer. The resulting measurements are used to adjust the device and maintain consistency in colour reproduction over time. Calibration needs to be performed regularly on all devices (monitors and printers) in a CM workflow.

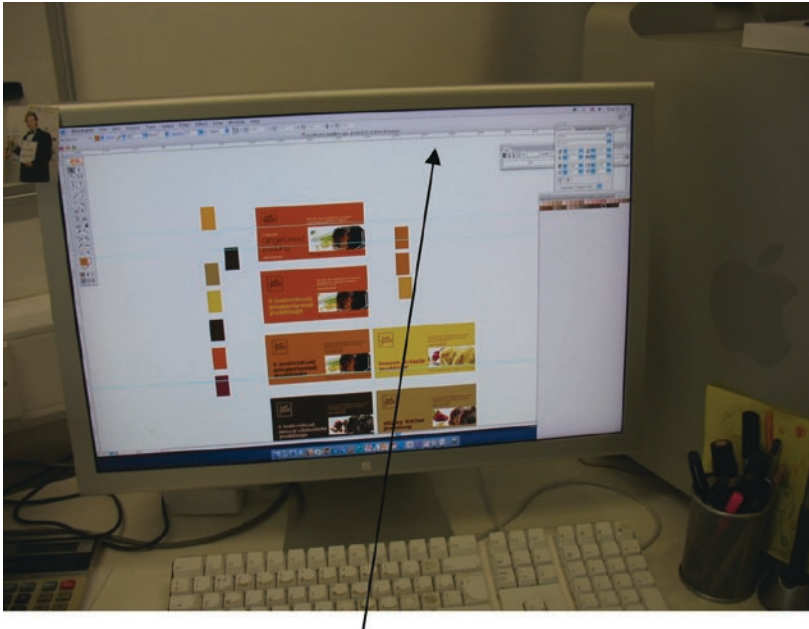


Fig. 2.3 Designing in CMYK emulation space

(even when apparently turned off) CM is setting and altering the colour values in the files for printing. This can lead to some unexpected effects on printing.

2.7.3 Preferred Palettes and Known About and ‘Simple’ Colours

Graphic designers we observed had ‘preferred’ palettes and ‘known about’ colours. These are colours and sets of colours that, by experience, designers had found seemed to print well. This was not simply a matter of perceived consonance between screen and print but was also to do with having seen the colours printed a number of times and having been pleased with the results. When colour choices were left open they tended towards guiding customers to one of those colours if they felt it was appropriate for the product. On the other hand, certain colours were known to be problematic. For example, vibrant orange is difficult to reproduce using process colour (CMYK) combinations. This was one of the UK Universities’ corporate colours for which they had found a specific, preferred, print shop that could produce the colour well.

Another method that designers used to manage colour is to use ‘simple’ colours in their designs. What this amounts to varies, with some renditions clearly more easy to produce and others may amount to practitioner misunderstanding.

For example, simple colours might be considered to be colours made up of 100% C, M, Y, or K; or a mixture of just two of CMYK. Single colours or simpler combinations of just two colours were intuitively understood to be more dependable in output. However, some designers prefer regular breakdown percentages like 25% C 50% Y, etc. as opposed to 17% C 39% Y, etc. The extent to which a colour made up of varying percentages of four colours is 'complex' is open for discussion. Some designers reported that the reason they consider colours composed of irregular percentages more complex is not to do with mixing colours but rather that it is more difficult for them to know how a colour composed in a more complex way will look 'in real life' when it is printed out. For example, in one situation observed, a brown with a high magenta content looked like a rich brown on screen or printed on offset, but printed on a digital print device it was burgundy in colour. Another technique designers used was to use shades (lightening/darkening) of the same colours. As we were told, an issue between screen and print is that of harmony between colours – combinations that look harmonious on screen can be dissonant in print. Tricks of the trade like using shades ensure a harmony between the colours.

We have two examples of designers using 100% cyan (Fig. 2.4). In the first, the brief was to provide some 'straightforward/clean' designs for a plumbing parts company. The catalogues were black and white with one extra colour. Looking through various samples of previous work the designer noticed that out of four colours used, one appeared to be 100% cyan. As one of the four colours in colour printing (CMYK), it is easy to 'hit' this colour consistently, as it does not involve mixing any colours (Fig. 2.5).



