An investigation into colour accuracy and colour management issues in digitally printed textiles for Higher Education

A Thesis submitted to The University of Manchester for the degree of Doctor of Philosophy in the Faculty of Engineering and Physical Sciences

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Abstract

There is an abundance of information available (from industry journals, company websites, and specialist trade fairs) relating to commercial digital textile printing. However, there is a scarcity of information regarding how digital textile printing is being used and taught, in undergraduate textile design degree programmes and how staff and students deal with colour accuracy issues. This research aims to explore and compare approaches to achieving colour accuracy in digital textile printing in industry and HE environments. The research findings are intended to provide useful information for educators involved with delivering digital textile printing in Higher Education (HE) to benefit the industry.

Secondary research contextualises the study, with the history of printed textiles examined in order to place digital textile printing in context. The evolution of digital textile printing, colour communication and colour management in the digital textile printing process are also studied, as is the current status of digital textile printing in industry. A review of literature relating to learning and teaching styles presents aspects of pedagogy relating to the research aims and objectives.

The primary research undertaken for the study was through interviews, visits and questionnaires. Questionnaires completed by educators at HE institutions that offer digital textile printing as part of their undergraduate textile design programmes were followed by visits to comparison institutions. The second stage of data collection consisted of individual and group interviews with educators and students from a BSc textile design programme. The individual and group interviews with educators and students led to the formulation of a questionnaire that was sent to industry professionals (including graduates of the BSc programme). For the final stage of the data collection, interviews were conducted with graduates from the BSc programme who were working with digital print.

From the primary data collection the key aspects that require teaching for a good understanding of the design process for digital print were identified and rated with regard to importance. This led to a teaching model for an undergraduate textile design programme and the development of initial lectures for such a programme. In addition the data analysis indicated that further work could be done to develop learning resources to improve students’ knowledge in this area and support their transition from the HE environment to industry.
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Chapter 1
Introduction

1.0 Introduction
“The most significant advance in fabric printing technology since the invention of the silk screen” (Bowles and Isaac, 2009:10) is how digital textile printing is described by Melanie Bowles, a textile designer and senior lecturer at the Chelsea College of Art and Design with 10 years’ experience in digital print. In a status report for the Society for Imaging Science and Technology, Professor Hitoshi Ujiie describes digital textile printing as being “regarded as an upcoming critical printing technology” in the U.S. Market (Ujiie, 2012:1). Digital textile printing opens up a whole array of possibilities for textile designers to push the boundaries of their own creativity, by providing them “with creative challenges [that lead] to the emergence of new, exciting and vibrant printed textiles” (Briggs-Goode, 2013:28). As an emerging print technology which is rapidly becoming established, it is vital that robust approaches to teaching digital print production and colour management are established in higher education textile programmes.

A consequence of the importance attached to this technology is that industry has an expectation that graduates have an understanding of the issues and factors which affect the application and use of digital print (Leak, 1998; Kavanagh, 2004). As Treadaway comments, “the increasing use of digital ink jet printing and digital imaging technology has already begun to influence the type of design work industry requires” (2006:11).

Colour matching between computer screen and final printed output on fabric is a key issue for both design students and for industry. Indeed, colour matching presents problems when printing onto any substrate. In his book, Silver Pixels, Tom Ang describes a long history of photographers’ frustration with the unpredictability and unreliability of colour reproduction; digital technologies have brought their own complexities and potential for variation (Ang, 1999). Ang explains the importance of ensuring consistency between devices to achieve continuity of colour, and how sensitive this system really is, “colour reproduction can even depend on the weather: cold, damp days can make paper take up inks more slowly than on hot days” (Ang, 1999:90). Problems occur when the fundamental variances between how different devices physically create colour are not understood; as Bowles explains, “many of the issues that arise around colour and digital printing are often based on the mistaken assumption that the colours viewed on screen will automatically match those in the final print” (Bowles and Isaac, 2009: 182).
The aim of this research project is to identify the key colour management issues when teaching and applying digital textile print technologies in Higher Education (HE). The research examines how colour in digital textile printing is understood and managed, and considers how to raise students’ awareness of the colour matching issues faced as a consequence of the techniques used and the design process, in order to optimise teaching of this important developing technology. Although the research focus is on digital textile printing and related colour accuracy issues within the HE environment, it compares approaches to achieving colour accuracy in digital textile printing in industry and HE, in order to determine the perceived importance of colour accuracy in both environments.

Respondents from undergraduate students, educators and the textile printing industry constituencies were consulted and asked to give their perspectives on the subject. The primary research undertaken among these groups provided in-depth data from which comparisons and similarities could be examined. This data directly informed the development of a teaching model relating to the research issues. For educators, the teaching model is designed to improve students’ knowledge and understanding of all aspects of colour in the digital textile print process, enabling them to work accurately with digital textile technologies during their degree. This will benefit students by giving them knowledge relevant to the needs of industry, thereby enhancing their employability. The benefits to the textile printing industry will comprise better informed graduates coming from HE into the work place.

1.1 Research Context

Information is readily available (from industry journals, company websites, and specialist trade fairs) relating to commercial digital textile printing; examples include, Digital Textile magazine, the Society for Imaging Science and Technology, the World Textile Information Network, Techexchange, and the Federation of European Screenprinters Associations (FESPA). Since 1951, the Internationale Textilmaschinen Ausstellung exhibition - which translates as the International Textile Machinery Association (ITMA) - has provided a platform for the textile industry to showcase innovation (Cematex, 2004). The recognition of the growing importance of digital technologies to the industry is reflected in the new European Digital Textile Conference, held in Germany in January 2014, organised by the publishers of Digital Textile magazine. The conference focussed on ‘Digital Printing for Homes and Interiors’. This reflects the importance of digital technologies in the textile industry, described by the organisers as the “newly emerging trend for industrial-scale digital printing of home textiles” (World Textile Information Network, 2013 [online]).
Innovations and developments, such as the latest printers and the newest colorants and colour management systems, are widely documented across these platforms. However, although textile digital printing is becoming widely available in HE establishments, there is a scarcity of information about how digital textile printing is actually being used by students and taught by educators in undergraduate textile degree programmes, and how staff and students deal with colour accuracy issues in particular.

It is not unusual to find a digital textile print facility in HE institutions that offer textile degree programmes (Treadaway, 2006). To have access to a digital textile printer is undoubtedly an asset for students. Having a working knowledge of a range of textile printing processes and their associated applications, restrictions and potential, will be beneficial in their future careers. Students on textile design degree programmes may gain experience of various Computer Aided Design (CAD) software programmes (for example, Adobe Photoshop, Lectra Kaledo Print, AVA) for creating their textile designs, giving them transferable skills they can take forward into the workplace (Kavanagh, 2004). These transferable skills should also include an understanding of the intricacies of colour management. For a textile design student, working with colour is a fundamental part of the design and print process. Having an understanding of colour and its application throughout the design and print process will help students to work more confidently and more effectively (Diane and Cassidy, 2005). As Treadaway comments, “the capacity to communicate accurate colour in design data is imperative” (2006:10).

In terms of colour matching, digital textile printing comes with its own restrictions and requirements (Treadaway, 2006). A colour viewed on screen cannot be accurately reproduced if it is not within the achievable colour range (or ‘gamut’) of the particular digital textile printer and colorants being used (Leak, 1998); a colour that is viewed on screen will appear differently depending on the actual monitor used for viewing and may also not be an accurate representation of the actual desired colour if it is not within that particular monitor’s gamut (Sharma and Trussell, 1997). Each individual monitor or printer will have its own achievable gamut; so a colour viewed or printed on one device may appear different when viewed or printed on another device. As Bowles and Isaac (2009), and Ang (1999) state, and also from the author’s own teaching experience in taught programme units with digital print outputs, people are often disappointed when colours in a design that they have created on a computer do not match when it is digitally printed onto fabric. With no prior knowledge of the technicalities of colour matching, it is not unreasonable to have an expectation that there will be an exact match from screen to textile. To have an understanding of colour matching and colour
management issues for digital textile printing would undoubtedly be an asset in the colour-sensitive world of textiles. Ujiie suggests that “...an effective textile education should encourage problem solving in digital inkjet fabric printing and cutting edge design concepts” (2002:256).

Defining the function of digital textile printing in a HE environment is an important stage in understanding the related colour accuracy issues. Having access to this design tool gives students the opportunity to experience digital printing technology alongside more traditional methods (for example, screen printing). It gives an extra dimension to their creative practice allowing them to bring their CAD work into real world applications as furnishing or apparel fabrics. In comparison to more traditional textile printing production methods, involving many stages and requiring production in volume to be cost effective, digital print opens up entrepreneurial opportunities for the textile designer. Digital textile print has “the potential to have major economical effects on printing on textiles” (Dehghani et al, 2004:262). Ujiie describes the opportunities for digital textile print, “individual textile designers can also become small printing mills, manufacturers, and even brand owners” (2012:3).

The digital textile printer can be utilised on a number of levels, with different aspects of the machine and its function giving students different experiences: it is a design tool; it is a machine for the coloration of textiles; it offers a more environmentally friendly alternative to traditional methods; it provides an insight into colour matching and finishing issues; it is an adaptable and flexible medium for exploring technical textile applications. In all of these cases a basic knowledge of how the machine works, the different colorants that are used, the requirements or limitations for the substrates and the applications, plus fundamental aspects of colour management will give students grounding for a whole range of future roles including those of designer, technologist, buyer and manufacturer.

Digital textile printing is a more sustainable printing process; it enables a rapid response to changes in fashion, is more environmentally friendly than other methods such as screen printing (using less water and creating less waste) and lends itself to innovative technical textile applications (RA Smart, 2010). In a changing market where the production of printed textiles is moving away from long print runs, digital textile printing is coming to the fore. As Holme comments: “within Europe, the average production run is now only 500 metres or less.” (Holme, 2006:104). Knowledge of the issues relating to colour accuracy and how these can be dealt with is vital in industry.
Compared to more traditional textile printing processes, such as block printing, digital textile printing is still in its infancy. Students are in a position to explore and develop this as a medium. The core function of digital design is to create representations of things that do not (yet) physically exist. Having a machine that allows the realisation of these designs blurs boundaries: the digital textile printer is a device for printing onto cloth, but it is also a relatively new medium with its full potential as yet undiscovered. In an interview with the Cooper-Hewitt National Design Museum, Ujiie describes the impact of new technologies, “throughout history, textile designs have been tailored to the production methods in use, and each technological innovation has led to a change in the visual vocabulary” (Cooper-Hewitt, 2011 [online]).

Contemporary design education is having to adapt in order to provide learning experiences that create graduates with the skills to compete in “the global economy” (Souleles, 2013: 252). Today’s graduates require skills that include “new forms of visual literacy and competencies that cater for the interpretation of digitally generated visual outputs, as well as to address the ability and skills to create them” (Souleles, 2013: 252). For a design student, having the skills and knowledge to successfully use digital technologies for textile printing, is clearly part of this remit.

1.2 Research questions

As digital textile printing is a growth area in the manufacture of textiles, (Ujiie, 2012; Bowles and Isaac, 2009) it is highly relevant for textile design students going into all areas of the textiles and fashion industry to have an understanding of the key issues regarding colour management. Therefore, the central research questions of this study are as follows.

- How is colour management in digital textile printing experienced by students and educators on undergraduate degree programmes?
- What are industry expectations of graduates' understanding of digital print technology and colour management?
- Can an effective model be developed to optimise teaching of colour accuracy and colour management of digital textile printing within undergraduate textile design programmes?

1.3 Research aims and objectives

The primary aim of the study is to establish the issues related to colour management in digital textile printing experienced by educators, students and industry, and propose a teaching model to address these issues in HE, creating graduates who are better equipped to apply effective colour management to digital
textile printing in industry. In order to achieve this aim, the main objectives of this study are set out below.

1. To determine the context and significance of digital textile printing with regard to its history, colour management, basic colour theory and colour communication.
2. To review aspects of learning and teaching styles specific to design education.
3. To determine the current status of colour management in digital printing in the textile industry.
4. To identify what colour management issues exist for undergraduate textile design students and educators working with digital textile print.

1.4 Research outcomes
The intended research outcomes from this study are as follows.

1. To identify and compare the most relevant issues relating to colour accuracy and colour management in digital textile printing for undergraduate textile design students, educators and industry.
2. To develop a teaching model that can be used by educators to improve students’ knowledge and understanding of all aspects of colour in the digital textile print process, and therefore better equip them to work more productively with digital textile printing.

1.5 The scope of the thesis
There are three stakeholder constituencies represented in the thesis: textile design students, textile design educators and industrial textile printers. The three constituencies each give their own views on what they consider to be the key elements to consider when teaching digital textile printing; providing data that can be analysed and discussed in order to answer the central research questions. While the samples from industry and other educational institutions are small, they come from a range of companies and institutions based in the UK. The data from these constituencies therefore represent variation in the samples, adding to the richness of data gathered. The scope of this thesis does not cover scientific details on the textile chemistry of dyestuffs used in digital printing, as the primary focus of the research deals with students’ and educators’ experiences and industry perspectives on digital textile printing in Higher Education.

1.6 Characteristics of research methodology
In order to achieve the main aim of the thesis as set out in 1.3, the research objectives were addressed using the following methods:

- secondary data collection via a review of literature and analysis of data;
• primary data collection using interviews and questionnaires;
• inclusion of three separate constituencies in the collection of primary data, namely undergraduate textile design students, educators, and representatives from the textile printing industry, to enable the collection of data across all relevant stakeholders to address the research problem;
• analysis of primary data from all three stakeholder constituencies pertaining to the central research questions outlined in 1.2.

The initial secondary data collection stage formed a contextual framework which provided the basis for the design of the primary data collection methods. The contextual review of the development of digital textile printing technologies and associated colour management issues gave direction to the interview and questionnaire designs used in the study.

1.7 Organisation of thesis
Figure 1 (page 22) illustrates the organisation of the thesis. The thesis is set out in seven chapters. Chapters 2, 3, and 4 present the secondary research undertaken to contextualise the study, by examining literature relating to key areas relevant to the central research questions. These contextual reviews consider the following issues.

• The history of printed textiles to place digital textile printing in context.
• The evolution of digital textile printing and colour matching issues to understand its development from a carpet and graphic printing process.
• The current status of digital textile printing in industry, to gain awareness of what innovations have been made and how these relate specifically to colour accuracy issues and provide comparisons with findings from HE in later chapters.
• An overview of basic colour theory and how colour is communicated, in order to understand what colour actually is and how this relates to colour matching in digital textile printing colour perception.
• Colour communication and colour management in the digital textile printing process.
• Learning and teaching styles which present aspects of pedagogy that are related to the research aims and objectives.

The secondary research conducted during the contextual reviews informs the research design for the subsequent data collection stages of the study. The results of the data collection are analysed in relation to the central research questions (see section 1.3).
Chapter 5 presents the research methodology for the study, explaining the approach that underpins the study and the qualitative research methods used. The first stage of data collection consisted of a questionnaire to members of staff at HE institutions that offer digital textile printing as part of their undergraduate BA, BSc or BDes textile design programmes; the questionnaire was followed by visits to three of the institutions to interview the members of staff in more depth. The second stage of data collection consisted of group and individual interviews with members of staff and students from a BSc textile design programme. The stage one and two interviews led to the formulation of a questionnaire that was sent to industry professionals involved with digital textile printing. For the final stage of the data collection, in-depth interviews were conducted with graduates from a BSc textile design programme who engage with digital textile printing issues within their design roles.

Chapter 6 presents the primary research undertaken for the study. The results from the data collection stages are discussed and compared.

Chapter 7 concludes the thesis with a discussion of the research findings and suggestions for further work.

Appendix A contains the completed questionnaires from HE institutions and industry.

Appendix B contains the code of ethics for interviews that were carried out for the study.

Appendix C contains the full transcripts of the interviews that were carried out during the study.

Appendix D contains the lectures that were prepared and delivered during the course of the study.

Appendix E contains the article based on this research published in the Journal of the International Colour Association.

1.8 Chapter summary
In this chapter the impetus for the study was explained as having arisen from the author’s experience of encountering and observing recurrent issues with colour matching in digital textile printing. The framework for this study was set out in
terms of the thesis argument, the central questions to be addressed, the aims and objectives, and the intended research outcomes.

The following chapter gives a brief chronological overview of the history of printed textiles. The purpose of this is to gain a deeper understanding of how digital printing evolved, how it was used, its relevance, and to show that, in relative terms, it is still an emerging technology.
Chapter 1
Introduction

Chapter 2
The emergence of digital textile printing

Chapter 3
Colour communication

Chapter 4
Learning & teaching styles

Chapter 5
Research methodology

Chapter 6
Findings

Chapter 7
Conclusions

Figure 1: Thesis structure.
2.0 Introduction
Students need a full understanding of all the processes and techniques involved in textile printing, otherwise they will not have the required level of technical ability, which underpins design ability and creativity. If the characteristics of the materials and the processes that are being worked with are not known and fully understood creativity can be constrained and the realisation of a design compromised.

The emergence of digital textile printing arose from the coming together of a number of developments in different areas of printing (Gregory, 2003:71). This chapter gives an overview of textile printing, including a description of the evolution of digital textile printing (the term ink-jet printing is commonly used to refer to the same process). The characteristics of the digital textile printing process are described, including the history of ink-jet technology and requirements for pre and post-treatment of fabrics.

The assimilation of digital printing into the global textile printing industry is also described, along with a review of the most up-to-date machines available and industry analysts’ predictions for the future. The importance of colour accuracy and how to communicate colour effectively is discussed as is how digital print is being used by fashion and home ware designers. The technical applications and innovative ways in which designers are exploring the medium are outlined. The chapter ends with a discussion of digital textile printing in HE.

2.1 Textile printing
The practice of decorating the surface of textiles has been carried out for thousands of years (Storey, 1992:11). This practice is generally referred to as ‘textile printing’, although this term also encompasses dyed patterning techniques. The practice of textile printing can be divided into different categories dependent upon the process used. There are four different categories of textile printing usually referred to, which are, ‘resist’, ‘mordant’, ‘discharge,’ and ‘direct’.

2.1.1 Resist
The resist method of textile printing is, strictly speaking, a dyeing process. The resist method involves applying a barrier (for example, wax) onto the fabric’s surface prior to applying a colorant (Briggs-Goode, 2013:22). The barrier repels the colorant and designs are created from a combination of the resulting dyed and non-
dyed areas of fabric (Hann, 2005:11). Storey describes this method as “the oldest method of patterning cloth with dye” (Storey, 1992:123). Examples of this method exist from the 4th and 5th Centuries. Forms of resist printing include: batik, where wax is used as a resist, and tie-dye, where sections of fabric are knotted and tied to prevent the penetration of colorant into those areas.

2.1.2 Mordant
A mordant is used to achieve the opposite effect of a resist: whereas an applied resist repels the colorant, the mordant (usually a metal oxide) attracts the colorant to the areas where it is applied. A chemical reaction occurs between the mordant and the colorant, rendering it light-fast and wash-fast. A range of colours may be achieved by using different mordants. This process was extensively used in India to create hand painted designs on cotton; textiles decorated in this way were brought to Europe in the 18th Century (Hann, 2005:15).

2.1.3 Discharge
Established in the 19th Century, discharge textile printing refers to the process of removing colorant from areas of a previously dyed fabric (Storey, 1992:12). A subsequent step may then be the introduction of a second colour into the areas from which the first colour has been removed (Berry and Ferguson, 1994:196). This method of printing textiles “enables the creation of a negative image - a white or coloured pattern on a dark background” (Wells, 1997:139). Discharge printing allows elaborate patterns that retain their definition and clarity to be produced, something that was difficult to achieve with direct printing methods (Berry and Ferguson, 1994:196).

2.1.4 Direct
The process of direct printing involves the simultaneous application of both colorant and fixing additives as, for example, in screen printing (Hawkyard, 1994:18; Storey, 1992:12). Complex patterns may be created by applying colours to the surface of the textile one at a time to build a richly multi-coloured surface (Wells, 1997:115).

2.2 Textile printing techniques
To get a sense of where digital textile printing fits in to the history of printed textiles a timeline detailing some of the key dates from the history of printed textiles is shown in Figure 2 on page 26. It should be noted that advances in technology do not necessarily signal the cessation of earlier techniques, for example, block printing continues to the present day “as a means of producing exclusive fabrics for a specialized market” (Storey, 1992:31). Other techniques such as manual flat screen printing are still widely practised, for example by
individual designers producing their own products in a non-mass-produced way (Hann, 2005:35) and in countries such as China where labour is cheap. Each printing method has its own particular characteristics and nuances. Many factors influence the choice of printing method: the end application, the desired effect, the substrate, and, cultural and economic criteria. Combining traditional textile printing techniques with digital textile printing technologies opens up a whole range of possibilities for textile designers to create complex and innovative surface patterns and texture.
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th Century BC</td>
<td>India producing block printed textiles</td>
<td></td>
</tr>
<tr>
<td>4th Century AD</td>
<td>Earliest existing remnants of resist printed textiles from Egyptian burial site</td>
<td></td>
</tr>
<tr>
<td>8th Century AD</td>
<td>Japan introduces stencil plate Textile printing, the forerunner of flat screen printing</td>
<td></td>
</tr>
<tr>
<td>1460</td>
<td>Nuremberg Book is written, detailing 100 textile dye recipes. “One of the most important sources for the technology of printed textiles” (Wells, 1997:10).</td>
<td></td>
</tr>
<tr>
<td>1752</td>
<td>Francis Nixon (Dublin) attributed with introduction of engraved copper plate printing</td>
<td></td>
</tr>
<tr>
<td>1783</td>
<td>Thomas Bell (Scotland) patents engraved copper roller printing technique</td>
<td></td>
</tr>
<tr>
<td>1907</td>
<td>Samuel Simon (England) patents flat screen printing process</td>
<td></td>
</tr>
<tr>
<td>1920s</td>
<td>Manual flat screen printing widely used commercially</td>
<td></td>
</tr>
<tr>
<td>1950s</td>
<td>Advent of automated flat screen printing</td>
<td></td>
</tr>
<tr>
<td>Mid 1950s</td>
<td>Advent of rotary screen printing</td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>Milliken introduce their ‘Millitron’ ink-jet carpet printer</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>Stork introduce their ‘TruColour’ digital textile printer</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Timeline of some key dates in the history of printed textiles (by the author). Sources: Cahill, 2006:3; Hann, 2005:9; Hawkyard, 1994:19; Moser, 2003:12; Robinson, 1969:42; Storey, 1992:11.
2.3 Digital textile printing
This is a comparatively new development in the history of printed textiles. Moser states: “the first true inkjet printer for fabric was exhibited by Stork in 1991” (Moser, 2003:12). Digital textile printing has only been in full use since the early 1990s (Gregory, 2003:71; Stork Prints, 2011a), although ink-jet technology existed prior to this point in the graphic and carpet printing industries adapting the process for direct printing onto a range of textiles required a great deal of modification (Dawson, 2003:1). However, not every stage of the process required modification: traditional methods are still used to pre-treat and finish digitally printed fabrics (Dawson and Ellis, 1994:337).

2.3.1 Adapting existing ink-jet printing technology
Ink-jet printing is defined by Le (1998) as: “a non-impact dot-matrix printing technology in which droplets of ink are jetted from a small aperture directly onto a specified position on a media to create an image” (Le, 1998:1). Existing ink-jet printing technologies from the graphic industry and carpet manufacturing industry were adapted to extend their applications: the Milliken designed Millitron ink-jet printer for carpet, launched in 1975 was the first of its kind; wide-format ink-jet printers (WFP) were in use in the graphic industry for signage and banners (Cahill, 2006). These technologies then had to be modified to make them suitable for direct printing onto a variety of textile substrates.

The first designated commercial digital printer for textiles appeared in 1991 at the International Textile Machinery Association’s (ITMA) exhibition, the largest trade show of its kind (Moser, 2003:12). According to the ITMA website, one of its roles is to “be the showcase for the latest technology in the textile and garment machinery industry in order to meet the requirements of all the actors of the textile field” (ITMA, 2011). It was here in Hanover that Stork showcased their TruColour TCP2500 digital textile printer, designed for producing small samples on fabric. The TruColour used reactive dyes, which meant that established pre and post-printing treatments (coating, steaming and washing) were used to achieve acceptable colourfastness and fabric handling.

2.4 History of ink-jet technology
The basis of the technology used in digital textile printing can be traced back to the 1600s (Cahill, 2006:1). The French scientist Edme Mariotte (c.1620 – 1684) recorded the results of his experiments with fluids in *Traité du mouvement des eaux et des autres corps fluides* (published posthumously in 1686). Mariotte’s research discovered that “a liquid jet ends in a train of droplets.” (Pomeau and Villernaux, 2006:42). Further research was carried out by Lord Rayleigh and
reported in his 1878 paper for the London Mathematical Society, *On the Instability of Jets*. This understanding of the dynamics of fluids eventually resulted in the drop-on-demand (DOD) method of discharging ink used today in digital textile printers. The Swedish scientist Carl Hertz of Lund University registered the first continuous ink-jet patent in 1968 (Gregory, 2003:75). It was this patent that directly led to the development of Stork’s TruColor Jet, unveiled at ITMA 1991 (Cahill, 2006:3). Stork followed this by exhibiting their Fashion Jet textile printer at ITMA 1995, which had the capacity to print onto fabric on a roll (Moser, 2003:2). Another key company was the Japanese company Mimaki, who introduced the first of their ‘TX’ series of textile printers in 1998. The TX textile printers were adapted from existing wide-format colour ink-jet printers used in the graphic industry for signs and banners (Kobayashi, 2006:98).

ITMA 2003 (held in Birmingham, UK) is generally regarded as a significant milestone in the development of digital textile printers. It was here that several major companies, including Du Pont, Mimaki and Reggiani, introduced machines with greatly improved printing speeds and fabric handling capabilities (Cahill, 2006:9). As Moser (2003) comments: “...ITMA ’03 may be remembered in the future as the real beginning of digital textile printing as a viable production process” (Moser, 2003:13).

