A New Approach to Colour-Picker Tool Design

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Abstract

It can be readily observed in both the commercial and educational environments that the majority of users do not easily apply their existing creative instinct or knowledge of colour to the computer environment. The tendency is to adopt an approach of trial and error led by expectations from the feedback delivered by the colour information visible on the monitor screen; an approach often leading to misinterpretations and exaggerated assumptions of the colour range of the whole system, specifically the output printer.

Introduction

Certainly some colour interfaces are easier to learn than others but the question still remains as to what is actually intuitive about colour to the average digital user? What are perceptually meaningful dimensions of colour-space to a naïve user and importantly how successfully can users' existing colour knowledge be transferred to the digital environment? Our research seeks a better understanding of the digital colour process from a design perspective and re-evaluates the relationship between established colour management workflows and creative colour selection strategies. The focus of the work is the development of a colour-picker-tool that facilitates an improved user understanding of the relationship between a monitor colour-space and the selected printer colour-space, an important step in overcoming any exaggerated expectations with regards to printer performance. By dispelling any preconceived functional-fixedness in the workflow of colour relationships, a more rational colour selection process may well be supported in terms of reproducible hard copy colour. By uniquely providing a user with the means to specify a printable colour-space that is then reflected in the gamut of the colour-picker-tool, they are able to exercise their colour critical abilities in a positive interaction. Furthermore, with the objective of firmly linking with a user's intuitive colour knowledge, colour selections are created through an engaging process of subtractive mixing rather than the ubiquitous point and click.

Review

There are some interesting questions to consider with regards to the design of digital colour interfaces and colour-picker tools. Certainly the current standard arrangements are deemed easy-to-use and have changed little in design since their original conception, but do preferences for familiarity and ease in fact impede creativity or even adequately promote rational colour selection? Global coloration tasks, the manipulation of photo-realistic imagery, etc., are readily facilitated often without any colour-matching requirements beyond the pictorial norms. Colour-critical design tasks of palette selection and colourway manipulation, although achievable, are less predictable in terms of the aesthetic outcomes.

Novice designers, and design students alike, are seldom able to replicate the merits of colour judgments performed with traditional media [1], [2].

Colour management is seen as the answer to tackling such colour fidelity issues in many design industries, notably textiles, but at the same time it is accepted that the technical protocols are difficult to apply effectively for the majority [3].Studies evaluating digital colour workflows in the graphics print industry also acknowledge that a colour management infrastructure is an inextricable element wherever the objective is the production of colour across devices [4]. Technical procedures of colour management are criticised for not fitting well with practitioners' real-world procedures; a very valid point is made in the observation that however technically correct the various procedures are they are seldom used as intended by those focused on more creative and commercial objectives. Colour-critical decisions are underpinned by practical and visual assessment governed by unique and often fluid design contexts whilst integrated with equally unique and ad hoc working practices. Understanding of technical colour management procedures is assessed to be at best limited while many practitioners are highlighted as 'quite oblivious' to the necessary protocols.

There are many insightful texts offering explanations of the basics of colour science to the complexities of instrumental colour measurement, the irreconcilable nature of additive and subtractive colour spaces and the mathematical procedures for transforming colour coordinates between device-dependent and device-independent environments. Comparably there is little in the way of explanation offered as to why challenges with digital interactions might continue to exist for the novice designer engaging with digital colour in practice. What is perhaps curious is why this situation has not changed considering that design software and digital processes are so well established; time, money and consumables are still wasted due to lack of understanding. Improved education is often cited as the most accessible and obvious solution, but the simple matter is that colour is a complex subject.

Colour-Picker Design

A recurring theme in investigations exploring the effectiveness of digital colour interaction is the assessment and comparison of intuitiveness and ease-of-use, the measurement of which is valued against the speed and accuracy of the user performance with various colour arrangements, notably the RGB and HSV models. It is worthwhile at this juncture to briefly evaluate the concept of intuition; the phrase suggests that the user will exhibit a natural affiliation for the interface and the underlying model will be understood with little apparent effort [5]. Such perceptual understanding is defined as understanding without

training; these ideas relate to Norman's [6] theories on affordance, that is to say interfaces that demonstrate ease-of-use are, in essence, easy to interpret and understand as they contain visible clues as to their operation.