Fig. 2.4 Mission rubber 100% cyan

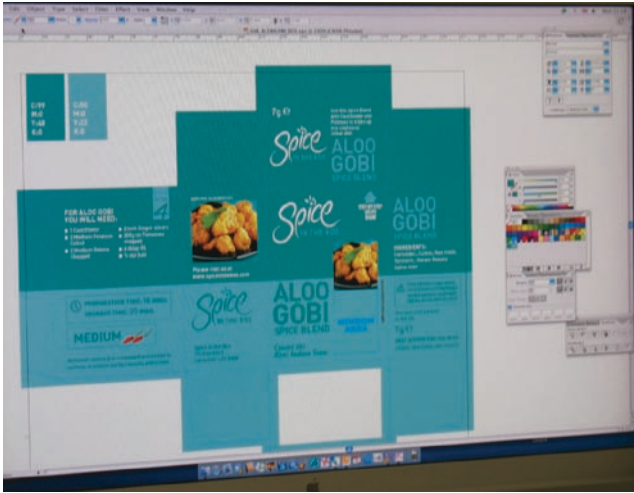


Fig. 2.5 CMYK key for block colours

At another design agency, the designer was showing us a university newsletter and noted how he had picked 100% cyan as the key colour along with black, white and grey because it looked good and was easy to produce.

2.7.4 Work with the Print Shop to Set the Colour Values

In situations where customers have very strict colour requirements, they or the designers must put in extra work with the print shop (and pay more) to ensure that the colour requirements can be met. This is done through printer (machine and person) selection, through encouraging customers to pay for Pantone inks and through process colour proofing, and proofing in general (Fig. 2.6). In this way tolerable/desired colours are achieved. We have seen these colours encoded as keys on files and print samples (Figs. 2.7). Certain print shops also get the reputation of being able to do certain things. For example (as pointed out above), the University designers went to a certain print shop when needed “because they could produce a really strong orange”. We observed the design of boxes for curry spice recipes (Fig. 2.7) where the design house sent the customer to the print shop because the customer had ‘very particular’ colour requirements. They were particular in that she wanted very specific colours (like the ‘jade’ green above) with very little tolerance but did not want to pay for specific Pantones. The designers told her that she needed to go to the print shop and work out the precise CMYK mixes that fitted her requirements. In Fig. 2.7 the CMYK process mixes have been added to the image as a key. The same process occurred for this design house when producing a set of boxes for some ‘puddings’ (see Fig. 2.3 for early designs and for colour proofs). By getting the customer to



Fig. 2.6 Colour proof test prints

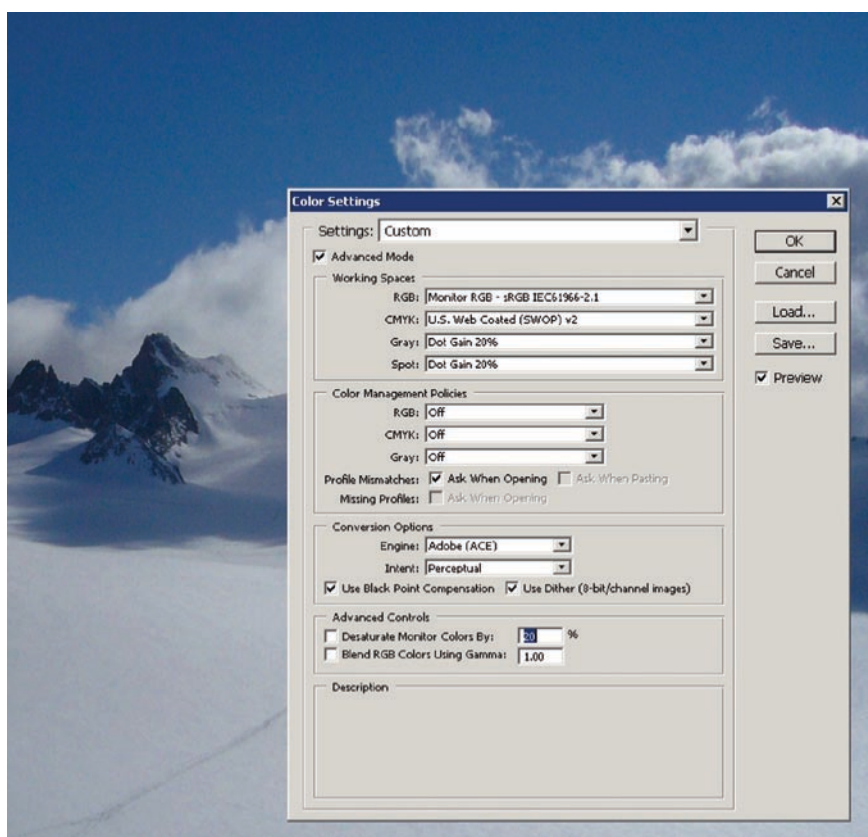


Fig. 2.7 Photoshop CM settings dialogue – working spaces, CM policies (turned off), conversion options, advanced controls

collaborate directly with both the print shop and the design house, good colour can be achieved. However, this is at a high cost if, for example, the run is expected to be short. Some design houses may tell customers who will be printing on digital that they must relax their colour requirements and graphic designers tend to consider that offset printing produces better quality colour than digital.