In the drop-on-demand method, the colorant is fired through a fine nozzle, which causes it to change from a continuous stream into droplets. An electronic pulse controls the droplets so the flow is either ‘on’ or ‘off’, thus controlling where and when each drop falls upon the fabric (Dawson and Ellis, 1994:332). Dawson (2000) examined digitally printed fabric under a microscope. He describes the physical arrangement of droplets and how these create the appearance of colour:

Lighter colours appear mainly as individual spots of cyan, magenta and yellow, whilst in darker shades there is an increasing tendency for the spots to be placed on top of others to produce mixture hues. The degree of colour mixing observed is much the same whether the inks are applied to paper or to textiles although on the latter the printed dots show more spreading by capillary action (Dawson, 2000:56).

### 2.5 Pre and post-printing treatment of fabrics

Pre and post-printing processes traditionally used in conventional textile printing using reactive dyes are an integral part of the digital textile printing process. Reactive dyes are primarily chosen for direct digital printing onto cellulosic fabrics such as cotton (Gregory, 2003:80). This is because of their colour range, wash fastness and handling qualities, particularly important considerations in apparel applications. The action and consequences of the colorant falling upon the fabric make it imperative that the fabric is pre-treated prior to printing; this is necessary
in order to avoid bleeding and to ensure a crisp edge is achieved. Another consideration is the achievable colour yield: conventional printing yields more colour than digital printing (Gregory, 2003:81). Typically, fabric for digital printing is coated with a paste containing chemicals to augment colour development, prevent colour bleeding and ensure even fixation (Dawson and Ellis, 1994:337).

Pre-treatment is also essential due to the low pick-up of colorant onto fabric compared to screen-printing, “say about 25% vs.100%” (Dawson, 2000:54). The difference here is that the coating is applied prior to printing whereas in conventional printing the additives would be applied to the fabric’s surface at the point of printing. With digital printing for textiles the purity and viscosity of the colorants are crucial factors; therefore it is not possible to incorporate the required chemicals with the colorants (Dawson and Ellis, 1994:337). To make a comparison between ink-jet printing onto paper and on to fabric, the viscosity of inks for paper printing is low, whereas for fabric printing ink viscosity is high. Viscosity affects the speed at which the droplets travel from the print head to the fabric’s surface, and also the shape each droplet retains whilst travelling. As Tyler (2005) explains: “When the drop takes longer to reach the substrate, there is more of a chance that air currents can deflect the drop and reduce the quality of printing” (Tyler, 2005:30). It is important for each drop to retain its sharpness both during printing and during the fixing process to retain definition of intricate designs (Dawson and Ellis, 1994:331).

### 2.6 Adapting digital printers for textile substrates

Adapting existing digital printing technologies for use with textiles was a complex process. Each component part of the process was assessed for performance with textile substrates. As Dawson and Ellis (1994) explain:

> When the initial experiments were carried out to see if, in principle, ink-jet printers used for paper could be adapted to printing textiles, it was established that the existing inks (based on aqueous glycol solutions of acid and direct dyes) would in fact yield prints of reasonable appearance, but the colour yield was rather low (Dawson and Ellis, 1994:336).

Colour yield was low due to the capacity of print heads at that time. The print heads were adapted from carpet printing, where control and continuity of ink droplets was not a requirement (Gregory, 2003:75). However, in order to reproduce finer, detailed designs directly onto textiles, control and continuity of discharged ink is essential.

The range of colours achievable from existing inks used for paper printing also created an obstacle. Textile printing required a broad range of colours which could not be delivered by the cyan, magenta, yellow and black configuration used for
paper substrates. As SuSu Gordon (from the Kimberly-Clark Corporation) points out: “The color gamut obtainable in CMYK\(^1\) is considerably smaller than the gamut of spot color inks used in conventional rotary screen printing of textiles” (Fibre2Fashion, 2011b).

A paper substrate and a textile substrate have many fundamental differences, each of which has an impact on the quality of the printed output. As Tyler (2005) comments:

Conventional paper printing is a big user now of digital technologies but has the advantage of working with relatively standardised substrates – typically smooth and flat. Textile digital printing has to address all the issues of conventional digital printing, but also new issues raised by the media to be printed: surface texture, end use performance, colour physics etc. Thus, textile digital printers must gain expertise in the chemistry of the processes they use and the physics of colour. (Tyler, 2005:5)

Even just considering paper as a substrate, there are many variations in achievable output due to the range of papers available. The same image printed on plain paper, matt coated paper and gloss coated paper will appear differently on each one. Dawson (2000) comments:

The substrates which yield the best build-up of shade are those on which the ink spots remain clearly defined, i.e. show minimum capillary spreading. Thus, prints on specially coated, glossy ‘photo’ papers or high definition matt types, are superior, both with respect to their sharpness and colour strength, to those on more absorbent papers and textiles (Dawson, 2000:57).

### 2.7 Industry models – the latest technology

The production rates of digital textile printers have greatly improved in recent years; in 2002, Brooks Tippett from Digital Printing Systems calculated the production speed of digital textile printers versus rotary screen printers. He found that the average speed for digital printers at that time was 1-2 yards per minute, compared to 12 yards per minute for rotary screen printing (Tippett, 2002:3).

Digital textile printers are marketed with the emphasis on their ability to facilitate a quick turnaround from design to production, and how this compares favourably with other techniques, such as screen printing. Figure 3 on page 31 shows an illustration from the Japanese company Konica Minolta’s advertisement for their Nasseneger VII digital textile printer, which actively promotes the benefits of digital textile printing compared to more traditional methods (Konica Minolta, 2011).

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\(^1\) **CMYK** is the abbreviation for the *Cyan Magenta Yellow Black* colour space; see Chapter 3 section 3.1.2
The Italian company Reggiani describe their DReAM digital textile printer (see Figure 4, page 33) as “the first industrial digital textile printer” (Reggiani Macchine, 2010a). On the market since 2002 and costing in the range of €750,000, the DReAM has a maximum production rate of 240 m²/h (at a print width of 340 cm). It can print with reactive, acid, disperse and pigment colorants. The DReAM ‘Combi’ incorporates flat-printing (screen-printing) to allow the addition of fancy effects such as metallic or glitter finishes (Scrimshaw, 2007). Reggiani have also developed the ReNOIR digital printer (see Figure 5, page 33) which is advertised at having a production rate of up to 400 m²/h and is capable of handling any substrate, including leather (Reggiani Macchine, 2010b).
The Italian textile machinery company Robustelli in association with Seiko Epson Corporation have produced the Monna Lisa digital textile printer (Figure 6, page 34), retailing at around €250,000. It can print onto any fabric substrate using acid and reactive colorants (Glover, 2003:15). The latest Monna Lisa model, the Evo, is advertised as having a production rate of 250-300 m²/h (at a printing width of 150cm), with a rate of up to 700 m²/h possible by varying image resolution (Robustelli, n.d.).
The Dutch company Osiris have developed the Isis digital printer (Figure 7). The Isis has a production rate of 1000 metres per hour at a printing width of 160cm (Osiris, 2011a). The Isis’ major advantage, as John Scrimshaw (2007) points out, is that it uses "standard screenprinting inks, vastly reducing the cost per metre ... [which] will be around €1 per linear metre; a little more for reactives. The figure includes capital costs, and no pretreatment is required” (Scrimshaw, 2007:50).

The Japanese company Mimaki has been associated with digital textile printing from the outset. Mimaki’s latest printer series, the Tx400-1800 (Figure 8, page 34) is
advertised as having a range of production rates and print quality modes, with a maximum production rate of 99.1 m²/h (Mimaki, 2011).

Korea’s d.gen Incorporated advertise their Artrix GT digital textile printer (Figure 9) as a “true industrial printer, designed for non-stop 24 hours a day 365 days a year” (d.gen, 2005). Designed to run unattended, the Artrix GT has a production rate of up to 100 m²/h at high quality image resolution.

Stork’s Ruby V-II digital textile printer (Figure 10, page 36) is designed to run unattended, and runs with acid, disperse or reactive colorants. The Ruby V-II is advertised as having a production rate of 58 m²/h at high quality image resolution, at a printing width of 160 cm (SPG Prints, n.d.).
The Japanese company Konica Minolta produce the Nassenger range of digital printers, which run on disperse, reactive and acid colorants. The latest model in the range, the Nassenger VII (Figure 11), is advertised as having a maximum production rate of 210 m²/h, and a maximum printing width of 180 cm (Konica Minolta, 2011).

2.8 Colour accuracy in digital textile printing

Achieving accurate colour in digital textile printing is something that the industry constantly strives for. The number of variables involved in the printing process makes it difficult to exercise complete control - the hardware, software, printer, fabric substrate, colorants, and finishing, all impact upon the results. Methods used to try to combat the impact of the variables and their interdependencies include sampling prior to final printing and regularly calibrating all equipment.

Colour accuracy issues are important in both industry and HE, but perhaps for slightly different reasons. A student who creates a textile design on a computer wants the final print on fabric to be as close a match as possible to the original to properly reflect their intentions; a commercial digital textile print facility is required to reproduce the exact colours from a client’s design in order to achieve continuity of output and remain in business. But what constitutes a close match? How far
removed from the original colour palette can a textile print be before it becomes unacceptable? Comparisons between images on a computer monitor (or on paper) and a digitally printed fabric are inherently problematic due to the fundamental differences between them. These differences affect the viewer’s perception of what they are looking at.

When comparing an image viewed on a computer monitor against the same image printed onto paper and fabric, it is difficult to confidently confirm that a satisfactory colour match has been achieved. If the source image were not available to make this comparison, would the decision to accept the colour output on the fabric from the possible range of colours determined by the printer gamut be easier to make? One individual’s interpretation of a colour is not necessarily going to be the same as another’s.

2.9 Communicating colour
Finding a universal language that communicates colour in a meaningful way between both human beings and machines is an on-going quest. Companies such as Pantone Incorporated have made this quest their business for over forty years, producing sets of standardised colours with unique references (Pantone, 2011a). These standard colour ranges can then be input into computers and then relayed to the printer. The intention is to remove ambiguity both in human dialogue, and communication between computer and printer. Pantone Incorporated’s standard colours are widely used in industry, but there still remain many variables that impact upon the success of this system. These issues will be discussed in more detail in subsequent chapters.

2.10 Colour calibration
In digital textile printing it seems the only way to achieve an exact colour match is to use a harmonised system where the software, hardware, fabrics and colorants are calibrated so as to ensure continuity across every element. The alternative is to produce test samples and make a subjective choice as to which sample is closest to what is required. Further difficulties arise when a design is created that is impossible to replicate as the colours may be out of the range that the printer is physically able to reproduce. Commercial digital textile printers may use colour management software that is calibrated to run with their particular model of printer and with the particular range of colorants they choose to run on that printer.

2.10.1 Achieving colour accuracy in industry
The ability to accurately reproduce colour is viewed in industry as an essential requirement and used as a selling point. The Dutch company, Stork, has a long association with the textile printing industry; the company then produced flat-
screen printing machines in the 1950s and rotary screen printers in the 1960s and they have played a major role in the development of digital textile printing technology. Stork have developed a colour communication system called Stork U See, which they say “ensures the efficiency of digital textile printing results, ensuring that what you see is really what you get” (Stork Prints, 2011b). This claim is entirely dependent upon fabrics being digitally printed using Stork proprietary software, hardware, fabrics, colorants, and working procedures.

Commercial digital print bureaux may use specialist equipment or software to enable more accurate colour matching. Often, this is featured in their advertising, as for example with R. A. Smart (a digital print facility based in Macclesfield):

Digitally printing presents no limitations on colour and through our specialist software we are able to colour match from monitor to printed fabric (R. A. Smart, 2011).

2.11 Designer applications of digital textile printing

The presence of digital textile printing can be seen across a breadth of fashion and interior design applications from the catwalk to the high street. Established fashion labels such as Alexander McQueen and Paul Smith (see Figure 12), and up and coming designers such as Mary Katrantzou and Erdem (see Figure 13 on page 39) utilise the versatility of digital textile printing to great effect. Tamasyn Gambell, writing about digital printing in the fashion and textile industry for the online trend analysis service WGSN, describes its potential: “designers are able to work with limitless palettes and to print the finest and boldest marks, enabling them to approach print design in a completely different way” (WGSN, 2009).

The accessibility of digital textile printing and the flexibility and convenience of being able to order small amounts of printed fabrics on a variety of substrates provides designers with a relatively straightforward route into business. Setting-up costs are relatively small, as no investment in plant or studio space is required other than access to a computer with the required software to create the designs. The designer Yosef Perez sells his digitally printed clothing collection through Etsy, an online retail outlet (see Figure 14 on page 40). Dominique Mosley works closely with a digital print bureau to produce her collection of luxury scarf designs, then sells them through her own website in addition to other outlets (Figure 15, page 40) Professor of Architecture at Cardiff University, Richard Weston, took his passion for the colourful qualities of rare minerals and transformed scans of his collection into digital scarves that were subsequently bought by Liberty to sell in their London store (Figure 16, page 41).

Digital textile printing is used by textile designers as the starting point for innovative surface treatments. Katy Aston (Figure 17) takes digitally printed velvet and embosses on top of the fabric to create interesting surface texture. "The fabric collection is digitally printed onto furnishing velvet. Once the design was fixed to the fabric I finished the designs by embossing into the pile of the fabric, adding an additional tactile effect." (Katy Aston, 2011)

Gina Pierce and Carlene Edwards (Figure 18, page 42) explore the ability of digital textile print to convey subtleties of line and texture, taking hand drawn and photographic elements as the starting point for their designs. From this starting point, both designers enhance the surface texture of their prints by using screen printing, foiling and flocking techniques (WGSN, 2009).
Textile designers are also using digital textile printing as a way of reinterpreting traditional techniques such as shibori and batik. In her MSc Thesis from 2002 entitled ‘Digital printing and traditional surface design techniques’, Genevieve Lawrence attempted to recreate the hand crafted elements of traditional textile printing using digital design and print (Figure 19).

Melanie Bowles, a textile designer and senior lecturer at Chelsea College of Art and Design, is involved with many projects researching and developing the possibilities of digital textile printing. Her ‘Digital Shibori’ project (Figure 20, page 43) explores the manipulation of “complex mathematical graphic geometrics to create light effects, folds and blends that retain the original essence of Shibori” (Bowles, 2011).
Digital textile printing is a strong presence in textiles for the home wares market. The Dutch designer, Nicolette Brunklaus uses digital print to produce home furnishings with strong graphic motifs (Figure 21).

In an interview for *Design Week*, Paul Simmons, from Glasgow based design company Timorous Beasties (see Figure 22 on page 44), sees digital print as offering an opportunity to achieve “amazing detail and colour” (Richardson, 2010) in textile design, but tempers this with the comment the possibilities offered by digital print are “quite endless, and sometimes too much choice is a bad thing” (Richardson, 2010).
2.12 Industrial applications of digital textile printing

In today’s marketplace the production of printed textiles is moving away from long print runs. As Holme (2006) comments: “within Europe, the average production run is now only 500 metres or less” (Holme, 2006:104). This seems to be accounted for by the general acceleration of changes in fashion, requiring rapid turnaround of new designs and colourways and resulting in a reduction in stock levels carried by retailers.

The application of digital textile printing for sampling or for short print runs seems to be where it is currently most successful in industry. The large volume of samples produced each season in order to yield a relatively small number of successful designs for production make digital printing preferable to traditional methods (Gregory, 2003:78). The time and expense involved in preparing numerous screens for each design is removed. Factoring in down-time of machines and making allowances for stoppages digital is preferable for sampling. As Dawson and Ellis (1994) explain:

> It is quite normal in practice for the actual degree of utilisation of a rotary-screen printer to be as low as 50% or less, whereas a figure of 90% seems feasible for a jet printer (Dawson and Ellis, 1994:331).

Many different colourways and designs can be swiftly generated. However, difficulties may arise when the samples are taken into rotary screen production. A digitally produced design would still require processing for screen engraving; the design would have to be separated out into its component colours. Designers need
to factor in the final production method from the start. Imagination may run riot when creating a new digital design, but, as Nicoll (2006) comments:

> It is necessary to start from zero and think like a textile designer, deciding from the start that the design will have, for example, three greens, four reds and a background, and that it should be adaptable to different colourways (Nicoll, 2006:25).

The situation alters if the production process is going to be digital. With advances in technology, the newest machines are becoming more viable for production printing. However, production via digital printer comes with its own unique issues, not least of which is the difficulty of colour accuracy.

Digital printing has the potential to push what is currently possible in textile design rapidly forwards if it is applied and explored creatively by individuals. It has a place in industry alongside established and traditional printing methods, not in competition with them. As Tyler (2005) points out:

> ...digital printing should not be seen as competing with rotary screen printing or other mass production techniques...the main market opportunities for digital printing are likely to be in areas of innovative designs and customised products (Tyler, 2005:6).

### 2.13 Technical textile applications of digital textile printing

‘Technical textiles’ is an area of exciting developments in digital textile printing. Karen Pooley, the Federation of European Screen Printers Association’s (FESPA) Group Marketing Manager, reporting from FESPA’s Digital Textile Conference in Geneva, noted that current research includes,

> ‘Chromic’ materials (which change colour under specific conditions); materials that delivered controlled release of substances such as pharmaceuticals; and antibacterial and anti-static finishes (FESPA, 2011a).

In addition, research is also being carried out into the possibility of using ink-jet technology to produce printed electronic circuitry within garments, with a view to creating “wearable electronics” (Holme, 2006:109). TenCate, a multinational company based in the Netherlands, is working to develop innovative uses of digital printing for textiles by combining it with chemical processes; for example, TenCate is currently working in association with Xennia Technology to incorporate nanotechnology into the digital textile printing process, using the possibilities of working on a microscopic scale to adapt and refine the surfaces of textile substrates (Koninklijke Ten Cate, 2012). Examples of some of the projects TenCate are involved with include incorporating functionalities into textiles during the digital printing process (see Figure 23 on page 46) relating to “antibacterial treatments, single-sided hydrophobic functions, systems for controlled release and special chromic functionalities” (Koninklijke Ten Cate, 2012).
Digital textile printing allows additions to be made to the surface of the textile, for example, electronic components, which are then disguised by printed designs. One such project by J. S. Hynek, J. R. Campbell, and K. M. Bryden, incorporates flexible solar powered battery units into a garment’s design, by mimicking the appearance of the batteries using digital print (Fibre2fashion, 2011a). The purpose of the design is to provide a convenient, portable method of charging devices such as mobile phones (Figure 24).

2.14 Digital’s share of the market

According to a market report conducted by Pira International in association with the Federation of European Screen Printing Associations (FESPA) in 2009, the world market for print production comprises upwards of 30 billion square metres (Pira International, 2009). Figure 25 on page 47 illustrates the report’s forecast of
market growth for digitally printed textiles, which is predicted to increase “from €115 million at the end of 2009 to almost €1 billion by the end of 2014” (Osiris Digital Print, 2011b). A recent market report carried out by Smithers Pira, published in October 2012, predicts that “the global market for digitally printed textiles is forecasted to more than double by 2017” (Smithers Pira, 2013).

![Turnover in Digital Printed fabric](image)

From these figures it is clear that digital textile printing is widely predicted to significantly extend its share of the market. Within the overall digital textile print sector, fashion fabrics and interior design fabrics are expected to be an area of substantial growth (Scrimshaw, 2008).

### 2.15 Digital textile printing and the environment

In today’s environmentally conscious climate, industry has an increasing requirement to report and reduce the environmental impact of their products, and to supply consumers with detailed information about their products. Digital printing of textiles is heralded as being less aggressive on the environment than more traditional methods (R. A. Smart, 2011). Companies are actively promoting their digital printers and colorants in this respect, for example, Osiris’ Isis printer is marketed with the following details,

> it is also a very environmentally friendly production process. Adopting this technology to replace energy wasting and polluting screen printing makes your printing operation future-proof, with 60% savings on energy, 80% savings on water, 90% savings on inks (Osiris Digital Print, 2011a).

Konica Minolta advertise their digital textile printing equipment with a chart showing how the digital process compares to screen printing of textiles in terms of energy use and wastage (Figure 26, page 48).
One of the main areas in which digital printing has a higher ‘green’ score than conventional printing is ink wastage; with screen-printing the colorants are prepared prior to printing and any unused quantity disposed of as waste; whereas in digital printing there is no waste. In addition to unused colorants being disposed of as waste in screen or roller printing, there is also wastage in the form of added chemicals such as binders. With digital textile printing, the preparation of textiles necessitates a much more controlled application of these additives (Tyler, 2005:32). Paul Machin is a member of the Health and Safety Executive’s Printing Industry Advisory Committee. On the FESPA website, Machin explains how new regulations applying to colorants and substrates will affect the textile printing industry:

‘REACH’ (Registration, Evaluation, Authorisation and restriction of Chemicals) is a European Union Regulation that is highly likely to affect every chemical producer, printing product supplier and printer that sells in Europe. It requires every substance whether sold on its own or incorporated into a product to be pre-registered with the European Chemicals Agency in Helsinki by 1st December 2008 (FESPA, 2011b).

Textile designers working with digital print are developing innovative ways of using the technology in an eco-friendly way. Eunmi Hwang (see Figure 27 on page 49), graduated from London College of Fashion’s MA programme in 2011. Hwang “uses digital technology to create a sustainable manufacturing process” (Harper’s Bazaar, 2011).
2.16 The function of digital textile print in HE

The function of a digital textile print facility in HE in most cases has a different focus than that in industry. There are HE institutions (for example Glasgow School of Art) that do offer a digital textile printing service to external paying customers, and are therefore subject to commercial pressures to produce consistently high quality results. However, generally speaking, in HE there may not be the resources available, both financially and in staff time, to continually upgrade equipment and software.

To have access to a digital textile printer, whether it is the latest model or not, is undoubtedly an asset for students. In this environment innovation may come from how the digital printer is used by the students. The aim here is not to keep up with cutting-edge technology in terms of the latest machines available; it is to interpret how the technology may be used in new and inventive ways. The students and practitioners who are free from the constraints of industry have freedom to explore the potential of digital textile printing as a medium. Digital design enables the creation of virtual representations of things that do not (yet) physically exist. Having a machine that allows the realisation of these designs blurs boundaries: the digital textile printer is a device for printing onto cloth, but it is also a relatively new medium with its full potential as yet undiscovered.

Defining the function of digital textile printing in a HE environment is an important stage in understanding the related colour accuracy issues. A digital print studio is a facility that enhances an institution’s attractiveness to prospective students. Having
access to this facility gives students an opportunity to experience digital printing technology alongside more traditional methods (for example screen printing). It gives an extra dimension to their own creative practice allowing them to bring their CAD work to life; otherwise this work would only exist on screen or on paper. Printing onto textiles gives textile design students the invaluable practice of working with a tactile material. Compared to other printing processes (such as block printing) digital textile printing is still in its infancy. Students are in a position to explore and develop this as a medium. In terms of their future careers, having a working knowledge of a wide variety of print processes and their associated applications, restrictions and potential, must be advantageous.

2.17 Achieving colour accuracy in HE

What are the options available in the majority of HE print studios to attempt to control colour matching? This is an area for which there is a scarcity of information available. As Britt comments there are “minimal existent studies regarding contemporary textile design HE in the United Kingdom” (Britt, 2013:50). Students may be instructed to produce a range of small samples of the same design, changing the colours slightly between each one. Another option is to calibrate the equipment to assert a degree of control over the output. Manchester Metropolitan University (MMU) encourages students to print small samples of their designs prior to a larger, final print. They produce guidelines explaining to students the problems of achieving accurate colour reproduction and that this cannot be guaranteed, as the following excerpt explains:

Even though the printers are calibrated using industrial standard software you need to be aware that without a great deal of time and effort on your part it is impossible to match colours accurately across the different devices and processes involved.

To minimise the colour variation you can do the following:
1. Carry out test prints: make a small file say A5 or A6 size that contains a sample of all the colours in your image. Adjust the colour values in Adobe Photoshop to give a number of variations to choose from.
2. Colour reduce your design so that you can select discreet areas of colour and input the RGB value you have chosen from the printed colour atlas available in the digital print room. N.B. this is extremely difficult with photographic images.

Even then because of the nature of the process the final print can vary from the test piece (Manchester Metropolitan University, 2007).

In order to maintain competitiveness within the industrial arena, it is essential for commercial digital textile printers to keep up-to-date with innovations in technology, an area of rapid change. To that end they must invest time and money in keeping abreast of new developments, an investment that must also include training of personnel to operate the latest equipment.
2.18 Chapter summary

In this chapter an overview of printed textiles and the development of digital textile printing and its applications was given, in order to better understand the function and importance of digital printing in HE.

There are several different methods that come under the umbrella of textile printing. Figure 2 (see page 26) clearly shows the relative newness of digital textile printing within the time frame from the first instance of decorating the surface of textiles until the present day. The chapter also provided a description of the evolution of digital textile printing and how it has been assimilated into the global textile printing industry. The most up to date machines available were reviewed, along with industry analysts’ predictions for the future. The impact of this relatively new process on the role of the designer and the myriad of opportunities that are opened up in response to this new technology were considered. Environmental concerns are increasingly influencing the choice of printing methods, and digital textile printing was discussed in relation to this issue. The newest machines were briefly reviewed, with particular reference to their performance capabilities and in terms of digital textile printing’s overall share of the printed textiles market.

The importance of colour accuracy and communicating colour effectively were discussed as is how digital print is being used by fashion and home ware designers. The technical applications and innovative ways in which designers are exploring the medium were outlined. The chapter ends with a discussion of digital textile printing in HE. In the author’s experience of academia and industry, the translation of a design concept into an end product requires a combination of technical and process knowledge. Students, therefore, need a full understanding of all the processes and techniques involved in textile printing. They have to know and fully understand the characteristics of the materials and the processes that are being used to enable them to make properly informed design decisions.

The next chapter discusses colour, colour mixing, and colour management in order to gain a greater understanding of the difficulties implicit in achieving accurate colour in digital textile printing. The author’s experience is that students lack an understanding that colour changes between substrate and process affects colour perception. The on-going work to develop methods of communicating colour in a non-ambiguous way and systems to ‘manage’ colour during the printing process are discussed in detail.
Chapter 3
Colour communication

3.0 Introduction
Printing machines and computer monitors have limited colour reproduction capabilities; in addition, substrates have different characteristics which affect the achievable colours of a printed output. It is only when the knowledge that comes with this experience and understanding that the importance of the factors affecting colour realisation can be fully appreciated. This is crucial for textile design students, in particular with regard to employability.