The experimental studies draw no firm conclusions with regard to the question of intuitiveness per se but rather make comparisons of how well a user may navigate what is essentially an unfamiliar colour environment. In the original study by Schwarz and Beatty [7] one of the initial objectives of the experiments was to test the assumption that the HSV colour model would be more intuitively appealing to an inexperienced subject than an RGB colour model. With regards to this general question the results are inconclusive. Also, little difference is observed between models with regards to which point learning occurs at. In a later study conducted by Douglas and Kirkpatrick [8] the emphasis of the investigation was their hypothesis that visual feedback from the user interface is the most important aspect in relation to the usability of a colour model. Their experiment was designed with a similar aim as Schwarz's, to compare the performance of RGB and HSV colour models. The objective of determining which model is the most natural and intuitive to an inexperienced user was assessed by comparing colour-matching performance in terms of speed and accuracy. The conclusion reached was that the improved feedback from visually constant samples does significantly improve accuracy. The improvements between the two RGB and HSV models are similar, which suggests that the users are able to apply the additional visual information regardless of the model organization.

Summary of Experimental Work

The initial research explored the hypothesis that observers may develop an intuitive understanding of subtractive colour mixing processes from a young age as they experiment with inks and paints. Many observers would not be surprised to be informed that yellow and blue inks mixed together make green but may find it hard to believe that red and green lights can be added together to make yellow. A simple two-stage experiment was devised to assess observers' ability (both naïve and those with colour expertise) to predict subtractive mixes; the first stage was conducted using physical colour samples the second was a replication of the colour prediction task in the digital environment illustrated in figure 1. Unlike colour-matching tasks where the objective is accuracy, in this case the results were evaluated based on the similarity of the results. Figure 2 helps visually demonstrate the concept that there is a relatively consistent understanding of physical colour interactions amongst all observers but what might be described as tacit colour knowledge is more evolved in those who regularly engage with colour-critical tasks. Based on these experimental conclusions it is further hypothesized that a colour-picker tool founded on subtractive mixing principles will prove to be more intuitive than an additive model of the same interface arrangement.

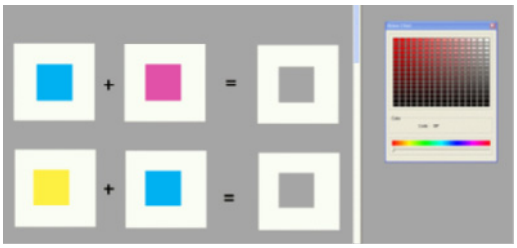

Figure 1. *CRT experiment of subtractive colour mixing*

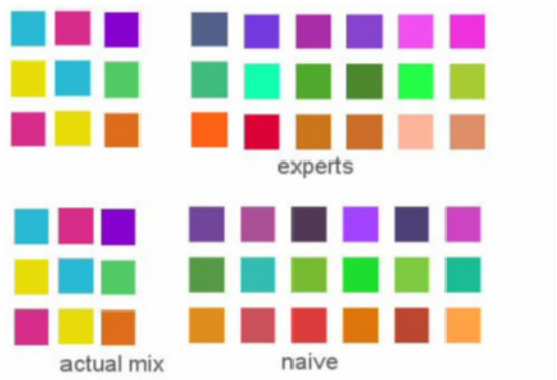

Figure 2. *Colour representation of matches (Experiment 1) made for binary mixtures of cyan, magenta and yellow. Each column shows the match made by an observer (experts in top half; naïve in bottom half) to the imagined mixture of the colours in 1st and 2nd columns. The colour in the third column is the actual physical mixture (which the observers did not have access to).*

To further develop the work a graphical-user interface (GUI) was created in MATLAB that enabled observers to select a colour by adjusting each of three slider bars (see Figure 3). In one condition the slider bars were set to the standard RGB additive mixing method and a second condition the slider bars were set to CMY designed to represent arbitrary subtractive primaries effectively simulating a similar experience to the mixing of paint. Users were instructed to adjust a sample colour so that it was a visual match for a target colour and were given a fixed amount of time to complete the task. In mind of Norman's theories of constraint and design signals, the observers were not provided any visible clues during the experiment, the slider bars were not labeled with an appropriate primary colour. The objective was to assess how well the users were able to understand each model without training or explanation. When observers were given a limited amount of time to use the sliders to match target colours their performance was statistically superior when they used the subtractive CMY sliders than when they used the additive RGB sliders. Again these results further suggest that observers possess better internal models of subtractive mixing than additive mixing and that the design of colour-selection tools could exploit this