2.8 Discussion: No ‘Working Around’ CM

A common feature of CSCW studies of workflow systems is that people often *work around* difficult elements of such systems. What is interesting here is that, being an infrastructure, it is not possible to truly work around CM. In our studies, supported by other work (Riordan 2005), we did not see any examples of properly implemented CM workflows. It is not that CM workflows are tried and fail in implementation because of intransigence, interference with user practice, mistakes or so forth, rather it is simply incredibly rare that any attempt is made to construct and use them. This produces the consequent problem that the colour resulting from printing can be highly variable in relation to what was expected. Our studies of print shops showed that the majority of files that arrived at the shops did not have profiles attached containing CM information. Furthermore, even when files arrived with profiles attached these were discarded as not being trustworthy. When problems occurred, print operators attempted to solve them, but effecting a solution often proved difficult. CM is *non-robust*, in that for it to work a CM workflow must be followed throughout the process. That is, it must be initiated upstream at document design.

Our subsequent studies of graphic designers confirmed they were not using CM workflows. Instead – often in concert with print shops to some degree – they use a number of practices that aim to provide some control over colour. Some of these practices (correct use of swatch colour books, use of 100% cyan) are practices that can really work, even when the infrastructure is misunderstood, but they only work for elements of a document and cannot be applied to photographs or complex graphics. Others, such as working in CMYK emulation space and using ‘simple’ colour mix ratios have more variable effects. The general and persistent effect, however, is when monitors are un-calibrated and CM workflows are not used, there is no clear way to understand the relationship between all the different colours on screen and what will print. This is because in *all cases* (irrespective of conscious knowledge) the CM infrastructure is being called upon as it is *impossible* to produce digital colour without some translation between devices and their colour spaces. Thus, although some applications offer the possibility to ‘turn CM off’ (and indeed some graphic designers choose these settings), colour data are still being processed according to the default settings of the device, which are oriented towards a CM workflow. This work goes on without the correct ‘encryption keys’ and thus is automatically translated wrongly – often without the user having any idea what is going on. This makes ‘non-CM’ workflows *opaque* as a variety of transformations and encodings are going on in the background.

We suggest that colour production printing is an intriguing example of cooperative work that enabled us to examine some issues concerning infrastructure and

workflow. These provide a different 'take' to the investigations of workflow systems previously presented in the CSCW literature. What marks this investigation out from previous work is the fact that we investigate the link between a particular infrastructure and the workflows that it implies. The nature of CM as an infrastructure means that even when using non-colour-managed workflows it still necessarily impacts on the way colour is processed and rendered and therefore affects the appearance of colour in documents. CM is an infrastructure which is 'scientifically' correct. It makes sense from a purely technical point of view, but it is very complex to put into place the workflows required to successfully make the infrastructure work to produce consistent and good colour. To make informed choices between the many possibilities offered by applications and devices, one needs to have a technical understanding of how CM actually works, i.e. some awareness of colour science. Currently such specialised knowledge and skills are largely absent in the design and print industries. Below we list three points which illustrate the complexity of CM and its presentation to the average user.

2.8.1 Confusing Presentation of CM Functions and Options

It is clear that the way in which CM options and controls are presented on the graphical user interface (GUI) of common editing and design applications means that the average user has problems understanding if they are operating, how they are operating, what would be the best option for 'this document' and so forth. For example, colour translation takes place, irrespective of whether CM is supposedly 'switched on or off', or whether the practitioners know what the settings are.

The CM options offered up are often opaque to practitioners and explanations are not ready-to-hand (rather they are hidden in the help systems) nor articulated in a way which is comprehensible to them – the potential sophistication of the system means the novice is presented with a dizzying set of options. In popular design applications when an image or photograph is imported the user will be given options that regard the preservation, conversion or removal of the file profile, and also whether they would like to preserve the profile but work in a different 'emulation' (or *working*) space (i.e. the appearance on screen). There are also various options for dealing with different types of image element differently (e.g. for CMYK versus RGB), as well as dictating how any conversion of profiles should work, as well as various advanced options. The implications of making certain choices are not self-evident unless one understands the underlying process of conversion between different colour spaces, and decisions not based on a clear understanding will often lead to unexpected results when the document is printed.