In order to understand the difficulties implicit in achieving accurate colour in digital textile printing, it is necessary to gain a greater understanding of what colour actually is, and how it is perceived in human vision. The on-going work to develop methods of communicating colour in a non-ambiguous way and systems to ‘manage’ colour during the printing process are considered in this chapter.

3.1 What is colour?
“Colour is not a physical reality” (Chrisment, 1998:5), rather, it is a sensation produced by the viewing of light wavelengths in various environments (Chamberlin and Chamberlin, 1980:1). Billmeyer and Saltzman (2000) describe the sensation of colour as being a result of “interaction of a light source, an object, and the eye and brain, or a visual system” (Billmeyer and Saltzman, 2000:2). Colour can be ‘additive’ or ‘subtractive’, depending on whether it is created by mixing light wavelengths (additive), or by mixing physical colorants together (subtractive) (Woodhouse, 1976:209). For the purpose of this study, both additive and subtractive colour are considered – additive colour when viewing a design on a computer screen, and subtractive colour when viewing the same design printed onto fabric.

3.1.1 Additive colour and RGB colour space
Colour generated by the mixing of several sources of illumination, where the light sources combine together to produce white light, is said to be additive. RGB colour space (one of several specific ordering systems for colour) is so called because it is a combination of red plus green plus blue wavelengths that combine to create white light (Crone, 1999:153). RGB colour space is typically used for monitors and scanners – i.e. devices that produce colour electronically (GretagMacbeth, 1998:1.2). There are several RGB colour space variants as different standards apply
for different applications: for example, ‘sRGB’, ‘ISO RGB’, ‘Adobe RGB 98’; As Süsstrunk, Buckley and Swen explain,

There is no “one size fits all” approach, no one RGB color space that is ideal for the archiving, communicating, compressing, and viewing of color images. The correct color space, be it RGB or not, depends on the application. (Süsstrunk, Buckley and Swen, 1998:8)

A working knowledge of colour basics is essential for students across all design disciplines. Research has shown that colour knowledge is generally undervalued in secondary school curricula and this can lead to students lacking in confidence when working with colour (Diane and Cassidy, 2005:45). Having some knowledge of the different colour spaces used when designing and printing digitally onto textiles, and, most importantly, knowing that each individual device (i.e. laptop, monitor, digital textile printer) will have its own distinct colour gamut (range of achievable colours that can be viewed and/or printed) will go a long way in demystifying some of the issues students have concerning colour in digital textile printing.

3.1.2 Subtractive colour and CMYK colour space

Another colour space, CMY (Cyan, Magenta, Yellow) is created when red, green and blue colorants are blended together in different permutations. Different types of surfaces absorb different wavelengths of light leaving a remainder of unabsorbed light that is reflected from the surface into the eye to create the sensation of a particular colour (Chamberlin and Chamberlin, 1980:18). Colour generated in this way is said to be subtractive colour. While additive colour produces white light, the starting point for subtractive colour is understood to be the white of paper. CMYK (Cyan, Magenta, Yellow, black) is the colour space historically associated with graphic design and ink-jet printing on to paper, which in turn is the model that has been adapted for use in digital textile printing (Campbell, 2006:160).

In additive colour mixing, white is achieved by combining red, green and blue wavelengths. In subtractive colour mixing a satisfactory depth of black can only be achieved by the addition of a separate black component represented by the letter ‘K’. For digital textile printing, the basic CMYK format did not yield a sufficiently wide range of colours (Dawson, 2000:52). This was addressed by including additional colours such as blue and grey (Campbell, 2006:180). As with RGB, there are several variations of CMYK, for example, CcMmYyKk, where there is an additional, lighter version of each colour.

Difficulties arise when trying to recreate the colours produced when mixing light wavelengths (additive mixing) by using physical colorants (subtractive mixing). Because of the inherent differences between additive and subtractive colour mixing it is not easy to recreate the range and depth of colours from a design on computer.
screen to a digitally printed textile (Campbell, 2006:180; Dawson, 2001:188; Dawson and Ellis, 1994:337). This creates a problem that is constantly being addressed by industry, in the quest to achieve the closest colour matching possible. In their online resource *Learning Library*, Wasatch Computer Technology (an American company with twenty five years’ experience in colour management) describes the printing process:

> The real challenge of printing ... color images accurately is that we are attempting to approximate the colors of the real world using devices or technologies that are not capable of reproducing anywhere near all the colors in the visible spectrum (Wasatch Computer Technology, n.d).

Textile students often build the colour palettes for their designs using different sources, for example, colour libraries in software packages, decorators’ colour charts, or scans of original artwork. They recreate these colours as best they can on screen and then expect their chosen colours will look exactly the same as the original palette when their designs are digitally printed onto fabric. This is not an unreasonable expectation to have without some basic knowledge of the many variables affecting colour in digital textile printing, which is why they need the knowledge of the factors impacting colour realisation and reproduction.

### 3.2 Colour perception

The human eye’s limitations restrict the range of what is visible in the light spectrum to an approximate band of between 380 and 760 nanometers \( (\text{nm} = 1/1,000,000 \text{ mm}) \) (Diane and Cassidy, 2005:48). Within this range, the eye can discern the colours of the rainbow from violet through to red. Typically, this translates as the average person being able to “distinguish about 2.3 million colours” (Billmeyer and Saltzman, 2000:3).

Computer monitors are capable of reproducing millions of colours: “far more than the eye can see” (Treadaway, 2004:265). The perception of colour is different for each individual, as the information received visually has to be interpreted by the brain and human beings are non-standard. As Taylor (1962) comments:

> the eye is only a conductor. It does not analyse or determine the character of what we observe, but only passes the message on to the brain. In other words it is the brain which determines the colours seen, and no two human brains discern or comprehend in like manner (Taylor, 1962:43).

When evaluating whether or not an acceptable colour match has been achieved on a digitally printed textile, the colour vision and colour perception of the person making the evaluation, the viewing environment (lighting, background colours etc.) and the method of assessment, all have an impact (Billmeyer and Saltzman, 2000:107; Taylor, 1962:43). An evaluation of the colour reproduction is made by examining the printed textile output against the required standard. In this scenario,
the light source has a direct effect on the appearance of the print; whether the print is assessed by a human or a mechanical process will also affect the interpretation. Colour perception is affected by the light source being used at the time of viewing, that is, natural or artificial or a mixture of both. Further variations occur within the sources themselves, for example, the time of day, or the type of artificial light (fluorescent, neon, etc.) (Diane and Cassidy, 2005:79). A change in colour perception due to different light sources is known as metamerism (Billmeyer and Saltzman, 2000:28). If there is a difference between input and output, it is then necessary to describe the difference in a meaningful way, and then make a decision as to whether the difference is acceptable or unacceptable (Westland and Cheung, 2006:17). Students need knowledge of the impact the viewing environment has on colour perception to properly assess what is required for accurate colour representation.

### 3.3 A language to describe colour

Using words to describe colour in a meaningful way to another person is extremely difficult; a fabric colour described as ‘light blue’ may be visualised by different people in many variations. Descriptive words may be attached to a colour in an attempt to convey it more accurately: ‘baby blue’, ‘cornflower blue’, ‘navy blue’ etc., but this does little to guarantee a common interpretation (Diane and Cassidy, 2005:41). The quest to create a method of communicating colour without ambiguity has been on-going for many years. The American colourist Albert Munsell (1858-1918) devised a system for colour notation that still influences today’s work in colour science (GretagMacbeth, 1998:1.9). Munsell was a key figure in the development of a dedicated language to describe colour in a scientific way, reducing the margin for misinterpretation. Birren (1969) describes Munsell’s philosophy on working with colour:

> [The] art of the colorist [should] be furnished with a scientific basis and a clear form of color notation... Without a measured and systematic notation, attempts to describe color harmony only produce hazy generalities of little value in describing our sensations (Birren, 1969:78).
3.3.1 Munsell’s system

Munsell’s system separated colours into three discrete sections: ‘hue’, ‘chroma’ and ‘value’ (Figure 28) each of which has its own separate dimension and scale. The *Hue* scale represents the colour itself, for example, red, yellow etc. This is depicted by a circular band with divisions between each colour from red through to yellow, green, blue, purple and back to red again. The colours are further divided into gradations, for example, from red to yellow-red through to yellow then to yellow-green and so on (see Figure 29 on page 57).

In this way, a finely honed system of distinguishing colour differences is created. In Munsell’s three-dimensional system, the *Chroma* scale represents the strength of hue, and the *Value* scale represents the lightness or darkness of hue (GretagMacbeth, 1998:1.11). Any colour may have its coordinates mapped in terms of these three constant values. By plotting a colour’s position within this three-dimensional space, a distinct and unambiguous reference is created. This concept of mapping colour and plotting a reference point that remains constant and unchanging is a key aspect of colour management theory and forms the basis of today’s systems, such as L*a*b* colour, which will be discussed in the following section.
3.4 Colour management in digital textile printing

Colour management in digital printing attempts to minimise all the variables involved when printing colour images by using specific colour modes or spaces. In terms of printing digitally onto textiles, colour management could be said to “facilitate[s] the achievement of acceptable colour fidelity” (Dawson, 2000:54) in that an evaluation is made between the on screen colours and colours on the digitally printed textile. For the textile design undergraduate student working with digital print, this evaluation of colour output is generally based on a visual comparison between a design viewed on computer screen, and the same design printed onto a paper and/or textile substrate (see section 6.6). The idea of managing colour throughout the printing process, from monitor screen to printed media, is intended to increase the chances of achieving colour accuracy. The concept of digital colour management was first introduced in the 1980s; however, according to Boris Oicherman, a colour management specialist at the University of Leeds, while the concept was straightforward, the reality was far from it:

The “correct colour”, being a philosophical, rather than technical term, could not be delivered, simply because no one knew what it was. Thus, it was gradually replaced by “consistent colour” - which was at least technically definable, though not really achievable. This was due to colour gamut limitations inherent to different imaging devices. The scanner can capture colours which are not reproducible by the printer, who in turn can generate colours that are not reproducible by the monitor - meaning that the colour can be maintained consistent only within some fairly narrow limits (Digital Print Centre of Industrial Collaboration, 2008).
3.4.1 Colour management between different modes

The International Commission on Illumination, or Commission Internationale de L’Eclairage (CIE) as it is more commonly known, was founded in 1913 (CIE, 2011). The CIE has a broad remit covering all aspects of light and lighting, including colour vision and image reproduction. Technical and scientific data is shared and discussed across the member countries. The standards and models produced as a result of this dialogue are commonly used across the world. The Commission is divided into seven sections, with the first of these devoted to research into the study of colour vision and reproduction. A key example of the work carried out by the CIE is their development of the L*a*b* colour space, a depiction of colours in a mathematical ‘map’ format (Figure 30).

![Figure 30: Left: Gamut of RGB colours in L*a*b* space viewed in a*b* plane; Right: Graphical representation of L*a*b* space in the colour picker in Photoshop CS2, showing relationship to hue, relative chroma and lightness.](source: Briggs, D. (2007) The dimensions of colour, orthogonal systems. Retrieved 23/10/2011 from http://www.huevaluechroma.com/076.php)

Because it is not device dependent, CIE L*a*b* space can be used to provide a bridge between RGB and CMYK colour spaces. In CIE L*a*b* space, colours are referred to in terms of their position on axes within a three-dimensional model, where ‘L’ represents the value between black and white, i.e. the lightness of a colour; ‘a’ represents a colour’s position on the red to green axis, and ‘b’ represents a colour’s position on the blue to yellow axis (see Figure 31, page 59). These values are constant and remain unchanged regardless of what application is used, i.e. computer, scanner or printer (Dawson, 2001:187). But despite the values remaining constant, there will still be variations in appearance dependent upon the type of media being viewed – screen, paper, textile etc.
Figure 32 shows a representation via AVA’s CAD CAM software of the achievable range of colours for two specific devices: the Apple Mac monitor and the Mimaki TX1600s digital textile printer which is used in the BSc programme’s digital textile printing studio. This clearly illustrates the differences between devices, and that the monitor is capable of displaying a greater range of colours than the Mimaki printer is capable of accurately reproducing (with the specific set of colorants and fabric substrates it is set up to work with).

3.5 Colour profiles

The *International Colour Consortium* (ICC) comprises five founding companies and a large membership of additional companies from around the world who have a vested interest in the business of colour reproduction. The five founding companies
are: Adobe Systems Incorporated, Agfa-Gevaert N.V., Apple, Inc., Eastman Kodak Company, and Microsoft Corporation (ICC, n.d.). The ICC’s initial remit when it was formed was to develop a “framework for the imaging industry” (Billmeyer and Saltzman, 2000:194) that would facilitate the standardisation of all of the components associated with viewing colour, for example, the equipment it is viewed on, the light sources used when viewing, computer software that generates colour, and so on. The ICC developed this framework, which provides a system for managing colour, and describes the achievable colour output of a device as a colour ‘profile’ (Campbell, 2006:181). A colour profile may be an ‘input’ or an ‘output’ profile; ‘output’ encompasses all the variables involved in producing a colour print, e.g. what media is being used and what the capabilities are of the printer being used. ‘Input’ refers to the specifications of the computer, scanner, and specific colour space being used. An ICC colour profile takes the numerical information for a particular colour in a particular colour space (e.g. RGB), then expresses the same colour in another colour space (e.g. CMYK). Both sets of information are then combined to produce a third set of figures in L*a*b* colour, which facilitates the correct transfer of information from input to output (Billmeyer and Saltzman, 2000).

### 3.6 Colour matching systems

The American company Pantone (now owned by X-Rite Incorporated) produces colour reference systems and colour calibration equipment for design applications across a range of disciplines, including textile design. Within the Pantone colour reference systems, standardised colour swatches are given a unique code allowing continuity of reproduction, for example “Cornflower Blue 16-4031 TPX” (Pantone, 2011b). Pantone produce a vast array of colour matching tools, including colour guides on paper, cotton and plastic, plus software packages and calibration equipment (see Figure 33, page 61). The colour guides on paper are supplied on different paper stocks, for example matte or coated, to allow for variation in appearance. Even within the Pantone system itself, there are further variables; in a press release from 2004, Richard Herbert, the president of Pantone commented:

> It's important for designers and printers to replace their guides every year. We hear of numerous colour miscommunications resulting from out-of-date formula guides. Pigments fade and paper yellows over time. If designers and printers are not both using a current guide, the colour may not be correct. Using an older guide could lead to costly discrepancies (Web Media Brands Incorporated, 2011).

The plethora of material available from Pantone illustrates just how difficult it is to minimise the variables involved and just how elusive colour matching and colour consistency can be. This fact is acknowledged by Pantone and referred to on their website:
...the truth is that color is one area of the printing process destined to remain subjective. Every individual perceives color differently and many variables come into play, including ink density, press proof and proof calibration, paper stock and humidity, dot gain, screen angles, and many others. True perfection is probably something that can never be attained (Pantone, 2011c).

Working in a similar way to Pantone, Global Colour Research Limited distribute RAL colour systems in the UK. Originating in Germany in the 1920s, RAL (Reichs-Ausschuss für Lieferbedingungen) have developed standardised colour nomenclatures that include colour charts on paper and plastic (see Figure 34, below). RAL also produce their colour libraries in digital format, specifically for use with CAD. ‘RAL Digital’ software allows designers to import RAL’s colour libraries into a computer, which provides a standardised colour palette to work from (RAL, n.d.). Students need knowledge of colour specification systems to properly assess what is required for accurate colour representation.

Figure 33: X-rite Colormunki colour calibration equipment. 

Figure 34: An example of a RAL colour chart.
3.7 Chapter summary

The difficulties of standardising colour and creating a universal language with which to describe it have been discussed throughout the chapter. At every point in the process of describing and reproducing colour there are a vast number of variables at work waiting to undermine the outcome. ‘Colour management’ is the phrase used for systems and parameters that attempt to control colour, yet colour persists in being unmanageable to a great extent. In Taylor’s (1962) opinion:

It may well be that the rationalistic view of matter will be found to be quite untenable, and that as regards colour no object will be considered to have an intrinsic colour in the sense of human vision, but only a specific electromagnetic wave vibration which every human being may resolve differently (Taylor, 1962:43).

The final variable in the equation is the human interpretation of colour, by definition an element that will continue to remain impossible to standardise.

As one of the outcomes of the study is to define an effective strategy for teaching colour management of digital textile printing on an undergraduate textile design programme, it is important to have an understanding of different ways of learning and teaching. The next chapter gives an overview of the development of learning and teaching models.
Chapter 4
Learning and teaching styles

4.0 Introduction
A significant proportion of the primary research for the study is concerned with the teaching content relating to digital textile printing on undergraduate textile design degree programmes. The key outcome of the study is to define an effective model for teaching colour management of digital textile printing within undergraduate textile design programmes (see section 1.4). As this outcome is about delivering the subject to students, the analysis of the primary data should be informed by an understanding of pedagogy. This chapter aims to link the research approach with the outcomes of the study and to inform the choice of teaching recommendations. The intention of this chapter is therefore to give an overview of learning and teaching styles, with specific reference to the requirements of design students. This is a complex area, with significant diversity of views and no unified approach (Coffield et al, 2004b). In addition, there is a lack of academic research with specific focus on textile design within the wider arena of design research (Britt, 2012). This lack of academic discourse on the subject is described by Igoe as "a paucity of academic writing concerned with the idiosyncrasies of the textile design discipline" (Igoe, 2010: 2), suggesting that textile design is a subject with particular complexities; these complexities are considered in this chapter.

4.1 The development of learning and teaching models
Jarvis (2002) describes the nature of knowledge as both theoretical and practical, discussing three types of knowledge: practical knowledge is knowledge ‘how’; knowledge about people and places is knowledge ‘of’; and factual knowledge based upon research or argument is knowledge ‘that’ (Jarvis, 2002:18). In an educational context, the “recall or recognition of knowledge and the development of intellectual abilities or skills” (Simpson, 1966:1) was organised into a classification system by the educational psychologist, Benjamin Bloom, in the 1950s.

Bloom’s ‘Taxonomy of educational objectives for the cognitive domain’ categorises the learning process into a series of levels of thought, ranging from low order to high order cognitive skills (Crowe, Dirks and Wenderoth, 2008; Driscoll, 2000). Students may take a deep or surface approach to the acquisition of knowledge (Tomkinson, 1996). The deep approach to learning involves critical thinking, connecting concepts and ideas, and retaining information for application in future problem solving; the surface approach to learning involves learning by rote and
short term retention of knowledge for examination purposes (Higher Education Academy, 2011 [online]). For an undergraduate student at university, it is the deep approach to learning that is usually required (Tomkinson, 1996); the critical thinking and problem solving skills achieved through deep learning “promote understanding and application for life” (Higher Education Academy, 2011 [online]). Figure 35 shows a comparison of characteristics associated with deep and surface approaches to learning.

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>DEEP LEARNING</th>
<th>SURFACE LEARNING</th>
</tr>
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<tbody>
<tr>
<td>Examining new facts and ideas critically, and tying them into existing cognitive structures and making numerous links between ideas.</td>
<td>Accepting new facts and ideas uncritically and attempting to store them as isolated, unconnected, items.</td>
<td></td>
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<tr>
<td>Looking for meaning.</td>
<td>Relying on rote learning.</td>
<td></td>
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<tr>
<td>Focussing on the central argument or concepts needed to solve a problem.</td>
<td>Focussing on outwards signs and the formulae needed to solve a problem.</td>
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<tr>
<td>Interacting actively.</td>
<td>Receiving information passively.</td>
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<tr>
<td>Distinguishing between argument and evidence.</td>
<td>Failing to distinguish principles from examples.</td>
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<tr>
<td>Making connections between different modules.</td>
<td>Treating parts of modules and programmes as separate.</td>
<td></td>
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<tr>
<td>Relating new and previous knowledge.</td>
<td>Not recognising new material as building on previous work.</td>
<td></td>
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<tr>
<td>Linking course content to real life.</td>
<td>Seeing course content simply as material to be learnt for the exam.</td>
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Since its publication in 1956, Bloom’s taxonomy “has had a considerable impact on educational thought and practice all over the world” (Seddon, 1978:303). The taxonomy was specifically designed to be a general, descriptive tool, and not discipline specific (Furst, 1981); the intention was for each discipline to interpret the taxonomy according to “the context of their field” (Crowe, Dirks and Wenderoth, 2008:369). The classifications within the taxonomy can be translated into appropriate learning activities; Figure 37 (on page 65) shows examples of learning activities relating to each level, along with an expanded list of descriptive terms for each level. In 2001, Anderson et al reviewed and refined the categories to convey them in a more active way, and to reflect more contemporary theories of learning; for example, ‘application’ became ‘applying’ (Shank, 2013). Figure 36 (page 65) illustrates the taxonomy in both its original and revised forms.
Rolfe and Cheek define a learning style as: “The characteristics of a learner that influence the way in which that person learns. Differences in individuals shape how they learn” (Rolfe and Cheek, 2012:176).

For both students and educators, understanding different learning styles will help with receiving and delivering teaching content in an effective way (Montgomery and
Groat, 1998). There are many theories about learning styles in existence; a significant two-part report published in 2004 by the Learning and Skills Research Centre identified 71 learning style models. The authors of the report selected 13 of the 71 learning styles for in-depth evaluation; selecting those models they considered to be the “most influential and potentially influential models and instruments of learning styles” (Coffield et al., 2004a:81). The 13 models chosen for detailed analysis were:

- Allinson and Hayes’ Cognitive Styles Index (CSI);
- Apter’s Motivational Style Profile (MSP);
- Dunn and Dunn model and instruments of learning styles;
- Entwistle’s Approaches and Study Skills Inventory for Students (ASSIST);
- Gregorc’s Mind Styles Model and Style Delineator (GSD);
- Herrmann’s Brain Dominance Instrument (HBDI);
- Honey and Mumford’s Learning Styles Questionnaire (LSQ);
- Jackson’s Learning Styles Profiler (LSP);
- Kolb’s Learning Style Inventory (LSI);
- Myers-Briggs Type Indicator (MBTI);
- Riding’s Cognitive Styles Analysis (CSA);
- Sternberg’s Thinking Styles Inventory (TSI);
- Vermunt’s Inventory of Learning Styles (ILS).

(Coffield et al., 2004a:9).

For the purposes of this study, three of the learning style theories commonly associated with education in the United Kingdom as identified by Coffield et al. (2004) and their particular significance to design education are considered in more detail in the following sections. These three models are Myers-Briggs, Kolb, and Honey and Mumford.

4.2 Myers-Briggs Type Indicator

The foundation of the Myers-Briggs Type Indicator (MBTI) lies in the work of psychiatrist Carl Jung (Pulver and Kelly, 2008). Katherine Cook Briggs and her daughter, Isabel Briggs Myers, began working on the MBTI in the 1940s with the intention of turning Jung’s theories on human personality into a tool that would be useful in everyday life (Coffield et al., 2004a). The MBTI “has had a considerable academic impact” (Coffield et al., 2004a:47); the test is used to determine an individual’s personality within given parameters along four dimensions relating to:

- orientation to life (Extroverted/Introverted);
- perception (Sensing/iNtuative);
- decision making (Thinking/Feeling);
- attitude to outside world (Judgement/Perception)

(Montgomery and Groat, 1998:2).

These four dimensions are particularly relevant to designers. By definition, there is a relationship between the customer or audience and the designer, requiring judgment and perception; creative intuition evolves from lateral thinking and tacit knowledge, and is a quality in design graduates that is sought after by industry (Leak, 1998; Britt, 2013). In her research into textile design, Elaine Igoe comments...
that textiles have “relational, emotive and communicative qualities” (Igoe, 2010: 8); qualities which students fully realise when they experience their textile designs in an industry context following graduation. A design student’s ‘orientation to life’ and whether they have an extroverted or introverted personality is of great importance as designers are required to work in teams in addition to working as individuals. Figure 38 shows the Myers-Briggs personality types. An individual’s preferences within these parameters build their own personality profile, which is conveyed by the capital letter associated with each trait; for example, an extroverted, intuitive, feeling and perceptive personality would be represented as type ‘ENFP’ (Coffield et al, 2004a).

Since the publication of the first MBTI manual in 1962, it has become widely used in business and management applications. The MBTI is used by educators to help them to develop effective learning strategies based on a better understanding of their students’ personality traits; it is also used as a way to raise students’ own awareness of both their own and their peers’ learning style preferences, in order to: “...help them to develop their communication and interpersonal skills by giving them a better sense of audience so that they can present information that appeals to all four learning styles” (Goby and Lewis, 2000:39). Having a sense of audience is particularly relevant to textile design students as it directly relates to the relationships between the textile designer and other designers, the textile manufacturing industry and the market being designed for. As Igoe comments, “designed textile objects are innately highly relational, a quality of which textile designers are aware. At the same time, textile designers must regularly court manufacturers and other types of designers who are looking for textiles to help them realise their own design ideas” (Igoe, 2010: 5).

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<tr>
<th>ORIENTATION TO LIFE</th>
<th>Extroverted</th>
<th>Introverted</th>
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<td>Group interactions</td>
<td>Working alone</td>
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<td>Applications</td>
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<th>PERCEPTION</th>
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<td>Facts and data</td>
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<td>Routine</td>
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<th>DECISION MAKING</th>
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<td>Logical</td>
<td>Search for harmony</td>
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<th>ATTITUDE TO OUTSIDE WORLD</th>
<th>Judgement</th>
<th>Perception</th>
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<td>Planning</td>
<td>Spontaneity</td>
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<td>Control</td>
<td>Adaptive</td>
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Figure 38: Preferences of Myers-Briggs personality types. Adapted from Montgomery and Groat, 1998:3.
4.3 Kolb’s learning styles

David Kolb, Professor of Organisational Behaviour at Case Western Reserve University in the United States (Coffield et al, 2004a) proposed that one learns from one’s experiences and that learning is a continuous process (Rolfe and Cheek, 2012). Kolb’s experiential learning model conceptualises the learning process in such a way that differences in individual learning styles and corresponding learning environments can be identified (Kolb, 1981). Developed in the 1970s, Kolb’s model is described by Coffield et al as “one of the most influential” (Coffield et al, 2004a:60).