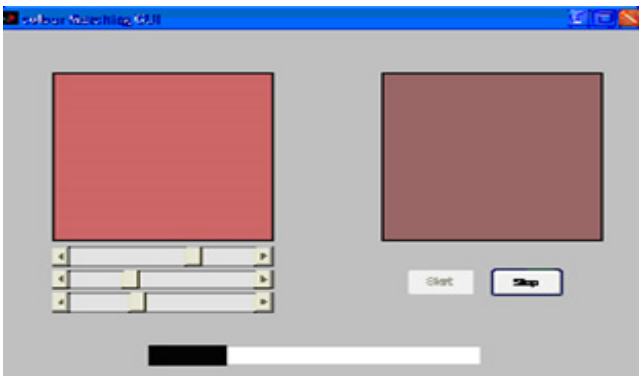

Figure 3. *MATLAB GUI for colour selection. The left-hand colour is adjusted by the sliders to match the right-hand one. The bar at the bottom indicates the time remaining for the task.*

Key points to note are that HSV models are perceived as a more natural colour-space than RGB and, with regards to colour-picker design, visual feedback significantly enhances user understanding beyond the characteristics of the underlying colour-space. A further set of experiments were conducted to assess how well the intuitive attributes of a subtractive based colour mix model would perform in terms of intuitive appeal when measured against a HSV colour-space and a standard full-colour GUI configuration. A similar set of colour matching experiments were conducted with a range of variables designed to assess user understanding of the various models presented as well as to compare working studio environments against a more controlled set of laboratory conditions. Of the colour models tested RGB proved to be the least accurate therefore was considered to be the least usable or intuitive which is consistent with earlier work (see table 1). What is perhaps the surprising result is that the full-colour GUI did not demonstrate any significant advantage over the simple slider-bar arrangements presented in the CMY and HSV models. This outcome would suggest that intuitive characteristics of colour understanding are potentially a more powerful tool in guiding users towards a more rational colour selection process.

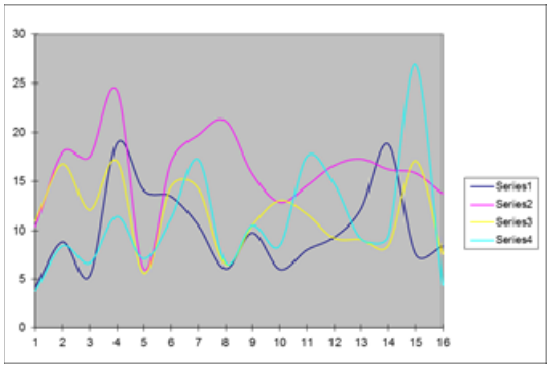

Figure 4. *Matching results comparison Series 1=GUI Series 1=GUI Series 2=RGB Series 3=CMY Series 4=HC*

Table 1 T test Comparison

GUI v RGB	0.000436	sig at 5%
GUI v CMY	0.327308	not sig
GUI v HCL	0.674328	not sig
RGB v CMY	0.000588	sig at 5%
RGB v HCL	0.00536	sig at 5%

Discussion

The ability to consistently predict the outcome of colour mix combinations demonstrates a well-developed understanding of colour relationships. Further, the cognitive ability to decipher the colour interactions of a three slider-bar interface without any visual clues or prompts strongly suggest that our intuitive understanding of paint mixing is well established. Although it may be argued that an HSV colour arrangement perhaps demonstrates equal or superior usability characteristics, the important point is that the colour gamuts of printing devices are subtractive by nature. Embedding a sufficiently clear metaphor within the design of a new colour-picker tool has the potential to invoke intuitive understanding of the pertinent colour relationships thus helping to prevent a user from being distracted by the exaggerated colour gamut displayed on an average colour imaging device.