2.8.2 No Means of Recovery

There is a related issue around recovering information about the document creators' colour intent from documents at different stages of the workflow, in particular in

situations where the colour as rendered by a specific device does not match the user's expectations. In the absence of a properly colour-managed workflow, neither the system nor the user will necessarily know just how the current set of encodings actually relates to what was intended or desired. Operations like colour space transforms may be applied without the user's knowledge and there is no meaningful audit trail or history. This may point to an issue with the 'intelligence' of the CM system and it is necessary to consider how useful information about the relationship between colour values and the way they are rendered on any given device can be communicated to the user. Currently there is no way to backtrack to an earlier state, beyond reverting to a previous version of the document or the assets contained within it – once a transform is applied to an element the values have changed (and therefore the colours have changed in some way). This issue and the lack of audit trail make the system particularly impenetrable to users. Once the design is some way 'down the road' to completion users often have no idea what the colour information is contained in their files, whether different elements have different profiles and so forth, and there may be quite a marked discrepancy between what colours they see on screen and how they will print out. This is clearly very problematic as it does not facilitate user learning by being able to analyse document (and document element) profile (and profile transformation) histories. We are not saying that this would be an easy solution to colour (re)production but it would allow users to compare and contrast good and bad results on, for example, photo quality or colour reproduction.

2.8.3 *Difficult to Understand Impacts of Selections*

That colour is an issue which those in the design workflow strive to control is evident in the many non-colour-managed workflows we observed. These methods tend to be far more *visible*, *tangible* and *collaborative*. However, because these methods do not specifically orient to the way in which infrastructure operates they produce varying results. Examining these methods raises a second issue; CM by its nature is somewhat abstract and the complexity of the possible workflows makes it very hard to make *concrete visual* mappings between the colour choices, encodings and their effects on a current document and a future print. To some extent colour must be understood abstractly. Furthermore, to take up a couple of points made in the previous section, managing colour according to CM protocols means: (1) making principled decisions on how to handle graphical elements at all stages (i.e., actively making a number of decisions and understanding their implications), (2) keeping some kind of memory or record of those decisions so users can keep track of where they are, and (3) having an understanding of how the colours they see on screen, relate to the colours recorded in the profile and ultimately to what they may print. The nature of the tasks and abilities required to colour manage are difficult and potentially unintuitive for practitioners, as they not only are complex and badly supported by the technology, but crucially they work against the normal everyday ways people apprehend, work with and understand colour.

2.9 Conclusion: New Technology and New Markets

While it might seem easy to make a critique of CM on the basis that it is not used, not understood and does not fit with the work of practitioners, this would not easily point us to a better solution of this difficult problem, with a long history and many complex features. Colour has intrigued many great scientists and philosophers – for example, from Newton to Goethe to Wittgenstein, and in many ways the work on colour leads us to a central, still unresolved problem which is the relationship between colour as a physical property and colour as perceived and reasoned about by people. To boil this argument down to a simple instantiation, there is no simple relation between colour as objectively measured and colour as perceived, talked about and understood by people. Colours are scientifically measured using standard, arbitrary values, such as hue (the colour, e.g., yellow), saturation (intensity) and value (lightness–darkness) under a given lighting condition. People – even though it is likely that our visual systems, if we are not colour blind ‘perceive’ colours in the same way – show great variability in responses to colour. Our perceptions are impacted by context – and not just visual context, but also what we are doing, who we are interacting with, what our knowledge is, how we *look* (our visual practices). We also can precisely discriminate colours side by side but if asked to recall (by picking out) a precise colour at a later date, we are shown to have poorer memory. We see familiar objects as always having the same colour, even when lighting conditions mean they do not. For example, our prior knowledge of the colour of an object ‘instructs’ us when seeing a New York taxi-cab to see yellow, or for an (old UK) telephone box, red. Even at night. Our response to colour in applied contexts (i.e. ‘real world’), beyond what we know about the human visual system and colour perception from an experimental point of view, is not properly understood (Armour 1996; Goodwin 1997). However, for example, Wittgenstein (1978) in his usual slightly enigmatic way, points us to the importance of context in perceiving colour (in terms of *other colours*, in terms of *discernable objects and features*, and within a *coherent ‘assembly’ of ‘things’*) by way of a thought experiment:

Imagine a painting cut up into small, almost monochromatic bits which are then used as pieces in a jig-saw puzzle. Even when such a piece is not monochromatic it should not indicate any three-dimensional shape, but should appear as a flat colour-patch. Only together with the other pieces does it become a bit of blue sky, a shadow, a high-light, transparent or opaque, etc. Do the individual pieces show us the real colours of the parts of the picture? (Aphorism I-60) [20]

The important point to take from this is that even if CM worked in all cases, it would not necessarily mean everyone was happy with their ‘prints’. A print is still different from an image on screen, and the (same) red in the print may not seem like the red I saw (some time ago) on screen. Also, choosing a colour from a small swatch surrounded by white is different to seeing it in a large block on a poster, or against other colours, or up close or faraway. And, furthermore, my perception of a colour as looking ‘good’ or ‘correct’ can be influenced by both other peoples’ views of it and my faith in the people, actions and technologies that produced it.