Research has shown that Kolb’s Experiential Learning Theory (ELT) is particularly relevant when considering design education (Demirken and Demirbas, 2008). Sayer and Studd carried out a comparative study of learning style preferences of design students on undergraduate textile design programmes. The learning style preferences of student cohorts from The University of Manchester and Manchester Metropolitan University were found to align with Kolb’s theory. Student preferences indicated that the most effective teaching methods should include a blend of “practical projects, demonstrations, problem-based learning and tutorials” (Sayer and Studd, 2006:174). Sayer and Studd’s findings are particularly relevant to this study as their research also involved student cohorts from a BSc textile design programme.

In their study of the learning styles of freshman design students, Demirken and Demirbas carried out a review of similar studies and concluded that, “design students should learn by experiencing, reflecting, thinking and doing” (2008:257). This sequence directly corresponds to Kolb’s experiential learning model. In his doctoral thesis, Adrian Leak observes that research into the process of design has shown that the “knowledge gained by practice […] is an essential part of the creative process” (Leak, 1998:80).

Within Kolb’s experiential learning model there are four learning styles: converging, diverging, accommodating and assimilating (Richmond and Cummings, 2005:45). Each of the four learning styles has its own distinct strengths; for example:

- the assimilating style (abstract, reflective) prefers abstract conceptualisation and reflective observation; likes to reason inductively and to create theoretical models; is more concerned with ideas and abstract concepts than with people; thinks it more important that ideas be logically sound than practical (Coffield et al, 2004a:146)

Kolb also described four ‘learning modes’, which characterise particular approaches to, and scenarios for, learning; the four learning modes are: concrete experience, reflective observation, abstract conceptualisation, and active experimentation
Each learning style incorporates one or more of the learning modes; for example, in Figure 39 the converging style of learning is placed between abstract conceptualisation and active experimentation. In terms of the converging learning style, it may be interpreted that the converger’s “greatest strength lies in the practical application of ideas” (Kolb, 1981:238), which directly relates to the problem-solving based teaching of design practice.

Kolb used his experiential learning model to develop the Learning Style Inventory (LSI) in 1976 (Coffield et al, 2004a:64). The LSI comprises a series of incomplete sentences describing learning; an individual choses from a selection of four different endings for each sentence. Each of the four different endings relates to a preference for one of the learning styles; therefore, by reviewing the results, an individual’s preferences for particular styles of learning can be measured (Rolfe and Cheek, 2012; Coffield et al, 2004a; Kolb 1981). The LSI is intended to be used as a guide to “help learners achieve skills in all four types of learning” (Rolfe and Cheek, 2012:177).

**4.4 Honey and Mumford’s learning styles**

Building upon Kolb’s experiential learning model, Honey and Mumford’s *Manual of learning styles*, first published in 1982, is intended to be a practical tool for educators (Honey and Mumford, 1992). The manual contains The Learning Style Questionnaire (LSQ) to be completed by students, the analysis of which reveals “the attitudes and behaviours which determine an individual’s preferred way of learning”...
learning” (Honey and Mumford 1992:1). The LSQ is based upon the idea that learning is a cyclical process with four stages (Kolb, 1981) (see Figure 40) but that individuals will not engage with each stage equally; it is an individual’s preference for certain stages of the learning cycle that indicates their learning style (Honey and Mumford 1992).

![Figure 40: Stages in the learning cycle. Adapted from Honey and Mumford, 1992:4.](image)

Each stage in the learning cycle has its associated characteristics: visual, auditory, read/write, tactile (Rolfe and Cheek, 2012: 176). According to Prashing (2008), “traditional university and adult education and formal training are still strongly based on auditory/visual information intake” (Prashing, 2008:141). This is supported by Oxman’s research into the teaching of design thinking skills, which states that teaching methods where the student’s role is passive rather than active, i.e. the lecture format, ”do not assure the acquisition of design thinking skills” (Oxman, 2003:65). The lecture format, is, however, still a valuable method of economically delivering information to large numbers of students; the lecture can be made more engaging by including more varied content: for example, by using mixed media and by including activities which require student participation (Studd, 2006).

Prashing’s earlier comment is supported by research carried out by Sayer, Wilson and Challis, who conducted a study of learning style preferences with textile design student cohorts on the Constructed Textiles module from the BSc Textile Design & Design Management programme at The University of Manchester. Staff observing
students’ performance on the module noted that students did not achieve deep learning through the more traditional teaching methods of lectures or laboratory classes (Sayer, Wilson and Challis, 2006:156). Honey and Mumford’s Learning Style Questionnaire was one of the data collection methods used for the study. From an individual’s preferences indicated by the LSQ results, their learning style can be described as ‘activist’, ‘reflector’, ‘theorist’, or ‘pragmatist’ (Coffield et al 2004a:71); the characteristics of each type translate into preferred learning styles, for example, a teaching method for a visual learner might be a PowerPoint presentation with additional notes (Rolfe and Cheek, 2012:176). Figure 41 shows the four stages of the learning cycle, with the corresponding descriptions of learning styles at each stage from Kolb’s and Honey and Mumford’s models. The LSQ results from Sayer, Wilson and Challis’s study indicated that the textile design students surveyed were ‘activists’, i.e. that they learned more through experiential activities (Sayer, Wilson and Challis, 2006:158). The activist category in the LSQ corresponds to Kolb’s experiential learning model, further supporting the results from Sayer and Studd’s research into learning style preferences of textile design students discussed earlier in this chapter (section 4.3).

Figure 41: Diagram showing Kolb’s model of learning with corresponding categories of learners from Honey & Mumford’s Learning Style Questionnaire. Adapted from Rolfe & Cheek, 2012:178.
Once an individual’s preferred learning style has been identified through the completion of the LSQ, both the individual and the educator can use this knowledge to be more effective educators and more effective learners. Using a variety of delivery methods helps to reinforce understanding and encourage deep learning for all types of learners (Rolfe and Cheek, 2012). Honey and Mumford comment that “learning is a life-long process” (Honey and Mumford, 1992:3); this corresponds to the evolution of the United Kingdom’s education system and the concept of lifelong learning (Coffield et al., 2004b; Jarvis, Holford and Griffin, 2003). The learning cycle is a continuous, cyclical process that echoes the idea of lifelong learning, in that the process is never finished.

4.5 Teaching styles

“Teaching has traditionally been associated with the idea that there is a truth (knowledge) or an accepted theory that can be disseminated through the agency of the teacher” (Jarvis, 2002:22). The traditional approach to teaching has been studied and resulted in a more complex multifaceted consideration of the role of the educator and the responsibility of the student (Banning, 2005). Pedagogy, or, the “theoretical and procedural knowledge about teaching” (Coffield et al., 2004a:172) is a research area that has been gaining momentum in recent years (Coffield et al., 2004a). This is resulting in a greater body of knowledge as to how people learn and therefore in how people can teach more effectively. This is a complex area with different knowledge requirements needing different approaches (Banning, 2005).

Within the straightforward description of the traditional role of the teacher given by Jarvis, there are many different approaches to teaching; such as didactic, Socratic, or facilitative (Banning, 2005). The role of the teacher in the didactic approach is the lecturer, with the student as the passive audience (Griffin, 2002); in direct opposition to didacticism, the Socratic approach is more democratic. The Socratic teacher “encourages students to think for themselves” (Brownhill, 2002:70); the facilitative approach promotes independence in students, by using critical thinking, reflection and self-directed study (Banning, 2005). Methods such as didactic, Socratic and facilitative teaching are techniques. The teacher’s own personality and how they themselves have been taught affects their style of teaching (Tomkinson, 1996:43) and this in turn influences how they interpret teaching techniques in practice. As Jarvis comments: “teaching methods are about the science of teaching whereas teaching styles are about the art of teaching” (Jarvis, 2002:24).

In design education, the characteristics of a degree programme dictate which learning styles may be most effective. Demirbas and Demirkan describe four categories of design courses. These are:
• fundamental courses, which are theoretical rather than practice based;
• technology-based courses, which are theoretical and practice based;
• artistic courses, in which design ideas are expressed through application;
• design studio courses, which combine elements from the previous 3 categories.

(Demirbas and Demirkan, 2007:346). In practice, the design studio course, combining theory, technical expertise and application, “is the main pedagogical framework for teaching” (Oxman, 2003:66); the design studio provides the setting for the interaction between learner and educator (Oxman, 2003), and according to Kvan and Yunyan, the design studio teaching method can also be “generalized to all professional education” (2004:19).

The design studio facilitates learning by doing, as well as encouraging the practice of reflexivity, which is “critical in the development of students’ knowledge […] as they are prepared for future practice” (Tezel and Casakin, 2010:267). Within this framework, the main teaching method is project-based, whereby “knowledge is transmitted from instructors to students” (Tezel and Casakin, 2010:262). In this scenario, the teaching style of the educator and the learning styles of the students may create potential difficulties; as Oxman explains, “the method of teaching the student how to acquire, organise and apply design knowledge depends very much on the tutor’s cognitive content and teaching style” (Oxman, 2003:66). Igoe expands upon this point with particular reference to textile design, stating that a designer’s tacit knowledge is embedded in every stage of the design process, from concept to realisation (Igoe, 2010).

The expression of a tutor’s implicit knowledge to make that knowledge explicit to the students can be problematic, in that it can be “difficult to articulate” (Igoe, 2010:2). The cognitive content or tacit knowledge of the tutor can be difficult to communicate to the student and it is important to balance tacit knowledge with objectivity, through questioning and by challenging assumptions (Igoe, 2010).

Kolb described four scenarios for teaching that are conducive for accommodating the different learning styles and learning modes; these are the ‘affective’ learning environment, the ‘symbolic’ learning environment, the ‘perceptive’ learning environment and the ‘behavioural’ learning environment (Richmond and Cummings, 2005:48). Within each one of these learning environments, activities that support particular styles of learning are grouped together; for example, the affective learning environment and the perceptual learning environment both support the divergent learning style. The affective learning environment relates to concrete experiences, an example of which could be a workshop activity; the perceptual
learning environment relates to the process of problem solving, an example of which could be a group discussion (Richmond and Cummings, 2005). Figure 42 illustrates the four learning styles, the modes of learning associated with that style, and the learning environments that support them.

Each of the four learning styles depicted in Figure 41 is linked to a particular style of questioning; the diverger asks ‘why?’ The assimilator asks ‘what?’ The converger asks ‘how?’ The accommodator asks ‘what if?’ (Montgomery and Groat, 1998:4). The type of question being asked can be linked to learning activities and to the educator’s role in those activities; therefore, “both learners and teachers contribute to the learning process” (Rolfe and Cheek, 2012:178). In their research into applying Kolb’s learning styles in engineering education, Harb et al have related four distinct teaching roles to Kolb’s learning model; these are motivator, expert, coach and evaluator (Harb, et al, 1995). The four teaching roles are not intended to be an exact match to Kolb’s learning styles; rather their purpose is to highlight the need for a range of different teaching approaches (Tomkinson, 1996:45). Figure 43, on page 75, depicts the four teaching styles and their associated approaches to teaching. Each of these roles represents a different approach to teaching, with
corresponding learning activities. Figure 44 depicts the four learning styles, the four teaching roles, and examples of activities associated with each one.

<table>
<thead>
<tr>
<th>Teaching role</th>
<th>Teaching approach</th>
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| **Motivator** | • introduces the subject  
• provides the big picture,  
• provides meaning,  
• generates enthusiasm  
• shows respect and interest |
| **Expert**    | • provides information to the student  
• organises and integrates new material  
• provides time for thinking and reflection |
| **Coach**     | • provides opportunities for students to apply the material  
• helps students to develop problem-solving patterns  
• establishes a safe learning environment for experimentation |
| **Evaluator** | • provides opportunity for self-discovery  
• provides opportunities for students to share discoveries and evaluates performance. |

Figure 43: Four teaching roles and their associated approaches (adapted from Tomkinson, 1996:45)

![Diagram of learning styles and teaching roles](image)

Learning style: **Accommodator** - What if?  
e.g. Education  
Teaching role: **Evaluator** -  
open ended problems  
student presentations  
design projects

Learning style: **Diverger** - Why?  
e.g. Humanities  
Teaching role: **Motivator** -  
group discussion  
group projects  
field trips

Learning style: **Converger** - How?  
e.g. Engineering  
Teaching role: **Coach** -  
demonstrations  
field trips  
homework problems

Learning style: **Assimilator** - What?  
e.g. Physical Sciences  
Teaching role: **Expert** -  
lectures  
objective exams  
textbook reading

Figure 44: Kolb’s learning styles with associated teaching roles and activities.  
Adapted from Montgomery and Croat, 1998:8.
Teaching styles, learning styles and ways of questioning depend on factors such as context, teachers’ experiences, and the particular academic area; for example, the divergent learner placed between concrete experience and reflective observation is associated with social sciences and humanities; while the convergent learner, placed between abstract conceptualisation and active experimentation is associated with science subjects, such as engineering (Montgomery and Groat, 1998).

Textile design is an interesting area when considering learning styles as it combines both technical elements and artistic elements, thus relating to both convergent and divergent learners (Sayer and Studd, 2006:165). The convergent learner prefers abstract conceptualisation and active experimentation found in the symbolic and behavioural learning environments (see Figure 42); in practice this translates as learning activities such as lectures and theory reading (Richmond and Cummings, 2005). The divergent learner prefers reflective observation and concrete experiences found in the perceptual and affective learning environments (see Figure 42); in practice this translates as learning activities such as group discussions and workshops (Richmond and Cummings, 2005).

The mix of artistic and scientific content requires a combination of delivery methods such as lecture and laboratory class with design studio project based assignments. In textile design there exists the potential for “imaginative frissons or collaborations” (Adams et al, 2013:142) between the scientific and the artistic practices contained within the field. Leak describes the design process as, “complex, diverse, and contains many variables” (Leak, 1998:79). This further reinforces the importance of the blended approach to teaching textile design, where students are active participants but are also given the opportunity to reflect upon their experiences. The complexities of textile design are explored in the research done by Elaine Igoe, who describes the subject as a “specific blend of knowledge” (Igoe, 2010:3), comprising content from “the broader disciplines of design, technology, art and craft” (Igoe, 2010:3).

The blending of learning styles is a necessary requirement for the textile design student; there is an expectation that they will bring their own unique combination of originality, creativity and technological expertise into industry, in order to maintain diversity. As Leak comments “the industry relies on designers’ subjectivity to produce a diverse range of designs from a single brief” (1998:79). This requirement for textile design graduates to have a combination of creativity and technical know-how is reinforced by Britt, who describes the function of the textile design degree programme as being to prepare students for “industry employment, self-employment and working on a freelance or commission basis as creative
practitioners” (Britt, 2013:50). The impact of digital technology on creative practice is described in detail by Treadaway, who notes the many points of interaction between digital technologies and the designer: “imagery can be collected, reviewed, stored, manipulated, combined and communicated with ease using digital tools and the resulting artefact expresses new visual characteristics, including complexity of colour and line” (Treadaway, 2006:47).

With reference to textile design students in particular, Kavanagh stresses the importance of having a grounding in the technical principles of technologies used, to “manage a technology effectively [...] to ensure the production of innovative products” (Kavanagh, 2004:6). A grounding in technology for graduates is particularly relevant in the burgeoning ‘global economy’, facilitated by the rise in technologies such as social media (Souleles, 2013). This has resulted in “an accelerated and heightened response capability by consumers of design products, and in doing so is having a profound effect on design, and therefore on education for design” (Adams, et al, 2013:142). In his article on the evolution of design pedagogies, Souleles describes this as a “challenge” to design education, and describes the need for design education to incorporate “new forms of visual literacy and competencies that cater for the interpretation of digitally generated visual outputs, as well as [...] the ability and skills to create them” (Souleles, 2013:252).

4.6 Chapter summary

This chapter discussed learning and teaching styles in order to address and inform the research outcome of delivering the subject of colour accuracy and colour management in digital textile printing to undergraduate students. It was acknowledged that pedagogy is a vast and complex area, and therefore a comprehensive analysis of the subject was beyond the scope of this study. The nature of knowledge and the acquisition of knowledge in an educational context were discussed; which included:

- a description of the classification of the stages in the learning process as devised by Bloom;
- how the learning process differs between individuals;
- the link between personality traits and approaches to learning.

Myers-Briggs, Kolb, and Honey and Mumford’s learning style models were examined in more detail, with reference to design education. The complexities of textile design as a discipline and particular learning style preferences of textile design students were discussed; research has found that textile design students’ learning styles preferences are a combination of types associated with both science and arts subjects. Kolb’s experiential learning theory was discussed with particular
relationship to the study of design students’ learning preferences. To use Kolb’s
descriptions, textile design students are a blend of convergent and divergent
learners. The convergent learner is associated with the sciences and prefers the
application of theory to solve problems, while the divergent learner is associated
with the arts and prefers to learn through practical activities. This would suggest
that an approach providing learning environments suited to the convergent and
divergent learner combined with educators in the roles of motivator and coach may
be the most effective method of delivery to improve students’ understanding of
colour management in digital textile design and production.

Teaching styles were discussed, in particular, how Kolb’s theory of learning extends
into descriptions of learning environments to support his learning styles model.
With reference to the textile design students, convergent learners prefer learning
environments where information is presented in a format such as a lecture, while
the divergent learner prefers practical activities such as workshops or field trips.
Finally, the link between teaching styles, learning styles and specific academic areas
was discussed.

This chapter informs the analysis of the primary data in Chapter 6; figures 73-75
(pages 164-166) illustrate a potential teaching model for the delivery of digital
textile printing, focussing on colour accuracy and colour management, to
undergraduate textile design students. The relationship between delivery methods,
learning styles and teaching content for digital textile printing on an undergraduate
textile design programme are shown.

In the next chapter, the research methodology for the study is discussed in detail.
Chapter 5
Research methodology

5.0 Introduction
The research methodology directs the research and determines what methods are used to gather and analyse information (Creswell, 2009; Dawson, 2002) and provides a “philosophical framework” (Van Maanen, 1983:4) that underpins every stage of the research process, from planning to evaluation. In this chapter the philosophical viewpoint that supports this particular study and the research methods chosen are discussed in detail. The details of the research methodology are documented in the order they occurred, as each stage informed subsequent stages of data collection and analysis (see Figure 45, page 80).

5.1 Research background
The impetus for this project emerged from the author’s experience when creating and printing designs digitally onto textiles and from observations made while working as a graduate teaching assistant on a BSc textile design programme. The difficulties encountered when colour matching across different media (between computer screen and digitally printed textile, for example) are an issue, as has been discussed previously. Over a number of years, the author observed different cohorts of students having the same recurrent problems with colour in their digitally printed textiles. As digital textile printing is a growth area (Bowles and Isaac, 2009:186), it is highly relevant for textile students going into all areas of the textiles and fashion industry to have an understanding of the key issues regarding colour.

5.2 Research questions
The central research questions of this study are as follows.
- How is colour accuracy and colour management for digital textile printing currently taught?
- What are the industry expectations of graduates’ understanding of digital print technology and colour management?
The first step to addressing these questions was to review relevant literature in order to contextualise the research. The contextual reviews revealed a lack of information relating to colour management issues in digital textile printing for undergraduate students.
As a result, the contextual reviews provided “evidence for the study and the underlying problem addressed by the enquiry” (Creswell and Plano Clark 2007:29). They also provided a starting point for the design of primary data collection methods.

**Figure 45: Stages of the research process (by the author).**
5.3 Research design for this study

The research methods used in this study are face-to-face, in-depth, semi-structured and unstructured interviews, and online and postal questionnaires. The chosen research methods were used to explore participants’ experiences and opinions of digital textile printing in a HE environment. As the purpose of the primary data collection stage of the study was to gather first-hand information from all participants about their experiences of digital textile printing, a qualitative rather than a quantitative methodology was used. The approach was from a phenomenological perspective, exploring participants’ experiences and opinions of digital textile printing in a HE environment; the phenomenological approach tends to be associated with research that is qualitative, subjective, humanistic and interpretative (Johnson and Christensen, 2004). Typically, “qualitative research explores attitudes, behaviour and experiences through such methods as interviews or focus groups” (Dawson, 2002:15). Phenomenology is concerned with developing an understanding of an individual’s personal experiences of a specific situation or event (the phenomenon) through the collection and interpretation of descriptive data (Creswell, 2009; Smith, 2009; Groenewald, 2004).

As a qualitative approach was taken for this study, the participants were chosen as purposive samples, rather than random samples. In qualitative research, the participants and locations for the research activities are selected by “purposive sampling” (Dawson, 2002:91) in order to target the people who have direct experience of the phenomenon and therefore most likely to directly contribute to an understanding of the central research question (Groenewald, 2004; Miles and Huberman, 1994). The sample sizes were small in comparison with a quantitative approach, but were in keeping with a qualitative approach. Quantitative and qualitative studies take different approaches to sampling: quantitative research usually deals with large, representative samples as the intention is to use the research to make generalised findings which can be applied to an even greater “research population” (Dawson, 2002:47). In quantitative data collection the participants are selected as “probability samples” (Dawson, 2002:90); in this case, the sample in the study is carefully chosen to be representative of a larger population (Bogdan and Biklen, 2007). Qualitative research usually concentrates on gathering detailed data from much smaller samples than quantitative research, with the intention of gaining insights about certain aspects of the larger research population (Dawson, 2002).

5.3.1 Interviews

In qualitative research the interview is also known as the ‘depth’ interview, as it is a means of gathering in-depth knowledge (Johnson and Christensen, 2004:183). In
contrast to the structured interview format used in quantitative research the responses from participants in the more open-ended qualitative interview format cannot be predicted. The unstructured, semi-structured and group interview formats are suited to qualitative research because of the rich data they can yield (Keats, 2000). In a semi-structured interview the researcher has a set of specific questions that they will ask the participant. While this will form the basis for the interview, there is also freedom to be spontaneous and expand the discussion to include related relevant points (Dawson, 2002). For the purposes of this study, in which the intention was to gain insight into participants’ personal experiences and opinions, the less structured, qualitative approach to interviewing was the most appropriate.

5.3.2 Questionnaires
Questionnaires were also used in as a means of gathering primary data in the study. The questionnaires included a combination of closed-ended questions, associated with quantitative research (Bogdan and Biklen, 2007) and open-ended questions, associated with qualitative research. The closed-ended questionnaire conforms to a fixed structure of set questions with no leeway for improvisation or expansion on the part of the researcher or participant (Fontana and Frey, 2003). The questionnaire is also used in qualitative research, but in an open-ended rather than closed-ended format; participants do not choose from a list of standard answers, or tick a series of boxes, instead they write responses to questions in their own words (Dawson, 2002:31). The purpose of the open-ended questionnaire is to find out people’s personal views, rather than to generate statistical data. This combination of question design was used for the study in order to gather specific data while giving the respondents an opportunity to expand upon their answers if they wished to do so.

5.4 Researcher bias
The interview gives a unique insight into the research topic from an individual’s perspective, through direct interaction between a researcher and participant (Gray and Malins, 2004:118). A researcher can tailor the exact format the interview takes to suit their needs; they have control over the questioning process (Creswell, 2009). One limitation of this method is the time involved in setting up, carrying out and transcribing interviews. Also, care needs to be taken to avoid influencing the participants, for example, by asking ‘leading’ questions, or imposing one’s own personal biases in the discussion (Creswell, 2009; Gray and Malins, 2004).

There is the potential for validity to be compromised by a researcher exerting their undue influence upon participants during data collection or by manipulating data to
obtain favourable results. This threat to validity is known as “researcher bias” (Johnson and Christensen, 2004:249). However, the very nature of qualitative research means there will be subjectivity on the part of the researcher (Creswell, 2009:192). Acknowledging this subjectivity in a reflexive statement where the researcher explains their perspective counteracts this threat by enabling a researcher’s own viewpoint to feed into the research in a productive way. This transparency adds to the overall trustworthiness of the results, showing the “integrity” rather than the “indifference” of the researcher (Maxwell, 2005:108).

The author has written this study from the perspective of a designer working with digital design and print, and also as a graduate teaching assistant working in HE with undergraduate students on a BSc textile design degree programme. In both of these roles, issues relating to colour management in digital textile printing arise on a daily basis. The recurrent nature of these issues led to a desire to understand more about digital textile printing from a personal point of view but, more importantly, from the point of view of being able to address these issues from the students’ perspective, in order to help them to have a more productive experience of working with digital textile print. There was an existing rapport between the author and staff and students from the BSc programme, which had been built up over a number of years. This relationship suggested a qualitative approach to the research would be appropriate. This familiarity could also be viewed as a disadvantage in that there was a potential difficulty in maintaining objectivity and impartiality during interviews. However, this was balanced by the stages in the study involving meetings and questionnaires with HE institutions and industry professionals with which the author had no prior relationships.

5.5 Secondary data collection: contextual review

Literature regarding the history of printed textiles and the evolution and development of digital textile printing was reviewed as a starting point for this study. The contextual review identified gaps in the literature regarding digital textile printing in the Higher Education environment. This lack of information led to the identification of the research questions and the design of the primary data collection methods used in the study, which focussed on the experiences of teaching staff and undergraduate degree students on textile programmes that featured digital textile printing. A review of literature relating to aspects of learning and teaching styles was carried out in order to address the central research questions (see section 1.3)

- How is colour management in digital textile printing experienced by students and educators on undergraduate textile design degree programmes?
• Can an effective model be developed to optimise teaching of colour accuracy and colour management of digital textile printing within undergraduate textile design programmes?

5.6 Primary data collection: survey of HE institutions

The lack of available information identified by the contextual review relating to colour management issues for digital textile printing in HE led to the decision to consult HE institutions directly, in order to gather primary source data. The first stage was to identify sources appropriate to the research questions, i.e. HE institutions with textile design degree programmes that include digital textile print. The process began by carrying out a search on the Universities and Colleges Admissions Service's (UCAS) website, to determine which degree programmes included textile print. Each of the identified institutions’ individual websites was then investigated, to establish whether digital textile printing was included in their programmes, to find out more details about the actual courses, and staff contact information. From the programme descriptions, twelve institutions were identified that included digital textile printing; these 12 programmes, therefore, became the purposive sample for the questionnaire.