Recent Results

An experiment was carried out to investigate how creative colour choices would be influenced if they were exposed to a colour-matching task that demonstrated the relationship between on-screen colour and hard copy colour. Figure 5 shows an Adobe Photoshop environment where participants selected colours using the conventional Photoshop GUI for six shades for a range of Women's Wear (Spring 2012) selected for their evocative naming and not for any purpose relating to colour accuracy. Prior to the task half of the participants were first asked to match colours of a characterisation print (viewed in a light booth) using a bespoke colour-matching environment on screen (Figure 6). An integral part of the task instructions include the requirement that the colour palettes produced would be printed on a specific printer. All participants were textile design students from the University of Leeds (School of Design) and were familiar with the selected device through regular use.

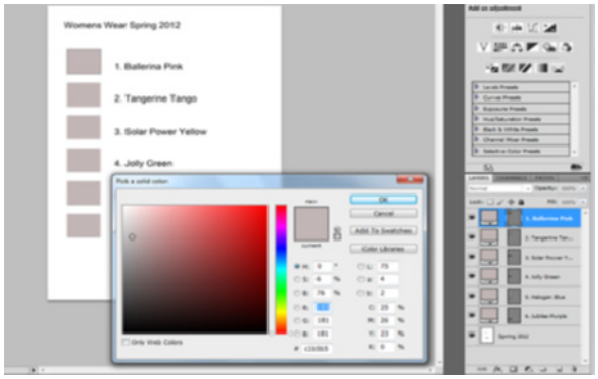

Figure 5. *The standard Photoshop colour HSV GUI*

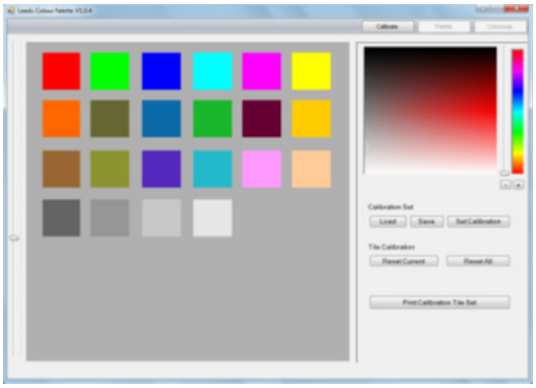

Figure 6. *The bespoke colour-matching environment*

Figure 7 shows the main results from the study. The CIELAB values of the colours selected are shown. The left-hand figures show the results for the control group that undertook the standalone Photoshop task and the right figures show similar results for the test group that first undertook the colour-matching exercise. There is some evidence that the test group chose less saturated colours for the fashion palette than did the control group which supports the hypothesis that the observers' creative process has been influenced by exposure to the colour-matching task. A post experimental questionnaire also revealed a number of differences between the two sets. Results from the control groups who completed the characterisation exercise before developing their colour palettes overall found the tasks harder and were in general less confident of the potential accuracy of any printed output of their individual palette. Those who first created their palettes using the standing Photoshop HSV GUI reported that the tasks, even the matching of the characterisation, were relatively easy and were more confident about the potential accuracy of a colour print. It is interesting to note that both groups reported that the GUI did not offer sufficiently saturated colour choice even though in the context of the experiment the full monitor gamut was utilised.

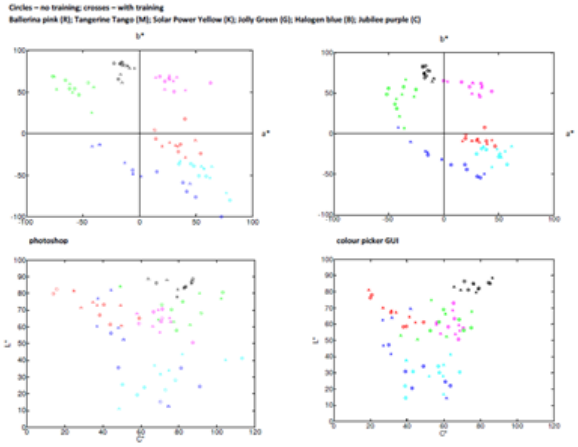

Figure 7. *CIELAB results for the colours chosen by the control group (left) and the test group (right) for each of the six colour name.*

Conclusions

This work is part of an on-going study to develop a new intuitive colour-picker tool. There is some evidence in this work that engagement with the colour-matching task (and hence the relationship between on-screen and print colour) helped digital colour users to make more rational colour selections in their creative task that were within the gamut of the printer being used.

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Author Biography

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