However, the fact is that there must be some system in place to transfer colour information from application to application and device to device. CM is an infrastructure that provides for a standard means of translation enabling diverse manufacturers to produce products that can integrate successfully with others to communicate colour information across that workflow. We understand that unfortunately CM has to be complex but somehow this complexity needs to be further reduced in the way it is presented to users or the problem of non-use and misuse will not go away. One can think about the problem as a classic interoperability problem but with a twist; providing translation between devices that ‘speak different languages’ or do things different ways is a classic computing problem, however, one that is usually solved by engineers and kept hidden from the users. In the case of CM not only must the users understand – at least to some extent – the processing and translation of colour but there must be close coordination and strict adherence to specific procedure across the workflow. This raises questions about who in the process should be responsible for recruiting the required expertise to design, implement and manage such a workflow, and whether this would make economic sense in the light of possible benefits. In this paper we have not sought to provide answers to questions such as these, but rather to provide insight into a complex problem. Although many colour scientists may not understand why CM is not used, we feel these issues will be familiar to those in the CSCW community.

2.9.1 A Mediating and Correcting Technology

One solution to these problems could be an additional software layer to bridge the gap between the current CM infrastructure and the actors of the workflow, such that there could be some translation of CM, or the requirements for CM, to make them more tangible and understandable for users. Our research also shows how far the current practices, knowledge and perspectives of those involved in graphic design and printing are from those required for the CM infrastructure to work correctly. We can infer from this that any attempt to design and implement a mediating technology that nevertheless still required a strict adherence to CM (albeit with translation) would lead to a failure in adoption or to the introduction of new attempted workarounds. Using ethnographic work studies as a resource for developing technology innovation, we have been exploring technological possibilities based on these findings. They have led us towards the design of technology supporting the workflow that is based on two principles: (1) that achievable, ‘good enough’ colour is what is strived for in most situations rather than technically correct colour reproduction and (2) that it should be possible to assess non-CM documents for detectable and correctable colour problems prior to printing. To this end we are in the process of developing a tool that can provide an assessment of non-CM documents prior to printing. It is based on integrating some technologies that can detect a number of colour problems – mainly when certain colours are likely to be printed out in a manner rather differently to how they appear on screen – and highlight these graphically and textually and offer various potential ‘corrections’ to these

problems. This seems to tally well with our findings that certain colours are more important than others in documents, that large changes in colour are more problematic, while at the same time clients are mainly looking for a good enough result.

2.9.2 *Preparing for Web 2.0 Markets*

How does this work relate to the World Wide Web and mass customisations? Put simply, it seems clear that if the new business of printing is going to take off (web submission of documents by customers essentially 'unknown' to print shops, capturing the 'long tail' with a mass of customers printing single items, 1–1 marketing with variable pictures and text-tailored for individual clients) better, more predictable colour results are required in digital production printing. There may be a number of barriers to implementing these solutions, one such being the relative lack of expertise in programming, database management and automating workflows within the design and print industries. However, this expertise does exist in other communities so it may be imported into the industry. But, another key feature of these potential growth areas is that none of them afford the time for extensive print proof cycles. In fact, in the web submission long-tail markets the idea would be that the full transactions would be carried out over the Internet, with no iterations and no direct conversation between customer and print shop, save perhaps some textual exchanges.

In the case of the 1–1 variable market the configuration is slightly different, as in many cases it is likely that there will be some kind of direct relationship. Setting up a bespoke database and workflow with variable text and images for tailored products is a relatively complex affair. Often this will take some time and a certain amount of interaction between customer, print shop and graphic designer. A key issue here though is proofing – it simply is not practicable to proof each individual item. Ideally, proofing should be automatic or carried out by eye on a small 'representative' sample.

In both these cases, our concept for technology design would provide a means of capturing problems at an earlier stage. It could work as a part of a web submission portal to assess and correct problems, as well as to gather additional information from customers in the absence of direct contact. Furthermore, it could run as an automatic checker on variable 1–1 documents and flag up problematic cases. In this way it might well be useful in helping to open up these markets. We will report further on this technology as it develops.

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