5.7 Primary data collection: questionnaire to HE institutions

Once the appropriate primary sources were identified, a short questionnaire was designed (see Appendix A, page 189). The purpose of the questionnaire sent to HE institutions was to gather information about each institution’s digital printing equipment, to find out whether they had any issues with colour management, what these issues were and how they dealt with them. The questionnaire was emailed to 12 key textile print design staff at each institution. The email included a message introducing the research. From this mail-out, five completed questionnaires were returned. This response rate is typical for unsolicited postal and email questionnaires. Fink suggests that unsolicited surveys receive the lowest number of responses and a 20% response rate is usual for the first mail out of a survey (Fink, 1995). Denscombe also supports this view, particularly in relation to postal surveys (Denscombe, 2003).

The questionnaire was designed with both closed-ended and open-ended questions, to gather specific data while giving the respondents an opportunity to expand upon their answers if they wished to do so. Examples of question formats used in a closed-ended questionnaire are:

• **Nominal scales**: for example, asking the respondent to indicate what type of car they drive from a given set of models;
• **Ordinal/Likert scales**: asking the respondent to indicate their strength of feeling in response to the question ranging from ‘strongly agree’ to ‘strongly disagree’;

• **Interval scales**: asking the respondent to indicate their age from a given set of ranges (20-25, 25-30 etc.);

• **Ranked responses**: for example, ranking a list of personal attributes necessary to be a teacher in order of importance;

• **Semantic difference responses**: placing a tick on a point between two opposing descriptive words to indicate opinion (e.g. school dinners are: tasty - - - - - - -unappetising);

• **Open responses**: the respondent is asked to write their own comments.

(Johnson and Christensen, 2004:173; Birley and Moreland, 1999:46). The design of the questionnaire to HE institutions is as follows

**Question 1**: open-ended

*What make/s and model/s of digital textile printer/s do you have?*

**Question 2**: open-ended

*What make/model of steamer do you have?*

**Question 3**: list question plus open-ended

*What colorants do you use to print with?*
- Reactive dyes
- Pigments
- Acid dyes
- Other (please state)

**Question 4**: list question

Do you use:
- Manufacturer’s sealed cartridges?
- Refillable cartridges?
- Bulk feed system?

**Question 5**: open-ended

*What software runs your printer?*

**Question 6**: open-ended

*What software do you use for creating designs?*

**Question 7**: list question

*Are your computers:*
- Apple Macs?
- PCs?
- Both?

**Question 8**: list question plus open-ended

*Which colour mode do you use when creating designs?*
- CMYK
- RGB
- LAB
- Other (please state)

**Question 9**: Likert scale question

*On a scale of 1-5, how important is accurate colour reproduction to you? (1 = very important, 5 = unimportant)*
- 1.
- 2.
- 3.
- 4.
- 5.

**Question 10**: closed-ended plus open-ended

*Do you have any issues with achieving accurate colour reproduction?*
- Yes
- No

*If ‘yes’, how do you deal with this?*

**Question 11**: closed-ended plus open-ended

*Is your digital printing equipment calibrated on a regular basis?*
- Yes
- No

*If ‘yes’, how often is it calibrated? If ‘yes’, what method is used to calibrate?*

**Question 12**: open-ended

*Any other comments?*
5.8 Primary data collection: follow-up visits to HE institutions

The responses to the HE questionnaires led to the author contacting members of staff at three of the institutions to request a meeting with them. One of the institutions visited provided a BA textile programme and the other institution provided a BDes textile design programme. The data gathered from across the three degree classifications provided a comparison of students’ and educators’ experiences of digital textile printing, which enabled conclusions to be drawn about similarities and differences between the three degree types.

The data gathered from visits to HE institutions offering BA and BDes textile design programmes was compared to data from a BSc programme. Similarities emerged during the evaluation of the data; the three broad types of degrees identified that students experience essentially the same issues when working with colour in digital textile printing. The BSc programme was, therefore, selected to be an exemplar of textile design programmes and became the focus of the primary data gathering stages. A further rationale for this choice was that the author had a number of years’ experience working on the programme as a graduate teaching assistant. This existing relationship facilitated access to potential participants in the study.

The purpose of the meetings was to discuss in more detail their experiences, and their students’ experiences, of colour issues in digital textile printing. Prior to each visit a list of potential questions was compiled as a guideline for the author. The intention was to build upon the information gathered from the questionnaire by talking to members of staff in situ and observing how each digital print studio was setup. Although the author had guideline questions, the visits were conducted as unstructured interviews. The author made notes during the meetings rather than capturing the discussion on an audio recorder, as the meetings were conducted while walking around each digital print facility. The guideline questions taken to each meeting included:

- What equipment is used?
- Which digital printer is used? (model, approx age)
- Which software is used? (design and printer driver)
- Which colorants are used?
- What fabrics are used?
- How are fabrics finished? Steamed and washed, or just steamed?
- Are students asked to do a range of small samples before final prints?
- Are students given an understanding of colour accuracy issues when printing?
- Do students have any lectures on digital print in broader sense – i.e. in industry?
- Do students demand prints are redone if not satisfied with results?
- Who looks after the printer on a daily basis?
- What maintenance is carried out regularly?
- Is the equipment calibrated regularly? How is this done? Who does it?
- How often are the machines serviced?
5.9 Primary data collection: individual interviews with educators

Qualitative research usually concentrates on gathering detailed data from much smaller samples than quantitative research, with the intention of gaining insights about certain aspects of the larger research population (Dawson, 2002). In qualitative research, the participants and locations for the research activities are selected by “purposive sampling” (Dawson, 2002:91) in order to target the people who have direct experience of the phenomenon and therefore most likely to directly contribute to an understanding of the central research question (Groenewald, 2004; Miles and Huberman, 1994).

A purposive sample of seven participants was selected from teaching and support staff on a BSc textile design programme. This sample size is conducive with the optimum number of between two and ten participants to be interviewed for a phenomenological study (Groenewald, 2004:11). Participants were selected because they were involved with the delivery of the digital textile printing component on the BSc programme. The author conducted a series of face-to-face, semi-structured interviews with the members of staff. Before the interviews took place, a pilot study was carried out to test the interview questions and to modify or amend the interview schedule if required.

5.9.1 Interview design

The interviews with individual members of staff were semi-structured. In a semi-structured interview the researcher has a set of specific questions that they will ask the participant. While this will form the basis for the interview, there is also freedom to be spontaneous and expand the discussion to include related relevant points (Dawson, 2002). The interview schedule was flexible, in that there were a series of open-ended questions prepared in advance but participants were also given the opportunity to expand or extend the discussion if they wished to do so.

The types of questions asked by a researcher in an interview situation will depend upon what type of interview it is, i.e. semi-structured or unstructured, and also what exactly the researcher is trying to find out (University of the West of England, 2007). Kvale (1996) lists nine types of question that may be asked in a qualitative interview, and describes how the interviewer might use them (see Figure 46, page 88).
<table>
<thead>
<tr>
<th>Type of question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introductory</strong></td>
<td>Opening interview with an invitation to discuss an experience, memory etc.</td>
</tr>
<tr>
<td><strong>Follow-up</strong></td>
<td>Inviting the interviewee to extend their answer, to say more</td>
</tr>
<tr>
<td><strong>Probing</strong></td>
<td>The interviewee is asked to give a fuller description</td>
</tr>
<tr>
<td><strong>Specifying</strong></td>
<td>The interviewee is asked to add more details</td>
</tr>
<tr>
<td><strong>Direct</strong></td>
<td>The interviewee is asked for their thoughts on a clearly stated topic</td>
</tr>
<tr>
<td><strong>Indirect</strong></td>
<td>Asking the interviewee to comment on the attitude of others in order to gain insight into their own opinion</td>
</tr>
<tr>
<td><strong>Structuring</strong></td>
<td>Keeping the interview on the required subject</td>
</tr>
<tr>
<td><strong>Silence</strong></td>
<td>The interviewer remains quiet giving the interviewee time to think, reflect and a chance to add more information</td>
</tr>
<tr>
<td><strong>Interpreting</strong></td>
<td>Rephrasing the interviewee’s answers as a question back to them to clarify meaning</td>
</tr>
</tbody>
</table>

Figure 46: Types of interview question (adapted from Kvale, 1996:133-135).

The interview schedule included the following core questions, which were asked in each interview.

**Introductory question**
- What are students on the BSc programme taught about digital textile printing?

**Follow-up question**
- How is the teaching content delivered - what form does it take?

**Direct question**
- What are the students taught about colour management issues?

**Probing questions**
- Why is it important that colours in a digitally printed design on a textile match the colours as seen on screen or paper?
- How do you think digital textile printing fit in to the BSc programme? Why is it included, and what do you think its function is on the programme?
- Do you see the digital textile printer as a design tool or as a technology tool in the programme or neither or both?
- Is there anything regarding digital textile printing that you think should be included in the teaching content that is not currently included?

**Specifying question**
- How do you think digital textile printing as part of this BSc programme differs from that of a BA programme?

5.10 Primary data collection: staff group interviews

Also referred to as a focus group (Fontana and Frey, 2003:71) the group interview in qualitative research differs from the quantitative focus group in that information about participants experiences are being sought, rather than opinions relating to market research (Dawson, 2002:29). A group interview typically comprises more than six but less than twelve people brought together to discuss a specific topic that they share an interest in or have experience of (Johnson and Christensen, 2004; Keats, 2000). The group is facilitated by a moderator who asks questions to stimulate discussion and maintains the focus of discussion on the key topic (Bogdan and Biklen, 2007).
Each of the seven staff members who participated in the individual interviews was invited to attend a group interview to discuss issues relating to the colour management of digital textile printing. The size of the group meant that it was small enough for everyone to have a chance to speak, but large enough for there be to be sufficiently differing opinions to spark discussion (Krueger, 1988:27). Each participant was a member of staff from the department associated with digital textile printing and the BSc programme, therefore the group was homogeneous and likely to produce a useful, balanced discussion (Johnson and Christensen, 2004:185). The purpose of the group interview was to build upon the interviews with individuals by generating discussion amongst colleagues involved in the delivery of the digital textile printing component of the degree programme. During the group interviews the author acted as moderator.

5.10.1 Staff group interview design
The group members were asked to participate in two activities, the results of which formed the basis of the resulting discussion. The activities were based around elements of potential or existing teaching content for digital textile printing on the BSc programme. The list of elements was compiled from the results of the earlier individual staff interviews. Due to time constraints it was not possible to review each of the elements in detail; therefore topics for review were selected because there were clear differences of opinion in the results of the activities, which enabled the moderator to select topics that would lead naturally into discussion (Krueger, 1998:43). The activity was intended to promote discussion and was not intended as a quantitative exercise, the point of the exercise was, as Krueger comments: “[to] get participants to think about the concept, offer a judgement, share it with others, and then discuss the concept” (Krueger, 1998:66).

5.10.2 Staff group interview design: activity 1
For the first activity a wall chart was prepared which featured a list of elements relating to potential or existing teaching content for digital textile printing (see Figure 47, page 89). Alongside the list of elements there were three columns entitled ‘essential’, ‘desirable’ and ‘non-essential.’ Participants were asked to rate the importance of each individual element by placing a sticker in one of the three columns to indicate whether they thought it was ‘essential’, ‘desirable’ or ‘non-essential.’ They were also asked to indicate whether each element was already included in the programme. There was an additional section on the wall chart entitled ‘what’s missing?’ where the participants were invited to add further elements to the list that they thought should be included. This activity was designed to “engage participants” (Krueger, 1998:43) by asking them to perform a physical task, which was to read and consider the list of elements, make a decision as to
how they rated each element, then discuss the results of the activity with the rest of the group.

<table>
<thead>
<tr>
<th>Element</th>
<th>Essential?</th>
<th>Desirable?</th>
<th>Non-essential?</th>
<th>Already included?</th>
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</thead>
<tbody>
<tr>
<td>Colorants used in digital textile printing: what they are and how they are used</td>
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<tr>
<td>Substrates: paper/fabric and differences between</td>
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<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing and how this impacts on digital textile printing</td>
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<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
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<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
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<tr>
<td>Calibrating the University's digital textile printer</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What’s missing?</td>
<td></td>
<td></td>
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</table>

Figure 47: Activity 1 from group interview with teaching staff (by the author).

5.10.3 Staff group interview design: activity 2

In the second activity participants were asked to review the same list of elements relating to potential or existing teaching content for digital textile printing, but this time to indicate which teaching method (e.g. lecture, lab class, demonstration) they considered to be most effective and appropriate for delivery to students. There was the option to rank methods as ‘first choice’ and ‘second choice’: for example a lecture (first choice) backed up by a practical demonstration (second choice). After the participants had completed the task, as with the first activity, there was a clear difference of opinions, which led naturally into discussion.

5.11 Primary data collection: interviews with individual students

Primary source data were gathered from 12 students specialising in print in their final year of the BSc textile design programme in order to gain an understanding of
the student perspective on digital textile printing. The criterion for choosing this purposive sample was that students in the final year of their programme would have the benefit of three years’ experience of a textile degree programme that featured digital textile printing. The face-to-face, semi-structured interviews were conducted by the author in situ at the department where the students experienced the phenomenon central to the research questions, i.e. digital textile printing. Prior to carrying out the main interviews, the interview design was piloted, then reviewed and amended.

5.11.1 Interview design
The face-to-face interviews with individual students were semi-structured. The interview schedule was flexible, in that there were a series of open-ended questions prepared in advance but participants were also given the opportunity to expand or extend the discussion if they wished to do so. The interview schedule included the following core questions, which were asked in each interview.

**Introductory question**
- What software programmes you use when you are creating your designs?

**Follow-up question**
- Do you use your own computer at home, or a laptop, as well as the University computers?

**Specifying questions**
- How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programmes?
- Do you know in what colour space you are working on in your designs – whether it is RGB or CMYK – or is it whatever the default is?
- When you are working in CAD do you make any changes to the colour management settings usually, or do you go with whatever the default is?
- Do you know whether or not the colours in your designs are within the printable gamut of the Mimaki?

**Probing questions**
- How do you feel about the colour accuracy of the textile prints you got compared to the on screen colours you had?
- Is it important for the colours in digitally printed textiles to exactly match the colours of your designs on screen?
- Why is it important?
- Is it acceptable for there to be any colour difference between your textiles and your CAD work – is there a tolerance level?
- Are you judging the colours using your discretion as a designer?

**Direct questions**
- What information have you been given about colour management issues in digital textile printing on the BSc course?
- Do you have any comments about digital textile printing on the BSc programme, your experience of it?

5.12 Primary data collection: group interview with students
The final year students who had been interviewed individually were invited to participate in a group interview; five of the twelve students were able to attend.

The interview was structured in a similar way to the first group staff interview with two activities involving the same list of elements relating to potential or existing teaching content for digital textile printing. In the first activity the students were asked to consider the list, then to rate each element as ‘essential’, ‘desirable’, or ‘non-essential’ by placing a sticker on the wall chart. They were also asked to add any elements they thought should be included in a ‘what’s missing?’ section. As with the staff group interview, the discussion following the activity arose naturally...
from differences in opinions. The second task required the students to give their opinions about the most effective teaching delivery method for each element. The students were given a set of stickers printed with different options such as ‘lecture’, ‘lab class’ and ‘demonstration’. They were then asked to place a sticker with the option they thought to be the most appropriate delivery method for each element on the wall chart. After the second activity there was another discussion about the results. The purpose of the interview was to gather information about the students’ opinions in order to provide a contrast and a comparison with the information gathered in the group interview with staff.

5.13 Primary data collection: questionnaire to industry

The list of elements relating to digital textile printing used in the group interviews with both staff and students formed the basis for the design of a postal questionnaire sent to industry professionals working with digital textile printing. A survey was carried out using business directories to identify appropriate sources. Two of the HE institutions contacted during the initial stages of the study formed part of the sample as they also operated as a commercial print bureau. The sample included graduates from the BSc programme who had followed careers relating to digital textile print. The questionnaire was sent to a purposive sample of 20 industry contacts; 11 responses were received, which are analysed later in the study.

The purpose of the questionnaire to industry was to gather information about the participants’ opinions in order to provide a contrast and a comparison with the information gathered from the interviews with staff and students from the BSc programme. The graduates’ experiences in industry brought a unique perspective to the study, building on and enriching data gathered from other participants. Collecting data from different sources relating to the same research questions adds robustness to the validation process, by triangulating findings “in order that they may be mutually corroborated” (Creswell and Plano Clark, 2007:62).

5.13.1 Questionnaire design

The questionnaire to industry professionals was entitled ‘Digital Textile Printing in Higher Education’. There was a short introduction with instructions for completion as follows:

- From interviews and focus groups the following elements have been identified as potential teaching content for an undergraduate textile degree programme featuring digital textile printing.
• Please tick those elements that you think textile graduates should have knowledge of and indicate how important you think each one is on a scale of 1 – 5.
• There is additional space for you to add anything that you feel is missing from the list.

The questionnaire design included a combination of closed-ended, Likert scale and open response questions (see Figure 48). Examples of question formats used in a closed-ended questionnaire are:
• **Nominal scales**: for example, asking the respondent to indicate what type of car they drive from a given set of models;
• **Ordinal/Likert scales**: asking the respondent to indicate their strength of feeling in response to the question ranging from ‘strongly agree’ to ‘strongly disagree’;
• **Interval scales**: asking the respondent to indicate their age from a given set of ranges (20-25, 25-30 etc.);
• **Ranked responses**: for example, ranking a list of personal attributes necessary to be a teacher in order of importance;
• **Semantic difference responses**: placing a tick on a point between two opposing descriptive words to indicate opinion (e.g. school dinners are: tasty - - - - - - - -unappetising);
• **Open responses**: the respondent is asked to write their own comments.

(Johnson and Christensen, 2004:173; Birley and Moreland, 1999:46)

<table>
<thead>
<tr>
<th>Element</th>
<th>Required</th>
<th>1: very important; 5: unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorants used in digital textile printing: what they are and how they are used.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Substrates: paper/fabric and differences between.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>The mechanics of how a digital textile printer works.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
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</tr>
<tr>
<td>Principles of colour technology: additive/ subtractive / partitive colour mixing and how this impacts on digital textile printing.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE Lab/ Pantone etc.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Principles of colour management: colour gamuts/ device profiles.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile.</td>
<td>□</td>
<td>1. 2. 3. 4. 5.</td>
</tr>
</tbody>
</table>

• Please add anything you think is missing from the list
• Do you have any other comments or thoughts?

Figure 48: Design of questionnaire sent to industry professionals (by the author).
5.14 Primary data collection: interviews with graduates

Following the completion of the questionnaire, interviews were conducted with three graduates from the BSc textile design programme who had who had followed careers relating to digital textile printing. Two of the graduates have set up their own businesses, and one of them is a print designer for a high street retailer. The graduates were in a unique position to provide an insight into their experiences of the phenomenon of digital textile printing both during and after the undergraduate degree programme.

5.14.1 Interview design

The interview design was based on the list of elements relating to digital textile printing used in the group interviews with staff and students from the BSc programme (see sections 5.10.1 and 5.12) and the questionnaires sent to industry professionals (see section 5.13.1) and was designed to explore the central research questions from the graduates’ unique perspectives. The interview schedule used direct, probing, specifying and follow-up questions (see section 5.9.1); for example,

**Direct question**
- In terms of colour and your knowledge of colour in digital textile printing, once you’d left the programme and started up your own business did you have already the background knowledge you needed or have you built that up since you left the programme?

**Probing question**
- How do you think your experience of digital print on the BSc programme prepared you for your setting up your digital print business and your digital design?

**Specifying question**
- Where do you think that information would be best delivered in terms of what point in the programme would that be most useful, do you think, for a student to have?

The author conducted one face-to-face interview and two interviews via ‘Skype’ (Internet telephone service). The questionnaire completed by the graduates provided a basis for the interview design, along with questions relating to their own experiences in industry. The purpose of the interview was to expand upon the questionnaire responses and to discuss in detail the graduates’ own experiences of colour management issues both during and after the BSc programme. The full interview transcripts are reproduced in Appendix C, page 210.

5.15 Primary data collection: ethics

In both quantitative and qualitative research, data collection, analysis and interpretation raises ethical issues that must be addressed (Creswell, 2009). Research findings must be recounted honestly and not manipulated to fit the researcher’s required outcomes (Creswell, 2009:92). Any researcher has a responsibility to treat all participants in a study with due care and respect (Bogdan and Biklen, 2007; Gray and Malins, 2004). This applies on a general level, for example, by being courteous and professional; it also applies on a more formal
level, for example, by ensuring that data protection standards are met and ensuring anonymity of participants (Creswell, 2009; Dawson, 2002). Standards must also be maintained during the writing-up of research data: for example, using language that is unbiased and sensitive when referring to interview participants (Creswell, 2009).

For any research project, drawing up a Code of Ethics (Dawson, 2002:140) provides a tangible safeguard that reassures participants about the integrity of the researcher and, just as importantly, reassures the researcher that the participants are fully informed about their part in the research and how the information will be used before any data collection begins (Groenewald, 2004). Discussing the Code of Ethics prior to the interview also helps to build “trust and rapport” (Johnson and Christensen, 2004:178) between the researcher and the interviewee.

A Code of Ethics was prepared for this study (see Appendix B on page 209) prior to each interview, participants were given a copy of the Code of Ethics and each of the following points was talked through with them.

- **Anonymity**
  It was guaranteed that names and addresses would not be used when storing or categorising data, or in the final report. \(^2\)

- **Confidentiality**
  It was guaranteed that no information provided in the interview would be disclosed directly to third parties, unless permission had been granted to do so.

- **The right to comment**
  It was agreed to keep the interviewee informed about the progress of the research if requested. Any comments or requests for alterations would be considered and acted upon, if appropriate.

- **The final report**
  It was explained that the interviewee could request a copy of the final report, in addition to being able to access the copy held by The University of Manchester library.

- **Recording**
  It was explained that the interview would be captured using an audio data recorder for transcription purposes only.

After reading the Code of Ethics, the interviewees were asked if they wanted to continue. All of the participants agreed to proceed with the interview and in doing

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\(^2\) All of the graduates interviewed had no objections to being directly associated with this study and agreed that their names could be used.
so, gave their "informed consent" (Groenewald, 2004:9). Interviews were recorded on a digital audio data recorder. After the interview was completed, the audio file was transcribed by the author in full and verbatim, with no editing or modification. The files were stored on computer with no personal information recorded in their titles: for example a typical file name would be “BScF4 Feb 17 2010”; a hard copy of the interview transcription was printed out and filed; this copy also had no personal information about the participant.

5.16 Validation methods for this study
Validation methods used for the research in this study include respondent validation, low inference descriptors, peer review and triangulation.

5.16.1 Respondent validation
Inviting participants to review and comment on information gathered during the research process contributes towards the validation of research methods; this process of consultation contributes towards interpretative validity through “respondent validation” (Johnson and Christensen, 2004:251). Validity can be achieved to a large extent through consensus of those involved in the study, for example, through peer review and through "member-checking" (Creswell and Plano Clark, 2007:31) where the researcher asks participants to review research data; using different sources to gather information on the central research questions also adds to the validation process (Creswell and Plano Clark, 2007).

Interviews conducted for this study were semi-structured and in-depth, in order to generate rich data. Interviews were conducted with individual students and staff, and also with a group of students, and a group of staff; this combination gave an added dimension and richness to the data gathered through the promotion of active discussion amongst participants. Following the interviews, individual participants were sent full transcripts and groups were sent summarised transcripts for comment. No requests for changes or modification to the data were received.

5.16.2 Interpretive validity
Interpretive validity refers to the link between the research data and the research questions i.e., that the data gathered from participants in the research are correctly understood by the researcher and accurately represented in the study (Johnson and Christensen, 2004:251). One way to ensure that a valid account of the participants’ views is given is to use “low inference descriptors” (Johnson and Christensen, 2004:251). A low inference descriptor reports participant’s views using words as close to the source a possible; for example, a direct quotation from an interview would be the lowest inference descriptor possible because it is verbatim. Gathering a significant amount of ‘rich’ data from interviews that yield deep and detailed
information from participants contributes to the interpretative validity of the research (Johnson and Christensen, 2004; Denzin and Lincoln, 2003). For this to be achieved, all interview data needs to be captured i.e. the interview should be captured as an audio recording then transcribed in full (Maxwell, 2005:110). Each of the interviews conducted for this study was transcribed in full, in order to report the participants’ views using the lowest possible inference descriptors. Gathering a significant amount of rich data from interviews yielded deep and detailed information from participants and, as such, contributed to the interpretative validity of the research.

5.16.3 Peer review
The theoretical validity of a research project establishes whether any theories that arise from the research findings can be correctly attributed to the interpretation of the data (Johnson and Christensen, 2004). The researcher may consult with peers and colleagues to bring objectivity and debate to the research process (Creswell 2009). Peer review is a “strategy for promoting theoretical validity” (Johnson and Christensen 2004:253). The researcher tests theories by offering them for examination by colleagues; this process can expose weaknesses or issues that need to be addressed, thus making the research more robust.

At each stage of the research, the designs of the data collection methods were discussed and constructive criticism requested (Gray and Malins, 2004:131). The author sought objective opinions from the Graduate Research Development Team and experienced academic staff within the Faculty. The purpose of these discussions was to expose any weaknesses or issues that needed to be addressed. The author was then able to refine and improve the research methods before proceeding with the next stage of the study.

5.16.4 Triangulation
Miles and Huberman (1994) refer to internal validity as “truth value” (Miles and Huberman, 1994:278). In other words, whether the research findings give an accurate, honest account of the research project as a whole. One method of validating the research findings is to use ‘triangulation’, which originates from the system of navigation that uses several points of reference to accurately calculate a location. In research the term refers to the use of several sources or methods of data gathering (Jick, 1983:137) to which the same research questions are applied in order to “contrast the data and ‘validate’ the data if it yields similar findings” (Groenewald, 2004:11).

This study explores perspectives from three groups: the students’ experience of digital textile printing as part of an undergraduate degree programme; the
academics’ experience of preparing and delivering the digital textile printing component; and the industry professionals working with digital textile printing in a business environment (see Figure 49). The same set of criteria was used for each group, i.e. the same list of elements relating to digital textile printing was used in the group interviews with staff and students, and in the questionnaire to industry professionals. Asking three separate sets of people the same questions provided an opportunity to discover if the data produced similar findings through “multiple perspectives in analysis” (Gray and Malins, 2004:142). Collecting data from three separate sources enabled data validation through triangulation (Creswell 2009). Extending the study outside the academic arena provided a contrasting perspective.

![Figure 49: Corroboration of viewpoints in data triangulation (adapted from Gray and Malins 2004:137).](image)

### 5.17 Data analysis techniques in this study

Gray and Malins (2004) describe a structured process of data analysis in three stages: “data reduction, data display, and drawing conclusions from these first two” (Gray and Malins, 2004:144). For both quantitative and qualitative research the process of analysing data follows a similar pattern. However, there are differences in how each of these three stages is implemented, according to the research approach (Creswell and Plano Clark, 2007:204). Examining the data in a systematic, detailed way enables the research to yield its findings and to be understood (Bogdan and Biklen, 2007; Gray and Malins, 2004). Organising data in this methodical way, through assigning meaning to chunks of text and grouping similar chunks together, gives a researcher an overview of the data as an entirety and enables conclusions to be drawn (Miles and Huberman, 1994:56). The data
become a body of evidence, the interpretation of which becomes the findings from
the research (Creswell and Plano Clark, 2007). The data collected from the semi-structured interviews with staff and students from
the BSc programme were input into QSR International’s NVivo software. NVivo is
one of several commercially available software packages that are designed
specifically to aid in the process of coding and analysis of qualitative data. NVivo is
marketed by QSR International as being valuable to the qualitative researcher as it
“lets you collect, organise and analyse content from interviews, focus group
discussions, surveys…” (QSR International, 2012 [online]).

Data collected during a qualitative study may be analysed throughout the collection
stage in order to give an insight into how the research is progressing; for example,
interviews carried out in the early stages of the study may be reviewed and adapted
to include emerging themes that are then incorporated into subsequent data
collection methods (Dawson, 2002:115). Throughout the study, interview data were
reviewed and emerging themes incorporated into subsequent primary data
gathering stages. Recognising, categorising and interpreting themes that emerge
from the research data describes the process of ‘coding’ (Johnson and Christensen,
2004). According to Creswell and Plano Clark (2007) coding is a “core feature of
qualitative data analysis... grouping evidence and labelling ideas so that they reflect
increasingly broader perspectives” (Creswell and Plano Clark, 2007:208).

For the data analysis stage of the study, coding categories were created in NVivo
using ‘nodes’, which is the term used within the software for specific topics chosen
by the user that are relevant to the study. Information from multiple interviews
relating to specific themes is collected within the node structure. The starting point
for coding data from this study was an a priori coding scheme (University of
Huddersfield, 2012) using themes identified from the group interviews with staff
and students from the BSc programme and the questionnaires sent to industry. The
list of elements relating to existing and potential teaching content used in the
interviews and questionnaires (see Figure 48 on page 92 and section 5.13) was a
common link between all of the participants and therefore an appropriate starting
point for data analysis.

Once the coding structure was in place the interviews were reviewed. Excerpts
relating to each category (i.e. node) were extracted from the text and placed in the
appropriate node. Within NVivo there are ‘free nodes’ and ‘tree nodes’ categories: a
free node is a standalone category, useful as a starting point at the beginning of
data analysis; a tree node allows data to be refined and examined in detail by
providing a hierarchical structure for categories and subcategories. Creating a
hierarchical structure using tree nodes in NVivo allowed the data to be examined in
detail by breaking down text from interviews into categories and sub-categories.
Figure 50 on page 101 shows a screen shot from NVivo software, illustrating some
of the tree node categories and subcategories used for this study. Coding took place
as each transcript was examined, with relevant text from each interview catalogued
under each heading.

Information from individual interviews with staff from the BSc programme was
analysed using NVivo software. The interview schedule (see section 5.9.1) was used
as a starting point for creating a coding structure within NVivo; for example,
*teaching content – digital textile printing,* and *teaching content – colour
management.* As the interviews were semi-structured, additional coding categories
were created for subjects discussed that extended beyond the interview schedule.
Data were further organised by creating subcategories relating to the list of
elements used in the group interviews with staff and students, and the
questionnaires to industry professionals and graduates. Examples of these
subcategories are *principles of colour management,* *the importance of sampling* and
*evolution of digital textile printing.* In this way, data were consolidated under
common themes.

For the analysis of data from the interviews with staff, the tree node ‘Topics
individual staff interviews’ was created. This contained categories and subcategories
relating to the list of elements; for example, data relating to teaching content for
digital textile print was broken down into detailed subcategories, such as *different
colorants and their use,* *how a digital textile printer works,* and *pre and post-
treatment of fabrics* (see Figure 51, page 101). The complete set of interview
transcripts can be found in Appendix C on page 210. Using the coding structure
created in NVivo, the interview transcripts were reviewed in detail. Excerpts relating
to specific categories were extracted from different interviews then grouped
together to enable effective analysis of data.
After inputting all of the transcripts from the individual staff interviews into NVivo, a coding structure was created using tree nodes (see section 5.18). Coding took place as each transcript was examined, with relevant text from each interview catalogued under each heading. Creating a hierarchical structure using tree nodes in NVivo
allowed the data to be examined in detail by breaking down text from interviews into categories and sub-categories.

The interview schedule (see section 5.11.1) was used as a starting point for coding the data gathered from the individual interviews with students. As with the interviews with educators, NVivo software was used to analyse the data from student interviews. The tree node ‘Topics individual student interviews’ was created. This contained categories and subcategories relating to the interview schedule; for example, comments made by the students relating software used, choosing colours and importance of colour matching on the BSc programme. The complete set of interview transcripts can be found in Appendix C, page 210.

5.18 Chapter summary
In this chapter the research methodology and research design for the study were discussed. A qualitative approach to the research design was taken and the reasons for this were discussed in detail. How the qualitative approach shaped the designs of the interviews and questionnaires used throughout the study was also explained.

The stages of the research design were discussed in chronological order; each step of the process was presented as a diagram and shown in Figure 44 on page 68. The initial stages involved developing a research proposal in order to establish the key research questions, the aims and objectives of the study and the intended research outcomes. A contextual review was carried out in order to gather secondary data relating to the research questions and to provide “evidence for the study and the underlying problem addressed by the enquiry” (Creswell and Plano Clark, 2007:29). The contextual review provided a starting point for the design of primary data collection methods.

Primary data were collected using questionnaires and interviews in a series of stages, with each subsequent stage being informed by the previous one. The stages of the primary data collection were

- Survey of HE institutions with textile degree programmes featuring digital textile printing (see section 5.6).
- Questionnaires to 12 HE institutions with textile degree programmes featuring digital textile printing (see section 5.7).
- Visits to BA, BDes, BSc textile design programme’s digital textile printing studios (see section 5.8).
- Individual interviews with 7 members of staff involved with the BSc textile design programme (see section 5.9).
o Group interviews with members of staff involved with the BSc textile design programme (see section 5.10).

o Individual interviews with 12 final year students on the BSc textile design programme (see section 5.11).

o Group interview with final year students on the BSc textile design programme (see section 5.12).

o Questionnaire to 20 industry professionals including BSc graduates (see section 5.13).

o Interviews with graduates from BSc textile design programme working with digital textile printing (see section 5.14).

Validation methods used for the research in this study were discussed; these included respondent validation, low inference descriptors, peer review and triangulation (see section 5.16). Finally, the data analysis techniques used in the study were outlined (see section 5.17). How NVivo software was used to organise and code data was described.

In the next chapter, the results of the data collection stages will be presented and analysed.
Chapter 6
Results: primary research findings

6.0 Introduction
Primary data were collected via interviews and questionnaires with staff and students from undergraduate textile degree programmes, industry professionals from digital print bureaux and textile design graduates using digital print. The purpose of the primary data collection was to gather information that would provide an understanding of the participants’ experiences and their opinions about digital textile printing in a HE environment.

Educators involved with digital textile printing at five HE institutions participated in the study by completing questionnaires and taking part in interviews. Students and educators from a BSc textile design programme participated in the study by discussing their experiences in individual and group interviews. Industry professionals, including graduates from the BSc textile design programme, participated in the study via questionnaires; the questionnaire responses were followed by individual interviews with graduates from the BSc programme working with digital textile print.

6.1 Experiences of digital textile printing: HE institutions
In the initial stages of the study a questionnaire was sent to a purposive sample of textile design staff at HE institutions (see section 5.7) in order to gather primary data about their experiences of digital textile printing and, more specifically, colour management. The questionnaire was designed to gather information about the equipment used by each institution to create digitally printed textiles, whether there were issues with colour management, and how any issues were dealt with. The questionnaire was sent via email to key textile print design staff at twelve HE institutions; the individual contact details were found in an earlier survey of textile degree programmes (see section 5.6). Twelve questionnaires were sent out and five completed questionnaires were returned. The responses to the questionnaires revealed commonalities and differences between the equipment used and the approaches to colour management across the sample. The configuration of digital textile printing equipment used (printers, steamers, colorants, computer hardware and software) varied at each HE institution.

6.1.1 Equipment
All of the HE institutions had Mimaki digital textile printers in their design studios; there were a variety of models used – ranging from older to newer models; one
studio also had additional Stork Sapphire printers (this HE studio also ran a commercial print bureau). Both Apple Mac and PCs are used in three of the studios, with the other two studios using only PCs.

The HE design studios used a range of software programs to create their textile designs. While all of the studios used Adobe Photoshop, two also used Adobe Illustrator; only one of the studios used AVA Suite (a dedicated textile design software program) in addition to Photoshop and Illustrator. Within the software programs used, there were different approaches to working with colour. While all of the studios used RGB (Red Green Blue) colour mode (see 3.1.1) when creating textile designs, one also used CMYK (Cyan Magenta Yellow Black) colour mode (see 3.1.2). Two studios used RGB when creating designs, then converted to L*a*b* colour mode for printing (see 3.4.1). One respondent commented that students should be given a very good grounding in Photoshop skills before attempting to understand colour managing their own files.

There was also variation in the ‘RIP’ software used to run the Mimaki and Stork printers. ‘RIP’ refers to ‘raster image processor’ – the software that converts digital data from an image file (e.g. a textile design created in Photoshop) into raster or bitmap format suitable for printing (Campbell, 2006). Three of the studios used ‘Smartprint’; two of the studios used the RIP software integral to the Mimaki or Stork printers; one studio used AVA software in addition to the Mimaki software.

6.1.2 Issues with colour management

All of the studios used reactive dyes to print with; one studio, with two Mimaki printers, used reactive dyes in one machine and pigments in the other. The majority of studios used refillable colorant cartridges in their printers; manufacturer’s sealed cartridges were used by two studios. One studio used a bulk feed system (using large volume colorant tanks for economy). Fabrics printed using reactive dyes require steaming to fix the colours; during the steaming process the colours brighten and intensify. The steaming process has an impact upon the final colour output of the printed textile. This was commented on by one of the respondents, who said,

> I have demo swatches on the lab wall showing how colours are affected by the steaming process.

Another respondent used the steaming process as a method to regulate the final colour output by reducing the time the fabric was left in the steamer “so colours are not too dark.” Variations in the final colour output of a digitally printed textile can occur when different fabric substrates are used, even if the same colorants are used throughout. This was pointed out by one of the respondents, who commented
from personal experience of digital printing I have found that the fabrics themselves can affect the outcome – for example a coated wool is very yellow in tone compared to a [silk] habotai or cotton optic.

There was a mixed response to the question “On a scale of 1-5 how important is accurate colour reproduction to you?” three of the respondents rated colour reproduction as ‘very important’; two respondents rated colour accuracy as ‘important’, with one respondent adding the comment,

depends on quantity of work to be printed and how serious the student is towards their outcome.

One respondent felt that students considered digital textile printing to be “instant and a quick option”; they also felt that students should be discouraged from this approach, and that it is

very important that students are aware of the need to sample – just as they should in other areas of textile dyeing and printing.

All of the respondents stated that they had issues with achieving accurate colour reproduction and described various ways of dealing with these issues. One studio took an ad hoc approach to correcting final printed colour output by either adjusting the time the fabric was left in the steamer or by adjusting the colours of the design in Adobe Photoshop and re-printing. Another studio managed the final colour output by using the AVA system to build colour profiles (see 3.5) and found this method to be “pretty accurate.”

Sampling was mentioned by three respondents as the method used to deal with colour accuracy issues, with one respondent commenting

students are encouraged to produce a ‘sample strip’ of their files to print before committing to a length.

One studio included the finishing process in their colour sampling, saying “we always build our profiles through to steamed, washed and dried fabrics.”

There was also a variety of responses to the question “Is your digital printing equipment calibrated on a regular basis?” Three of the studios did not calibrate their equipment at all; one studio calibrated equipment “when necessary” and one studio calibrated their equipment on a weekly basis, adding that this was mostly through visual analysis, not through building new profiles every week.

The results of the HE questionnaires revealed the differences between the equipment and processes used in each of the design studios; from colorants, to software, to the finishing of printed fabrics. The potential impact that the many variables at each stage of the printing process have on the colour in printed output was discussed in more detail in Chapter 3. The design studios had different
approaches to colour management; with both *ad hoc* and systematic approaches being used. The variables involved in colour management when digitally printing on textiles were discussed in detail in section 1.1.

Digital textile printing is often considered to be a quick and easy option, as one respondent commented, “there is a belief that digital printing is ‘instant’.” As with any textile print process, digital print requires careful preparation to ensure a successful outcome. Students need to have a good understanding of how to work with colour in the software they use to produce their designs. Students should also understand the importance of checking the colours in their designs by printing sample swatches before proceeding with their final prints. It is important for students to have an understanding of the variables that can affect the output in the digital textile printing process; for example, that different substrates (both paper and fabric) affect the colours in the final printed output. Pre and post-treatments of fabrics (coating, steaming and washing) also affect the colours in a digitally printed design.

**6.2 HE institution case studies**

Following the return of the questionnaires, the author visited the BA textile design and BDes textile design studios; the purpose of the visits was to discuss the responses to the questionnaire in more detail. The information gathered during the meetings provided a comparison between the different types of textile design programmes (BA, BDes, and BSc) featured in the study.

The visits to the HE institutions revealed further commonalities and differences between the equipment used and the approaches to delivering digital textile printing to students. The questionnaire results showed that each of the HE institutions used reactive dyes for digital textile printing, but the visits showed that there were differences in the colour ranges of the reactive dyes used. Table 1 on page 108 shows the differences in colour choices between HE institutions visited. The visits also showed that various systems are used for the delivery of colorants in each institution’s digital textile printer: manufacturer’s sealed cartridges, refillable cartridges, and bulk feed (see Table 2 on page 108).
After fabrics have been printed, various finishing methods are used. Table 3 shows the different finishing methods used at each HE institution for comparison. Figure 52 on page 109 illustrates the different types of steaming equipment used at each institution.

<table>
<thead>
<tr>
<th>HE1 (BDes)</th>
<th>Steaming equipment</th>
<th>Steaming method</th>
<th>Washing equipment</th>
<th>Washing method</th>
</tr>
</thead>
<tbody>
<tr>
<td>HE2 (BA)</td>
<td>Jacquard 'Steam Jet' or 'bullet' steamer</td>
<td>20 minutes</td>
<td>Hand wash</td>
<td>Cold rinse, hot wash, final cold rinse</td>
</tr>
<tr>
<td>HE3 (BSc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.3 Students’ experience of digital textile printing

6.3.1 HE1 (BDes programme)

During their first and second years, students learn how to use Photoshop, Illustrator and Corel Draw software programs through a series of CAD workshops. In the first year of the course, students produce prints of their designs on paper substrates, and have the opportunity to transfer their designs onto textiles using a heat press. In the second year of the degree programme, the students are given an introduction to a range of textile printing processes, including digital textile printing.

The teaching content is delivered through a combination of lectures and practical projects. During the practical sessions the students have the opportunity to experiment, creating dye recipes and combining different techniques to achieve surface pattern and texture effects on textiles; they also have access to a laser cutter. At this point in the programme, the students have an opportunity to create a limited amount of digitally printed textiles, and, due to time constraints, there is generally not an opportunity to pre-test colours by sampling.

Throughout their second year, the students build up a print and dye manual containing fabric samples from all their experiments, along with details of dye recipes, methods used, and so on. This manual becomes a reference resource for the students’ final year. The students build up an awareness of colour management issues associated with digital print and other textile print processes through working closely with the textile printing technician during the practical sessions.
In the final year of the programme, the students work on a one-to-one basis with the textile printing technician, printing small sample swatches of the colours in their designs before committing to a larger print. The technician works with students to help them to achieve colour accuracy in their printed fabrics, by making changes to the colours within the software program used to create their designs, or making changes to the finishing process by varying the time fabrics are steamed for.

Students are charged for their digital fabric prints.

### 6.3.2 HE2 (BA programme)

The students receive an introduction to digital textile printing in the first year of their degree programme via lectures and projects. A member of academic staff liaises with the textile printing technician to develop lecture content for digital textile printing. The students’ first project is to produce an A3 digital print on fabric, created in Adobe Photoshop. This is followed by an introduction to different fabrics and sampling (sampling is advised before students do any final prints). Students are charged for their digital fabric prints.

The print technician explains some of the methods to alter colours in a design within Photoshop, for example, adjusting colours using the ‘colour balance’, ‘saturation’ and ‘hue’ tools. The technician also encourages the students to keep careful notes about what changes they make to colours across their range of samples. In the textile studio there is a display of information about digital printing, showing a sample colour range (taken from the standard colour palette in Photoshop) printed on cotton with reactive dyes. The same sample colours are shown before and after steaming. There are similar samples on display for pigments (see Figure 53).

![Figure 53: Display of colour palette swatches for digital textile printing in HE2.](Photograph by the author)
6.3.3 HE3 (BSc programme)

In the first year of the BSc textile design programme students attend CAD workshops during which they are introduced to fundamental aspects of working with Adobe Photoshop for the design of printed textiles. First year students are introduced to textile printing processes through a series of lectures and tutorials; this also includes designing in repeat.

Students are introduced to digital textile printing in the second year of their degree as part of a module that encompasses a range of textile printing methods, including screen printing. At the time of writing, the module is delivered over one semester, limiting the scope for covering digital print in detail; the module does not include specific content relating to colour management. The module includes an assignment where students write a report on different textile print processes, including digital print; there is also a lecture on designers using digital print and students are given a tour of the digital print studio which includes a demonstration of the digital textile printer.

Students are not charged for the fabrics they use for digital prints. The digital print studio stocks pre-coated cotton, silk and wool fabrics for student use. In their final year, students are limited to a maximum of 4 metres of fabric for their final project; any students that require fabrics other than those stocked by the print studio may purchase fabrics independently from the supplier.

6.3.4 Summary

For both the BDes and the BSc programmes, the students are introduced to digital textile printing in their second year; students on the BA programme produce a small-scale digital textile print as part of their introduction to digital print in the first year of the programme. There are similarities across the different programmes in terms of equipment used; all of the programmes use Mimaki printers, reactive dyes, Adobe Photoshop software and all programmes steam fabrics following printing. Students from all textile design programmes will experience the same issues when working with colour in digital textile print: for example, discrepancies in colour between designs viewed on a monitor screen and on the printed output; variations in colours on different substrates; shifts in colour intensity after the finishing process.

There are different approaches to how the students are introduced to working with colour across the programmes. On the BDes programme, students have practical sessions where they experiment with different dyestuffs and techniques, using the results from their experiments to build their own individual print and dye manuals; the students learn about colour management issues from their experiences working
with the textile print technician in practical studio sessions; sampling colours prior to digital print is not something that is currently built in to the BDes programme due to time constraints. In common with the BDes programme, students on the BSc programme also experience different textile printing methods, and have the opportunity to use screen printing equipment as well as the digital textile printer. Due to time constraints, there is no specific teaching content about colour management, however there is a demonstration of the printing equipment during which the printing process is explained to students.

There is a more targeted approach to teaching colour management on the BA programme. Students are encouraged to sample their digital textile prints on different substrates and are advised to make notes of how the colours for each sample swatch were created in the software program used. The textile printing technician demonstrates how colours change during the finishing process by displaying ‘before’ and ‘after’ swatches of fabrics in the print studio.

6.4 Educators’ perspectives

Students’ experience of digital textile printing is broadly similar across the BDes, BA and BSc programmes discussed in the previous sections. Students from all textile design programmes will encounter the same variables in digital textile printing that affect final colour output. The BSc programme from the case study in the previous section was, therefore, considered to be an exemplar of textile design programmes and became the focus of the primary data gathering stages. The rationale for this choice was based on the author having a number of years’ experience working on the programme as a graduate teaching assistant.

The author’s experience resulted in a rapport between the author and educators and students from the BSc programme, which also facilitated access to potential participants in the study. Because of this relationship, a qualitative approach to the research was considered appropriate, with purposive samples of teaching staff and the student cohort on the BSc programme taking part in the study. To provide balance to the primary data, other stakeholder groups were consulted with which the author had no prior relationships (see section 5.4).

6.4.1 Educators’ perspectives: individual interviews

In individual interviews with educators, participants generally thought that students should have the opportunity to experiment with textile printing processes, including digital and screen printing. They felt that this is important in order for students to gain a greater understanding of what can be achieved with each process and also to experiment with combining processes to create surface pattern effects (see for example the work of Katy Aston and Gina Pierce in section 2.11).
Staff felt that it is important for students to have an understanding of the different colour management issues in digital textile printing. One participant commented that students’ knowledge of colour at the start of the degree programme would probably be limited to the subtractive colour mixing process taught in secondary schools.

All of the staff thought it was important for colours in a design on computer screen to match the colours when a design was digitally printed onto fabric. Comments from staff on this point included:

…it’s important that a designer – whether it be a student or a [professional] designer - has confidence in knowing that those colours are actually reproducible, consistently reproducible on fabric, so it would be a hindrance to the system, I think, if they developed a design on screen and were totally happy with it - all aspects of it including colour - and then to be disappointed because the colour on the fabric actually isn’t the same – it’s vital that it’s right.

Staff thought it was important for colours to match because of the time spent by a designer on creating a specific colour palette for a collection, also, because of cost implications, for example, if digitally printed fabrics form part of a larger collection printed using other methods and the colours do not match. Commercially, colour is integral to a product’s success (Harold, 2001); for example, fashion trends that require specific colour palettes.

It was generally felt that the function of digital textile printing on the programme (see section 2.17) was to provide a design tool for the students, but that it also provided an opportunity for students to develop an understanding of the technology behind the process, which was considered to be essential to their future careers. Comments from interviewees included:

I think currently it’s just a design tool – currently it tends to be used as a way to get a design idea quickly onto fabric.

...obviously we are trying to create graduates who have the skills for the industry otherwise there’s no point is there? And digital printing is an up and coming printing method it will be the printing method of tomorrow so they do need to learn about this. Because it’s a BSc we do ask them to understand rather than just use things.

The general opinion of the group on how a BA textile design programme differed from the BSc programme, was that on a BA programme students would be introduced to the digital textile print process from the start of the course, and have the opportunity to create and print a much larger body of work than on the BSc programme; staff were also of the opinion that students on a BSc textile degree programme would need to have an understanding of the underlying processes involved, to enable them to problem-solve more effectively in their future careers.
It was felt that the technical aspects of colour management were an important part of a BSc textiles design programme:

I think that we’re moving towards including more of the underpinning technology but that definitely needs to be included – they need to know about things like printer gamuts, monitor gamuts.

During the interviews, participants were asked to reflect upon the current teaching content relating to colour and digital textile print. Most of the interviewees thought there should be more teaching content about working with colour, including colour management, colour technology, calibration of equipment, and different substrates; comments from staff included:

Colour is absolutely essential and it’s something that I’d like to become a bigger part of their teaching and their awareness.

...most of the students who come in don’t realise that designs are going to look different depending on how you view them or where you view them or how they’ve been printed. They just assume that if they create something, say, on their computer at home and they bring it in here and print it out it’s going to be just as they expect, when it’s not. They quite often don’t appreciate the importance of the colour management side of it.

There were also suggestions that there should be more experimental sessions where students could combine different surface treatments to develop interesting fabrics; staff comments included:

The combination of screen printing and digital printing is probably something that’s important and we’re just not getting students exploring that very effectively at the moment, and it would be nice to see if that could happen.

One point made by educators was that the most basic of information should not be overlooked when developing teaching content; it was felt that explanations of processes should assume no knowledge in the students in order to provide a thorough grounding in the fundamentals. A step-by-step guide for students that pared the digital textile printing process down to absolute basics was suggested.

I’m a firm believer in ‘idiot’s guides’, whenever I work on anything, whatever it is, I tend to write things down like ‘turn the computer on.’ That’s the way to go forward I feel.

At the time the interviews for this study took place, teaching content related to digital textile print was delivered from the second year of the programme onwards. Participants in the second group interview with educators (see 6.4) were asked to complete an activity to define teaching content for each year of the degree programme. The discussion resulted in a consensus that a basic guide to the fundamentals involved in digital textile printing and colour management should be delivered to students in the first year of the programme.
6.4.2 Educators’ perspectives: teaching content

Seven members of teaching and support staff involved with the BSc programme took part in a group interview to discuss the digital textile printing component of the course. The interview comprised two activities designed to promote discussion within the group about the teaching content for digital textile printing: what content was currently included, how the existing content was best delivered to students, and what topics should be included but currently were not.

In the first activity participants were asked to consider a list of topics presented on a wall chart, relating to teaching content for digital textile printing. This list was based on data that emerged during the primary data gathering stages of the study; during individual interviews, educators were asked to list existing teaching content relating to digital textile printing, and also to suggest additional content (see 5.10.1).

During the group interview, participants were asked to rate the importance of each element of teaching content by placing a sticker on the wall chart in one of three columns entitled ‘essential’, ‘desirable’ and ‘non-essential.’ They were also asked to indicate whether each topic was already included in the BSc programme. There was an additional section entitled ‘what’s missing?’ where the participants were invited to add further elements to the list. The full transcript of the interview can be found in Appendix C, page 210. The results of the rating exercise are shown in Table 4 on page 116. Data from the group staff interview were input into NVivo software and coded using a similar structure to the one used for the individual staff interviews (see section 6.3).

In order to interpret the data gathered from the rating exercise a numerical value has been allocated to each response as follows

- ‘essential’ = 2;
- ‘desirable’ = 1;
- ‘non-essential’ = 0.

For each of the individual elements in the rating exercise, a total score has been calculated based on the number of times it was rated ‘essential’ ‘desirable’ or ‘non-essential’ by the participants. The maximum rating value a topic could achieve was 14. For example, ‘the importance of sampling’ was rated as ‘essential’ by all 7 participants, giving it a total value of 7 x 2 = 14. From these calculations, the data can be interpreted on the basis of what participants perceived to be the most important topics that should be included in teaching content. To add further detail to the interpretation of the data, topics from the rating task have been grouped together according to whether the teaching content is technical, theoretical or...
relates to the application of digital print technologies. Figure 54 on page 117
presents a diagram of the results of the rating exercise with educators, showing the
elements of teaching content in descending level of importance.

<table>
<thead>
<tr>
<th><strong>Teaching content: technical</strong></th>
<th><strong>Maximum Value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrates: paper/fabric and differences between</td>
<td>8</td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
<td>8</td>
</tr>
<tr>
<td>Colorants used in digital textile printing: what they are &amp; how they are used</td>
<td>7</td>
</tr>
<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
<td>6</td>
</tr>
<tr>
<td>How a digital textile printer works</td>
<td>5</td>
</tr>
<tr>
<td>Calibrating the University’s digital textile printer</td>
<td>5</td>
</tr>
<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Teaching content: theory</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>a</em>b*/Pantone etc.</td>
<td>10</td>
</tr>
<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
<td>8</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td>7</td>
</tr>
<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing &amp; how this impacts on digital textile printing</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Teaching content: application</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The benefits and limitations of digital textile printing</td>
<td>14</td>
</tr>
<tr>
<td>The importance of sampling</td>
<td>14</td>
</tr>
<tr>
<td>How digital textile print is being used by fashion/interior designers and companies</td>
<td>10</td>
</tr>
<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
<td>9</td>
</tr>
<tr>
<td>Digital textile print methods for different applications and substrates: direct/ sublimation methods</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 4: Results of rating exercise for teaching content – educators’ perspective
One participant added three further elements to the list in the ‘what’s missing?’ section, all of which were rated as ‘desirable’. These additions were: "more on digital print on other materials (other than textiles) might be useful"; “examples and information on designers who do post digital print treatments on their textiles, e.g. screen print, stitch”; “perhaps more examples of digitally printed products – final contexts for the work?”

Participants were asked to indicate which topics from the given list were currently included in the teaching content for the BSc programme, and which topics were not

![Figure 54: Elements of teaching content in descending level of importance – educators’ perspective](image-url)
currently included. The topics that were not included are shown in Table 5; the list contains a number of topics relating to colour management in digital textile printing considered to be ‘essential’ by participants, indicating this is an area for improvement.

<table>
<thead>
<tr>
<th>Teaching content not currently included in BSC programme</th>
<th>Essential</th>
<th>Desirable</th>
<th>Non-essential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrates: paper/fabric and differences between</td>
<td>**</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
<td>**</td>
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<tr>
<td>Principles of colour technology: additive/subtractive/partitive colour mixing and how this impacts on digital textile printing</td>
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<tr>
<td>Principles of colour management: colour gamuts/device profiles</td>
<td>**</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>A</em>B*/Pantone etc.</td>
<td>****</td>
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<td>*</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Calibrating the BSc programme’s digital textile printer</td>
<td>*</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

Table 5: Topics not currently included in BSc programme

Comments from individual and group interviews with educators support the point that content relating to colour management is recognised as being essential and also an area that could be improved.

For me colour is absolutely essential and it’s something that I’d like to become a bigger part of [the students’] teaching and their awareness.

It’s [colour management] been a missing component of the programme.

It’s something which we’re definitely working towards and a lot of these things come around quite slowly.

One participant commented that there was a lack of knowledge amongst staff about what was being taught on different modules on the same programme; this perceived lack of communication and sharing of information created barriers to a cohesive delivery of the subject.

One of the things that I think is very difficult here, particularly for print and issues related to print design, it’s difficult to find out what is going on in other peoples modules – what’s being taught [...] and I think it’s one of the things we have to address.
Following the rating exercise the moderator opened a discussion of the results; selecting topics where there was a clear difference of opinion in order to encourage a natural discussion (see section 5.10). The topics chosen for further discussion were:

- colorants used in digital textile printing: what they are and how they are used;
- the evolution of digital textile printing: how it developed from paper technology;
- how a digital textile printer works;
- principles of colour technology: additive/subtractive/partitive colour mixing and how this impacts on digital textile printing;
- communicating colour: e.g. RGB/CMYK/CIE LAB/ Pantone etc.;
- principles of calibration from computer screen to digitally printed textile;
- calibrating the Mimaki in B46 [digital textile print studio].

During the discussion staff commented that colour management in digital textile printing is a complex topic comprising many different aspects (see section 2.8), but that it is essential for students to have a basic knowledge of the principles of colour management throughout the whole process, from creating a textile design on computer to printing and finishing the final fabric. It was agreed that it was important for students to have a grounding in colour management as this would enable them to work more effectively during their degree course, but would also equip them with vital knowledge for their future careers; comments included:

Well I’m not sure because I think they need to know about colour calibration and printer gamuts and the whole thing here to be able to effectively work as a group and to get anything like the same sort of colours together, and I think they also need to know that for industry.

They’re quite surprised some of them when I say the printer can’t print that colour – you can view it on the screen but the printer won’t print it and they need to know that type of thing, the printer gamut is probably smaller than the monitor gamut.

Staff agreed that the basics of colour management should include: different colorants; different substrates; principles of colour technology; communicating colour; calibrating equipment.

6.4.3 Educators’ perspectives: delivery methods

In the second activity participants were asked to review the same list of elements and indicate which teaching method (e.g. lecture, laboratory class) they considered to be most effective and appropriate for delivery to students. There was the option to rank methods as ‘first choice’ and ‘second choice’: for example a lecture (first choice) backed up by a practical demonstration (second choice). Following the
rating exercise, the group discussed the results. As with the first activity, topics for discussion were chosen by the moderator because there was a clear difference of opinions that led naturally into discussion. The results of the rating exercise for methods of delivering teaching content are shown in Table 6 below.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lecture</th>
<th>Tutorial</th>
<th>Practical Demo</th>
<th>eLearning</th>
<th>Lab Class</th>
<th>Workbook</th>
<th>Individual Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorants used in digital textile printing: what they are and how they are used</td>
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<td></td>
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<tr>
<td>Substrates: paper/fabric &amp; differences between</td>
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<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
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<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology</td>
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<td>How a digital textile printer works</td>
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<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
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<tr>
<td>The benefits and limitations of digital textile printing</td>
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<tr>
<td>Digital textile print methods for different applications and substrates: direct/sublimation methods</td>
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<tr>
<td>Innovations in digital textile printing technology</td>
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<tr>
<td>How digital textile print is being used by fashion/interiors designers and companies</td>
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<tr>
<td>The importance of sampling</td>
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<tr>
<td>Principles of colour technology: additive/subtractive/partitive colour mixing and how this impacts on digital textile printing</td>
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<tr>
<td>Principles of colour management: colour gamuts/device profiles</td>
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<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L(^a)(^b)/Pantone etc.</td>
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<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
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<tr>
<td>Calibrating BSc programme’s digital printer</td>
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Table 6: Rating exercise for methods of delivering teaching content – educators’ perspective

Alternative delivery methods to those in the list were: “small group project”, for the importance of sampling, principles of colour management and communicating colour; “talk by a professional” for the importance of sampling. After the second activity, there was a discussion amongst the group about the choices made by
participants. Topics discussed included how a digital textile printer works and the importance of sampling. As the group interview drew to a close the moderator asked participants to reflect upon the session. As a closing exercise the moderator invited the group to write down suggestions for how the results of the discussions could be taken forwards. The group wrote their suggestions onto ‘post-it’ notes, which were placed on a wall-chart, entitled ‘what happens next?’ The group discussed delivery methods for teaching content, end of session thoughts, and suggestions for how to take the results from the session forwards.

Everyone in the group chose practical demonstration as the most effective delivery method for this How a digital textile printer works; second choices were lecture and eLearning. Comments included:

I like the fact that you can have videos or animations in eLearning which I think would work really well in showing what happens when a piezo crystal changes shape and expels a drop, that sort of thing. I think it would work really well.

There were a wide variety of responses to how the importance of sampling could be best delivered. Most people thought a lab class would be the most effective; tutorial and practical demonstration were the second most popular choices; lecture and talk by a professional were joint third; workbook and small group project also received votes as back-up methods. Comments included:

I put tutorial for that one because I thought it’s quite difficult to do it in a big class.

I’ve noted a small group project ... I think when you actually see what it does to something you’ve created, you start to realise how important things like colour calibration and colour management are in your own design work and the effect that they’re going to have on your work if you get it wrong.

As the discussion drew to a close, participants were asked to reflect on the interview session and to give their thoughts about how it went. Finally, they were asked to write down any suggestions for how ideas generated in the interview session could be taken forwards. The main point that was made about the interview session was that it identified the need for communication and clarification between staff about teaching content across the programme:

...one of the things that’s come out from today is that there probably will be some overlap in terms of what people are teaching, and it’s almost like with the restructuring you kind of need to know what everybody’s delivering – and ... spread it all out and just see where the commonalities – where the common areas are.

Staff felt that the format for the interview of breaking down subjects into their component parts, then discussing their relevance and options for delivery, would be a useful model for future meetings:
It would be good to take the results from this and then to move it on a stage to map exactly what we need and how it could be delivered, and then we could slot it into the new structure and we can see where it could be put.

I think we need to take this and make sure that it goes into the restructured programmes. And I think because print is one of the areas where actually the technology develops much faster and it’s quite different technology - from screen printing to digital print is quite massively different – weaving is weaving – knitting is knitting.

Suggestions for how ideas generated in the interview could be taken forward included collaboration between disciplines to deliver comprehensive content to the students:

Teaching of differences between silk screen and digital printing could be delivered within a group project between designers and technologists.

Identify: what units deliver some of the issues; who is involved in those units. Invite the people identified to re-think what is delivered by whom. Use results to re-think delivery method.

6.5 Educators’ perspectives: preparing students for the future

Participants from the first group staff interview were invited to attend a follow-up session. The purpose of the second group interview with staff was to discuss in detail their opinions about what textile design students need to know about colour accuracy and colour management in digital textile printing to prepare them for the future careers in the textile industry. The session consisted of two activities followed by a discussion. As in the first group interview, the author acted as moderator.

In the first activity, participants were asked to consider the following question, which was presented to the group on a PowerPoint slide: “going into industry at the end of the BSc programme, what do students need to know about digital textile printing, colour accuracy and colour management?” The moderator noted each of the participant’s suggestions onto a flipchart. All suggestions were noted, resulting in the following list.

- CAD: knowledge of the software used to create designs e.g. Lectra, Photoshop.
- The printing process e.g. history of printed textiles and how digital print has evolved.
- Pre and post-treatments of fabrics for digital print.
- Designing in repeat.
- Understanding of how colour works in the printing process e.g. limitations, gamuts.
- Colour separation.
- Substrates.
• Comparisons between printing methods e.g. rotary screen printing and digital textile printing.
• Communicating colour e.g. RGB/LAB.
• Digital image file formats e.g. TIFF, Jpeg.
• Costs associated with different print methods.
• How digital textile print is used in industry.
• Environmental issues.
• Entrepreneurial opportunities for using digital textile printing.
• Device profiling.

The list of suggested topics contained additional elements to those that had emerged from the study thus far (see 5.10.1). These additional suggestions were added to the overall list of teaching content. Building a framework of teaching content in this way informed one of the fundamental research questions of the study, which is: can an effective model be developed to optimise teaching of colour accuracy and colour management of digital textile printing within undergraduate textile design programmes? (1.2). Figure 55 on page 124 presents the list of teaching content indicating additional subjects that emerged from the group interview with educators.
<table>
<thead>
<tr>
<th>Teaching content: technical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrates: paper/fabric and differences between</td>
<td></td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
<td></td>
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<tr>
<td>Colorants used in digital textile printing: what they are &amp; how they are used</td>
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<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
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<tr>
<td>How a digital textile printer works</td>
<td></td>
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<tr>
<td>The evolution of digital textile printing from paper printing technology</td>
<td></td>
</tr>
<tr>
<td>CAD: knowledge of the software used to create designs e.g. Photoshop</td>
<td>Additional content from group interview with educators</td>
</tr>
<tr>
<td>Digital image file formats e.g. TIFF, Jpeg.</td>
<td></td>
</tr>
<tr>
<td>Colour separation</td>
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<tr>
<td>Device profiling</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: theory</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>A</em>B*/Pantone etc.</td>
<td></td>
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<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
<td></td>
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<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td></td>
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<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing &amp; how this impacts on digital textile printing</td>
<td></td>
</tr>
<tr>
<td>Understanding of how colour works in the printing process e.g. limitations, gamuts.</td>
<td>Additional content from group interview with educators</td>
</tr>
<tr>
<td>The printing process e.g. history of printed textiles &amp; how digital print has evolved</td>
<td></td>
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<tr>
<td>Environmental issues</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: application</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Different applications of digital print for different substrates: direct/sublimation methods</td>
<td></td>
</tr>
<tr>
<td>How digital textile print is being used by fashion/interior designers and companies</td>
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<td>The benefits and limitations of digital textile printing</td>
<td></td>
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<tr>
<td>Comparison of how colours are mixed in traditional printing methods with digital print</td>
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<tr>
<td>The importance of sampling</td>
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<tr>
<td>How digital print is being used in the textile printing industry</td>
<td>Additional content from group interview with educators</td>
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<tr>
<td>Comparisons between printing methods e.g. rotary screen printing &amp; digital textile printing</td>
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<tr>
<td>Costs associated with different print methods</td>
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<td>Designing in repeat</td>
<td></td>
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<tr>
<td>Entrepreneurial opportunities for using digital textile printing</td>
<td></td>
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</tbody>
</table>

Figure 55: Teaching content for digital textile printing with additional topics from group interview with educators
During the group interview participants discussed their suggestions for topics that should be included in teaching content. The educators agreed that students should learn about digital textile print in the context of its place in the overall history of printed textiles; they felt that this would give them a greater understanding of the process; some of the participants’ comments were:

It’s what they need to know about digital printing. To do digital printing they have to understand printing first of all.

There’s nothing to do with where digital printing’s come from, I think that’s quite important as well. Because when the first years come in, they don’t know whether we’ve had the digital printer for 40 years or whether we’ve just got one...

It was felt that it was important to include the subject of business applications, opportunities (see section 2.11) and costs associated with digital and other textile print processes:

I think digital printing provides quite a lot of opportunities – new opportunities – which students need to understand on a micro level for themselves as designers if they are working for themselves, and on a more macro level, an industry level – what goes on in industry with digital and screen print.

In order for students to have a full understanding of digital textile printing and its commercial applications, it was considered to be important for students to witness first-hand production in an industrial print facility:

I think they also need to have some understanding about the costs of digital printing. Maybe as compared to screen printing, on an industry level, and where digital printing might be more cost effective than screen printing and what scenarios that might be applicable to.

The participants felt it was important for students to understand the technical details involved with creating a textile design in a software program then taking it through the stages of getting the design printed on to a fabric; staff commented:

... it’s really important for students to understand those basic issues about taking design from their computer, or whichever computer they’re working on, through to digital print, and issues to do with resolution, dots per inch and so on...

I think they need to know something about practical device profiling\(^3\) as well. So they don’t necessarily – they’re not actually going to understand the models, but they know the models exist and roughly what the models do – for a screen, for a printer, on textiles, for a printer on paper, for a scanner – whatever it may be.

The list of suggestions generated during the discussion became a starting point for the second task; participants were asked to consider at what point in a textile design degree programme each component should be taught, i.e. what should be taught

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\(^3\) ‘Device profiling’ refers to the process of managing colour between devices e.g. a computer monitor with RGB colour space and a digital textile printer with CMYK colour space; A device profile conveys colour information from device dependent spaces in device independent format e.g. LAB. The profile of a device shows what proportion of colours within the independent format it is capable of reproducing (Billmeyer and Saltzman, 2000:195).
the first topic delivered to the students in the first semester of the first year of their degree, then what should come next, and so on. The moderator explained that broad topics could be broken down into smaller details. Participants were asked to write down the components on post-it notes and to place them onto a wall chart depicting the first, second and third years of the degree course as a timeline. As everyone proceeded with the task and began to place their ideas on to the timeline, one participant suggested grouping post-it notes into clusters where there was obvious agreement about the topic and where it should be placed in the degree programme.

Figures 56, 58 and 60 on page 127, 129 and 132, show diagrammatic representations of the post-it notes, which were the outcome of the timeline activity. The positioning of the coloured squares in the diagrams represent the placement of the post-it notes on the wall chart representing the first, second and final years of the degree programme; subjects were placed chronologically according to which point in the academic year participants felt they should be delivered.

After completing the activity, the group reviewed the timeline and discussed the results. The discussion began with an overview of a theoretical degree programme structure in which theory is delivered in the first year, followed by strategy in the second year, and application in the final year. The point was raised that, with a design degree, application should be placed earlier in the programme, as students learn through the practical application of design processes. The group agreed that in reality, there should be a blend of theory and application delivered to students in order to enable them to build upon and develop their knowledge and practical skills. Figures 57, 59 and 61 (pages 128, 130 and 133) show an interpretation of the data from the timeline activity, grouping the topics into technical, theory and application subject areas.
Figure 56: Consensus of staff opinion on the chronology of delivery of information during first year of degree programme (by the author).
6.5.1 Teaching content: first year

Figure 57: Summary diagram from timeline activity: first year (by the author).

Figure 57 shows a diagrammatic representation of the results of the group discussion about teaching content for the first year of a textile design programme. Topics are grouped together and placed chronologically according to which point in the academic year participants felt they should be delivered; this placement reflects the consensus of opinion reached by educators during the group exercise.

This exercise resulted in a way of organising teaching content for the first year. It was considered that the teaching content should provide the students with a basic grounding in digital textile printing and colour management issues; the fundamental knowledge required to begin working with the process. In addition it was thought that students should learn about the fundamental components associated with digital textile printing, including: a comparison between a range of textile printing processes; colour communication, mixing and management; technical information (working in CAD, file formats etc.); costs involved with different processes; business opportunities; environmental issues.
Figure 58: Consensus of staff opinion on the chronology of delivery of information during second year of degree programme (by the author).
There was significantly more discussion in the group around the second year of the programme; this may be attributed to the fact that the second year is a consolidation of core knowledge attained during the introductory year, and is also the foundation for more self-directed study in the final year.

It was considered important to extend knowledge to be able to develop practical application of digital print within the students’ textile design skills. In addition, it was agreed that content should include business issues relating to digital textile print, exploring the limitations and possibilities of digital textile print, for example, experimenting with special effect colorants or combining digital with traditional hand printing methods to create innovative surface effects (see section 2.11 for examples of Katy Aston’s and Carlene Edward’s work). The group felt that the degree programme should include visits to observe digital textile print and rotary screen printing equipment in an industrial facility; experiencing first-hand textile printing techniques on a large scale would reinforce their understanding of the different processes (see section 2.12):

I think industry visits like this though can really make the learning alive for the students - so they’re not just getting the theory, they’re actually seeing how it’s applied in industry and the value of what they’re learning.

It was agreed that students should be given an opportunity to experiment with surface treatments of fabrics early on in the degree programme, combining wet printing processes with digital printing. It was also agreed that in order for students
to have the confidence to experiment, they needed to know about colour management early in the programme:

[Colour management] should definitely be in the second year – it shouldn’t be left until the final year.

...in which case, we need to give them more time to try things out in the second year.

In the group discussion, there was agreement that the teaching content relating to colour management and digital textile printing delivered to students in the second year of the degree programme is crucial in order for them to achieve their full potential going forward in to the final year of the programme:

When they digitally print in the second year it’s very controlled isn’t it? They get their prints in at a certain date, [...] prints them, steams and washes them and then here they are. There are some bad ones and some good ones, but then they move on to the next project. Whereas in the final year, they have that kind of coming and going, and trying things out.
Figure 60: Consensus of staff opinion on the chronology of delivery of information during the final year of degree programme (by the author).
6.5.3 Teaching content: final year

In the group discussion around the final year of the programme, the participants felt it was important that students learn about digital textile print applications in a wider context; looking at innovations in technology, how designers and industry are using and developing the process. The group also felt it was important for students to explore the digital print process in-depth in terms of advancing their own design practice. The group felt that a holistic approach needs to be taken to ensure that students consolidate all of the teaching content into a useful and meaningful body of information. Comments included:

I think a big issue is that they’re not holistic in the way they actually take on board...they say they get everything they need but they say it’s not in the right order or they can’t join it up; that’s actually an issue for them in many respects that they don’t look at the ‘whole’...

They get the information but they don’t realise it. They just want to get the designs as good as possible and if it’s not they don’t query it - they’re just like – ‘oh, it hasn’t worked.’

6.5.4 Summary
The results from the second group interview with educators enabled a more detailed exploration of teaching content for digital textile printing. During the interview participants discussed topics in terms of their optimum point of delivery on the BSc programme. This discussion provided data that can be combined with the results from the earlier interviews with students and educators to inform one of the central research questions of the study (1.2). During the discussion, the group agreed that teaching content on a design degree programme should blend theory and application. This is reflected in the outcome of the group interview, which combines technical, theoretical and applied aspects of digital textile printing throughout each
academic year. The educators’ suggestions for teaching content compiled from their responses to the question “going into industry at the end of the BSc programme, what do students need to know about digital textile printing, colour accuracy and colour management?” (see 6.4) have been collated with the existing list of topics that has emerged during this study. Figure 55 on page 124 presents a diagram showing the augmented list of topics.

6.6 Students’ perspective

A purposive sample of students who specialised in print in their final year took part in the study; the students were from the same BSc textile design programme as the educators who participated in individual and group interviews. Final year students were selected because they could reflect upon their experiences of digital textile print over the whole period of study.

6.6.1 Students’ perspective: individual interviews

The students often use a range of different computers on which to create their textile designs: home PCs, laptops, and different machines in the BSc programme’s computer suites. Adobe Photoshop is predominantly the software students use to create their textile designs; this is because of its accessibility and perceived ease of use:

I’ve always worked with Photoshop because that’s something I’m really confident with because I’ve got that package at home.

From earlier primary research gathered from HE institutions (see section 6.1) Photoshop was identified as the predominant software used by other undergraduate textile design students. While other programs are used, including AVA and Lectra, these programs are not as popular due to them being less accessible, less widely available, and being too expensive for students to purchase themselves. In addition, there is little time available for tuition on these other programs, which are perceived as being more difficult to use:

What I’ve used so far is just Adobe Photoshop – I didn’t use Lectra, I found it too complicated.

Photoshop is the program of choice for creating textile designs for students as they are familiar with it and feel confident about using it. It is important that the perceived ease of use should not preclude the students’ developing a good understanding of working with colour in Photoshop; the importance of students’ developing Photoshop skills was commented on in the responses from HE institutions (see section 6.1); this was further emphasised in the interviews with students, when discussing the specifics of how they work with colour.

A multitude of sources are used by the students for the colours in their textile designs: some use scanned-in original artwork, or scanned-in colour chips from
decorating colour charts, others make selections from the colour palettes within the software used:

I normally do it straight from my artwork and then pick the colours using the tool.

I just use colours from the colour palette.

Last year I had colour chips from a paint chart which I scanned in so I used those, but this year I’ve used my own art work and I’ve put the colours from my own art work and matched those to the closest Pantone colour that’s in the library.

Despite this rather informal and inconsistent approach to working with colour, the students felt it was important that the colours in their designs on computer screen match the colours when their designs are digitally printed onto fabric. Some of the reasons they gave were:

It’s very important - because in my 2nd year project I did some designs that I felt were really good, and the colours really went together but when I printed them out the colour was completely wrong and my project went downhill from there.

Because that’s how I want the design to look – if I wanted it darker I would make it darker. I think it’s because I see the design, that’s how I want it to look. Having said that I am aware that it’s never going to be perfect it’s always going to be slightly different.

The students’ approach to working with colour contrasts with the approach used in industry, as discussed in Chapters 2 and 3. Companies such as Stork strive to maintain colour accuracy through an integrated colour communication system which they have developed (see section 2.10.1). Other colour management systems used in industry include colour reference systems and colour calibration equipment such as those produced by Pantone and RAL (see section 3.6). It is important for students to know about colour management systems in order for them to fully understand the process of digitally printing onto textiles, and also to fully understand just how difficult it is to achieve consistency of colour output (see section 3.4.1).

The students’ views are similar to those expressed by HE institutions and interviews with educators (see sections 6.1; 6.4). In the questionnaire responses, each of the HE institutions rated colour accuracy as either ‘very important’, or ‘important.’ Staff felt colour accuracy from screen to print was important from the point of view of the designer achieving their intended outcome, and also from the commercial aspect of achieving continuity of colour in production.
The students expressed frustration when the colours in their digitally printed fabrics did not match their designs on computer screen, and they did not understand the reasons why this happened:

...we think we can work at home and come in and it will print out the way we’ve seen it on the screen that we’re using at home. If we were more aware of the fact that that isn’t the case we’d be more inclined to always use the same machine or try and always use the same system to develop your work maybe. It would be interesting to have more teaching on it.

In the second year, we all intended to work from the same colour palette – our group – and at the end when we all printed out our designs they were all different colours, even though we all tried to work from the same colours.

There was a general lack of awareness amongst the students that different fabric substrates would affect the colours in their digitally printed designs; they commented that:

...one thing that’s been really interesting is that every different fabric I’ve printed on the colours have come out differently which is something that I completely didn’t expect, that’s been really hard to manage.

When you’re working on digital designs in repeat – it takes a long time to achieve it – and if you print out something that doesn’t look like what you’ve got on screen it’s a bit of a disappointment - you feel like it’s wasted work.

The students were asked during the interview about what teaching content relating to colour management in digital textile printing they recalled from the BSc programme. Some of the students recalled a lecture during the first year “with regard to colour in general.” The consensus of opinion was that there had been little content covering colour management; comments included:

I think we were told that some colours won’t be the same, but we weren’t told why or weren’t told how to prevent this.

I think it’s been quite minimal for my year

I don’t think we’ve had much practical help on matching colour; it’s mostly been up to us playing around with matching colour.

We haven’t been given any information on colour management that I can think of.

We’ve never really done a workshop on colour management and how to do it, or practised doing it or anything.

Two lectures have been developed and delivered by the author in response to the research findings as they were emerging. One lecture was on colour calibration issues in digital textile printing (see Appendix D, page 298), and one was on contemporary designers that are using digital print for interior design and fashion fabrics (see Appendix D, page 289). The content of the lecture on colour calibration issues included information on the different colour modes encountered when
designing a print for textile on computer, and then printing the design onto a textile. This was intended to give the students knowledge of some of the variables involved in the printing process, to enable them to be better informed when working with digital print. The students referred to the this lecture during interviews, commenting

The only real proper colour management lecture was the one that you gave the other day.

But the lecture that you gave the other day was really good – really got to understand a bit more.

The interview data would suggest that there is a lack of understanding of colour management at each stage of the design process. This needs to be addressed in order for the students to work more effectively with digital textile print during their degree and after graduation. The students expressed a desire to know more about working with digital textile printing technologies; one of the reasons they wanted to be more knowledgeable was to feel more prepared for their careers following graduation.

I would like there to be more about it really, because I think if you’re going to go into industry into digital printing as a job it’s something you need to know about and for us it’s just more a case of give it to [...] and see what happens kind of thing, you don’t actually know much of the background behind digital printing or colour management.

Colour management was something that was bottom of the pile, really.

I’ve never done digital print before. I didn’t actually know that they were steamed afterwards to make it brighter. I think I’ve learned a lot but it would be nice if we’d learned a bit more about it.

I feel like once I’ve left I should be professional in using the printer.

6.6.2 Students’ perspective: teaching content

The group interview with final year BSc students was structured in a similar way to the first group staff interview, with two activities centred on the same list of elements relating to potential or existing teaching content for digital textile printing. In the first activity, as in the group staff interview, the students were asked to consider the elements, which were presented on a wall chart, and to rate each element as ‘essential’, ‘desirable’, or ‘non-essential’ by placing a sticker on the wall chart. They were also asked to add any elements they thought should be included in a ‘what’s missing?’ section. In the second activity, the students were asked to consider the list of elements again, but this time to give their opinions as to what were the most effective methods of delivering the teaching content. As with the staff group interview, the discussion following the activities arose naturally from differences in opinions. The author acted as moderator and introduced the session by explaining that the purpose of the interview was to gather data for research.
purposes. The results of the first rating exercise are shown in Table 7 on page 139. The full interview transcripts can be found in Appendix C, page 210.

In order to interpret the data gathered from the rating exercise a numerical value has been allocated to each response as follows

- ‘essential’ = 2;
- ‘desirable’ = 1;
- ‘non-essential’ = 0.

For each of the individual elements in the rating exercise, a total score has been calculated based on the number of times it was rated ‘essential’ ‘desirable’ or ‘non-essential’ by the participants. The maximum rating value a topic could achieve was 10. From these calculations, the data can be interpreted on the basis of what participants perceived to be the most important topics that should be included in teaching content. To add further detail to the interpretation of the data, topics from the rating task have been grouped together according to whether the teaching content is technical, theoretical or relates to the application of digital print technologies. Figure 62 on page 140 shows the results of the rating exercise with students as a diagram. Elements of teaching content are shown in descending level of importance, according to the students’ perception.
<table>
<thead>
<tr>
<th><strong>Teaching content: technical</strong></th>
<th>Maximum Value = 10</th>
</tr>
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<tbody>
<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
<td>9</td>
</tr>
<tr>
<td>Substrates: paper/fabric and differences between</td>
<td>7</td>
</tr>
<tr>
<td>Colorants used in digital textile printing: what they are &amp; how they are used</td>
<td>6</td>
</tr>
<tr>
<td>Calibrating the University’s digital textile printer</td>
<td>5</td>
</tr>
<tr>
<td>How a digital textile printer works</td>
<td>4</td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
<td>3</td>
</tr>
<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Teaching content: theory</strong></th>
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<tbody>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>A</em>B*/Pantone etc.</td>
<td>8</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td>7</td>
</tr>
<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
<td>6</td>
</tr>
<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing &amp; how this impacts on digital textile printing</td>
<td>5</td>
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<thead>
<tr>
<th><strong>Teaching content: application</strong></th>
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<tbody>
<tr>
<td>The benefits and limitations of digital textile printing</td>
<td>8</td>
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<tr>
<td>Digital textile print methods for different applications and substrates: direct/ sublimation methods</td>
<td>8</td>
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<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
<td>7</td>
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<tr>
<td>The importance of sampling</td>
<td>4</td>
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<tr>
<td>How digital textile print is being used by fashion/interior designers and companies</td>
<td>3</td>
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Table 7: Results of rating exercise for teaching content – student perspective
<table>
<thead>
<tr>
<th>Value: 9</th>
<th>• Pre-printing and post-printing treatments of fabrics for digital print</th>
</tr>
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<tbody>
<tr>
<td>Value: 8</td>
<td>• The benefits and limitations of digital textile printing</td>
</tr>
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<td>• Digital textile print methods for different applications and substrates: direct/ sublimation methods</td>
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<td></td>
<td>• Communicating colour: e.g. RGB/CMYK/CIEL(a)<em>B</em>/Pantone etc.</td>
</tr>
<tr>
<td>Value: 7</td>
<td>• Substrates: paper/fabric and differences between</td>
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<td>• Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
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<td></td>
<td>• Principles of calibration from computer screen to digitally printed textile</td>
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<tr>
<td>Value: 6</td>
<td>• Colorants used in digital textile printing: what they are and how they are used</td>
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<tr>
<td></td>
<td>• Principles of colour management: colour gamuts/ device profiles</td>
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<tr>
<td>Value: 5</td>
<td>• Principles of colour technology: additive/ subtractive/partitive colour mixing and how this impacts on digital textile printing</td>
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<td></td>
<td>• Calibrating the University’s digital textile printer</td>
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<tr>
<td>Value: 4</td>
<td>• How a digital textile printer works</td>
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<td></td>
<td>• The importance of sampling</td>
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<tr>
<td>Value: 3</td>
<td>• The evolution of digital textile printing: how it developed from paper printing technology</td>
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<td></td>
<td>• Innovations in digital textile printing technology</td>
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<td></td>
<td>• How digital textile print is being used by fashion/interiors designers and companies</td>
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</table>

Figure 62: Elements of teaching content in descending level of importance – student perspective
Following the rating exercise the group discussed the results. The moderator selected topics where there was a clear difference of opinion in order to encourage a natural discussion (see section 5.10). The topics chosen for further discussion were:

- principles of colour technology;
- substrates: paper/fabric and the differences between;
- principles of calibration from computer screen to digitally printed textile.

From the discussion it emerged that some of the students were unclear as to the meaning of ‘colour technology’, indicating a lack of understanding that the students recognised and felt needed to be addressed:

I wasn’t quite sure what you were getting at and if it was to do with communicating the RGB that kind of thing, then I think it’s essential.

I went for ‘essential’, because I have had problems with this in this project for that reason because some of my documents are in RGB and obviously they’re printing out differently and it’s creating problems that really I should have been more aware of, I think.

The group also felt that they should be better informed about how different fabric substrates can change the colour output of a digital print:

I had no idea that printing out onto cotton drill, silk, cotton madras, cotton poplin, and all the different fabrics that I’ve tried my prints on were going to all come out completely different, and had I been told that beforehand and been told, well generally silks come out darker, or cottons come out brighter or whatever then I would’ve adjusted the design that I knew was going on to specific substrates to make it so that they were all more comparable because I got some really different results coming from the different substrates.

The students felt it was not important for them to know how to calibrate a digital textile printer themselves, but they felt they should have an understanding of the process:

It would be really useful to be able to know how to do it, but, generally speaking, in industry you would have a technician who would do it for you. So if you understood that’s wrong, you would then call someone up and say can you come and sort out the calibration. So although an understanding of it is good, you don’t need an in-depth understanding.

6.6.3 Students’ perspective: delivery methods

In the second activity, the students were asked to review the list of elements again, but this time to give their opinions about the most effective teaching method for each topic. The students were given sets of stickers with a range of teaching methods to choose from: lecture; tutorial; practical demonstration; eLearning; laboratory class; workbook; individual project; group task. The ‘group task’ option was included after it was suggested as a delivery method in the group interview
with members of staff. The results from the second activity are shown in Table 8 below.

<table>
<thead>
<tr>
<th>Delivery method: First Choice = ● Second Choice = ○</th>
<th>Lecture</th>
<th>Tutorial</th>
<th>Practical demo</th>
<th>eLearning</th>
<th>Lab class</th>
<th>Workbook</th>
<th>Individual project</th>
<th>Group task</th>
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<tr>
<td>Colorants used in digital textile printing: what they are and how they are used</td>
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<td>Substrates: paper/fabric and differences between</td>
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<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
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<td>The evolution of digital textile printing: how it developed from paper printing technology</td>
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<td>How a digital textile printer works</td>
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<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
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<td>The benefits and limitations of digital textile printing</td>
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<td>Digital textile print methods for different applications and substrates: direct/ sublimation methods</td>
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<td>Innovations in digital textile printing technology</td>
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<td>How digital textile print is being used by fashion/interior designers and companies</td>
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<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing and how this impacts on digital textile printing</td>
<td>● ● ●</td>
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<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
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<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L^a^b^*^/Pantone etc.</td>
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<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td>● ●</td>
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<td>● ○</td>
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<td></td>
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<tr>
<td>Calibrating the University’s digital textile printer</td>
<td>● ●</td>
<td>● ● ●</td>
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Table 8: Rating exercise for methods of delivering teaching content – students’ perspective

Following completion of the second activity to rate teaching methods, the moderator opened a discussion of the results. It was clear from the results that ‘eLearning’ was not a teaching method favoured by the students, as there were only
two votes for it across the whole of the list. In the discussion following the rating task, some of the students gave the following reasons for their dislike of eLearning as a method of delivering teaching content:

- It isn’t good – because I think we’re quite an inquisitive group and we like to ask a lot of questions and you can’t ask a question to the computer.

- Don’t like it – hate it!

- You just think, well I’m here for you to teach me, not to sit at home and look at it on a computer. I can find anything on a computer if I want to but I’ve paid for you to teach me, that’s my opinion, sorry.

None of the students chose ‘workbook’ as a teaching method for any of the elements.

Most people in the ranking task chose ‘lecture’ as the most effective teaching method for the evolution of digital textile printing; in the discussion afterwards, the students explained that they would prefer a combined approach of lecture plus practical tasks to reinforce their learning:

- I think smaller tutorials that are short where people are paying attention and they’re listening to half an hour and maybe then you go off and do a group task, but going for a full-on talk, an hour to a two hour lecture is too much.

- I think that’s the kind of thing that would be really dry if it was delivered in a lecture.

- I’d rather have a lecture on that for 2 hours and spend 10 hours in lab classes sampling and practical if that’s how they were going to break it down.

The students’ comments also indicate different learning environments preferred by individuals with different styles of learning, their choice of a lecture plus a practical exercise caters for a range of learning styles. The students’ preference for a mixed delivery method aligns with the findings from research carried out by Sayer and Studd, discussed in section 4.4; textile design as a discipline combines elements from both the sciences and the arts. This combination requires that learning styles associated with both areas are catered for; for example, a learning activity associated with a science subject is a lecture, while a learning activity associated with the arts is a practical workshop (see 4.5). By indicating their preference for a blended teaching approach, students were also choosing the method that would result in deep learning (see 4.1). By linking theory from a lecture to a real life, problem solving situation in a workshop activity, students are more likely to retain information for the future. This acquisition and retention of knowledge for application in future problem solving was commented on by the students,

- I think employers would expect you to come out of a BSc with enough knowledge that you could pick up when there was a problem and you would
The group felt that a practical exercise would be the most effective way for them to learn about sampling as they could see the results for themselves first-hand; they considered either a laboratory class or a group task to be appropriate. The students felt it was important to sample their prints on different substrates, not only to gain a greater understanding of the colour output, but also in terms of how much potential waste is generated through having to re-do prints. They commented:

I think because it’s not something that you’re taught to do you could just go in there with enormous prints and print them all out and think ‘oh my god they’re all wrong, I’m going to have to do them all again’, and it is a waste because there’s no guidelines in terms of ‘you need to take this time to sample them, and they need to be this size’, do you know what I mean? It’s just something that we’re not really taught about at all.

I think if we had a greater understanding of all these things in the first place though there wouldn’t be as much waste anyway.

The students commented that problems they had encountered with colour management in digital textile printing were due to a lack of understanding of the process and the variables involved:

...and when it doesn’t come out like you expect you don’t know why, you can’t then go and rectify it because you don’t know why, you just know that it’s wrong and then you go and experiment a little bit more, to maybe get another wrong one...

It takes ten times longer if you don’t really know what you’re doing, when you get it back to try and put it right, you then think you’ve put it right give it back and it’s wrong again and it’s so long winded.

The students generally felt that they should have an understanding of colour management throughout the digital textile printing process, from designing on computer to printing and finishing the final fabric, their comments about this included:

If somebody said to you ‘explain digital printing’ you’d be like, ‘well I give my design to a nice man and then he gives me this back.’ You need to know all the ‘in-between’ – I think it’s really important to know that.

They wanted to be confident when using it during the degree programme, but also felt it could be important for them going forward into a career in textiles:

In terms of it being a developing technology and it’s going to keep going and keep going - personally I actually at this stage I feel at a disadvantage, because I don’t think we’ve covered enough about it actually.

The group agreed that a basic knowledge of the principles and processes involved would be sufficient to equip them with the skills they needed. They also felt that they needed to know this information in the first year of the degree programme:

I think the thing is there are key things that you could go into, I think there are key things that need to be signposted, like it's very important to sample,
get sampling done early, fabrics produce different results, make sure you experiment with this, just fairly brief and concise guidelines that could be provided, because I didn’t have a clue about that until this year and even just being told that - it would be different - then you investigate it for yourself and you find out the result.

The students suggested incorporating more practical sessions about colour management in digital textile printing into the programme, possibly alongside, or instead of, sessions on screen printing. The students’ opinions on these points align with the opinions given by staff on the same subjects (see section 6.4).

6.7 Industry perspectives

The list of elements relating to digital textile printing used in the group interviews with both staff and students from the BSc programme provided the basis for the design of a questionnaire sent to a purposive sample of 20 industry professionals (see section 5.13). The sample included graduates from the BSc programme who had followed careers relating to digital textile printing. From this sample, 11 questionnaires were completed and returned.

6.7.1 Industry perspectives: teaching content

Participants were asked to give their opinion on the importance of each element in terms of what should be included in the teaching content of an undergraduate textile degree programme, and to rate the importance of each element on a scale of 1-5. The results from the questionnaire are shown in Table 9 (page 146). The completed questionnaires including all comments can be found in Appendix A, page 189. In order to interpret the data gathered from the rating exercise a numerical value has been allocated to each response. For each of the individual elements in the rating exercise, a total score has been calculated based on the number of times it was rated on the scale of 1 -5, with ‘1’ being ‘very important’, and ‘5’ being ‘unimportant’. The numerical value for each response is: 1 = 5; 2 = 4; 3 = 3; 4 = 2; 5 = 1.

The maximum rating value a topic could achieve was 55. For example, ‘the importance of sampling’ was rated as ‘very important’ by all 11 participants, giving it a total value of 11 x 5 = 55. From these calculations, the data can be interpreted on the basis of what participants perceived to be the most important topics that should be included in teaching content. To add further detail to the interpretation of the data, topics from the rating task have been grouped together according to whether the teaching content is technical, theoretical or relates to the application of digital print technologies. Figure 63 on page 147 shows a diagram of the results of the rating exercise with industry, with elements of teaching content in descending level of importance.
<table>
<thead>
<tr>
<th>Teaching content: technical</th>
<th>Maximum Value = 55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrates: paper/fabric and differences between</td>
<td>52</td>
</tr>
<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
<td>50</td>
</tr>
<tr>
<td>Colorants used in digital textile printing: what they are &amp; how they are used</td>
<td>50</td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
<td>44</td>
</tr>
<tr>
<td>How a digital textile printer works</td>
<td>42</td>
</tr>
<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology</td>
<td>31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: theory</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>a</em>b*/Pantone etc.</td>
<td>52</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
<td>52</td>
</tr>
<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
<td>48</td>
</tr>
<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing &amp; how this impacts on digital textile printing</td>
<td>42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: application</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The benefits and limitations of digital textile printing</td>
<td>55</td>
</tr>
<tr>
<td>The importance of sampling</td>
<td>55</td>
</tr>
<tr>
<td>Digital textile print methods for different applications and substrates: direct/ sublimation methods</td>
<td>52</td>
</tr>
<tr>
<td>How digital textile print is being used by fashion/interior designers and companies</td>
<td>51</td>
</tr>
<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 9: Results of rating exercise for teaching content – industry perspective
In addition to the rating questions, participants were asked to suggest additional topics that should be included in the teaching content for digital textile printing, and to give any other comments they had on the subject. Additional topics suggested included:

- a grounding in using computer software to create textile designs;
- a stronger focus on computer aided design work to prepare students for work in industry;

**Figure 63: Elements of teaching content in descending level of importance - industry perspective**
• extensive experience should be gained on various computer software systems;
• students should become familiar with RIP software;
• different fabric substrates;
• environmental issues;
• commercial applications and production costs associated with digital textile printing and other printing methods;
• the challenges and opportunities in recent developments to the future of the textile printing market;
• speed and reliability of digital printing and its commercial implication for the industry; experience of the commercial world and its tolerances.

There were similarities between the list of additional topics suggested by industry participants and those suggested by educators who took part in the group interview (see section 6.4); for example,

- An element relating to costs and efficiencies of scale (this could relate to benefits/limitations). For example, why use digital?
- Potential pitfalls – printing, steaming, washing.
- Difference between small production runs and manufacturing.

Suggestions from industry participants for additional teaching content from their responses to the questionnaire have been collated together with the existing list of topics that has emerged during this study. Figure 64 on page 149 presents a diagram showing the augmented list of topics. Additional subjects have been incorporated according to whether the teaching content is technical, theoretical or relates to the application of digital print technologies (as in sections 6.3.2 and 6.6.1).

In common with the educators’ viewpoints given in section 6.4, the participants from industry also felt it was important for students to have knowledge of textile printing processes in a large scale production scenario:

- The understanding of conventional wet on wet production printing is essential as the designer/colourist needs to be aware of the reproducibility of the inkjet samples they are producing – whilst the technology is brilliant it does have flaws and doesn’t predict colour mixing and printing orders to exactly emulate the production print, so the operator needs to be able to identify the problems and resolve them.
<table>
<thead>
<tr>
<th>Teaching content: technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrates: paper/fabric and differences between</td>
</tr>
<tr>
<td>Innovations in digital textile printing technology</td>
</tr>
<tr>
<td>Colorants used in digital textile printing: what they are &amp; how they are used</td>
</tr>
<tr>
<td>Pre-printing and post-printing treatments of fabrics for digital print</td>
</tr>
<tr>
<td>How a digital textile printer works</td>
</tr>
<tr>
<td>The evolution of digital textile printing from paper printing technology</td>
</tr>
<tr>
<td>CAD: knowledge of the software used to create designs e.g. Photoshop</td>
</tr>
<tr>
<td>Digital image file formats e.g. TIFF, Jpeg.</td>
</tr>
<tr>
<td>Colour separation</td>
</tr>
<tr>
<td>Device profiling</td>
</tr>
<tr>
<td>Extensive experience on various computer software systems</td>
</tr>
<tr>
<td>Students should become familiar with RIP software</td>
</tr>
<tr>
<td>Additional content from industry participants</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicating colour: e.g. RGB/CMYK/CIE L<em>A</em>B*/Pantone etc.</td>
</tr>
<tr>
<td>Principles of colour management: colour gamuts/ device profiles</td>
</tr>
<tr>
<td>Principles of calibration from computer screen to digitally printed textile</td>
</tr>
<tr>
<td>Principles of colour technology: additive/ subtractive/partitive colour mixing &amp; how this impacts on digital textile printing</td>
</tr>
<tr>
<td>Understanding of how colour works in the printing process e.g. limitations, gamuts.</td>
</tr>
<tr>
<td>The printing process e.g. history of printed textiles &amp; how digital print has evolved</td>
</tr>
<tr>
<td>Environmental issues</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching content: application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different applications of digital print for different substrates: direct/ sublimation methods</td>
</tr>
<tr>
<td>How digital textile print is being used by fashion/interior designers and companies</td>
</tr>
<tr>
<td>The benefits and limitations of digital textile printing</td>
</tr>
<tr>
<td>Comparison of how colours are mixed in traditional printing methods with digital print</td>
</tr>
<tr>
<td>The importance of sampling</td>
</tr>
<tr>
<td>How digital print is being used in the textile printing industry</td>
</tr>
<tr>
<td>Comparisons between printing methods e.g. rotary screen printing &amp; digital textile printing</td>
</tr>
<tr>
<td>Costs associated with different print methods</td>
</tr>
<tr>
<td>Designing in repeat</td>
</tr>
<tr>
<td>Entrepreneurial opportunities for using digital textile printing</td>
</tr>
<tr>
<td>The challenges and opportunities in recent developments to the future of the textile printing market</td>
</tr>
<tr>
<td>Speed and reliability of digital printing and its commercial implication for the industry</td>
</tr>
<tr>
<td>Additional content from industry participants</td>
</tr>
</tbody>
</table>

Figure 64: Teaching content for digital textile printing with additional topics from industry participants

Additional comments from the questionnaires to industry included:
Digitalised textiles are a rapidly evolving world. Students need to be kept up to date with state-of-the-art inkjet printing technology and to be confident with computer aided design.

Graduates need to understand, be able to put into practice and promote the specific print process they are overseeing. It is important to be confident and to be able to sell the process/product to the customer.

One particular response referred directly to the participant’s experience of digital textile printing on the BSc programme

I think when I was learning the above topics on the BSc course we went into too much detail in terms of the science behind everything. I could answer questions about the in depth knowledge of fabric specification but if a fabric was presented to me I wouldn’t know what it was. I think I would have preferred to be given simple explanations first and then gone into more detail. I think practical lessons and experimenting would have helped me put into practice what I had learnt.

The participants from industry who were graduates from the BSc programme agreed to be interviewed to discuss their experiences of digital textile printing in more detail.

6.8 Graduates’ perspectives

Three of the respondents to the questionnaire sent to industry contacts were graduates of the BSc programme featured in this study. All three graduates agreed to be interviewed to discuss their experiences of digital textile printing in more detail. Dominique Mosely (see Figure 65) and Rosie Spencer (see Figures 66 and 67 on page 151) have their own businesses designing garments and accessories using digital print; while Aimee Clarke is a print designer for a high street retailer. The graduates provided valuable insights into their experiences of digital textile printing both during and after their undergraduate degree programme. The full interview transcripts can be found in Appendix C, page 276.
During the interviews, Clarke, Mosley and Spencer were asked to reflect upon their experiences as undergraduates on the BSc textile design programme. They were asked what key elements about colour in the digital print process she thought a textile design student should know. Responses to this question were:

Always sample, most importantly, if you can get away with doing as many samples to begin with as possible but on a really small scale, just enough so that you can see what your colours are going to come out like. I’d say that’s the most important thing.

Sampling was also considered to be a key element by educators and industry participants (see section 6.3.2; Table 4; section 6.6; Table 9). Mosley also thought
it was important for students to be given time to experiment with digital printing and other textile printing techniques during their degree programme:

Be really experimental when you’re on an undergraduate course, because you can be, and you don’t need to worry about whether or not people are going to buy it.

Having time for experimentation was also felt to be important by the educators who took part in the interview process (see sections 6.3.1 and 6.4). This point was reiterated by Spencer and Clarke,

There should be more time to experiment – as digital printing is developing so fast – new things are coming through all the time such as embellishing on to the surface of digitally printed textiles... Students need to be given time to try new things.

They need to be brave and take chances and be able to move quickly.

The graduates had differing opinions on the blending of science and art within the BSc programme; in her comments about the BSc programme, Mosley felt that the blend of art and science in the teaching content gave students a more rounded understanding of textile design

I guess the best thing that I found from the course, with it being a mix of design and more practical production related processes, you just didn’t feel in the dark and I think a lot of people categorise themselves as being ‘scientific’ or ‘creative’, and it’s not the case – you do need to be aware of both.

She went on to comment that having the knowledge of the technology relating to textile design gave her confidence

I think given that the course does give you a really broad skill set - if digital print is going to be a part of that, and if people are going to go into jobs where they’re using it a lot more, they’d be at such an advantage by having a really good understanding of the whole process.

On the other hand, Clarke felt that there could have been more of a balance between the technical and creative elements of the programme

The BSc programme sets students up really well for industry, though personally I would have liked more practical, more design work. The focus is on exams in first and second year, on the theory; students need to put the knowledge into practice.

These points link to earlier discussion in Chapter 4 relating to learning styles, learning environments, and the relationships to particular academic areas (see sections 4.4 and 4.5). Textile design as a discipline was noted as being particularly interesting as it combines both scientific and artistic elements (4.5). Creativity (the artistic element) is required to produce the initial textile design; the realisation of the design is made possible through the technology of the digital print process (the science element).

The digital printer in a textile design studio fulfils various functions: it is not just a
device for printing on to fabric; it is also a relatively recent technology with its full potential and applications still being explored. This was discussed in more detail in Chapter 2 (see section 2.17). This was commented on in the interviews with graduates, all of whom talked about the importance of textile design students keeping up to date with new developments; Clarke commented that students needed the time to experiment with combining digital textile printing with other techniques in order to push the boundaries; Spencer commented

> Most students definitely need to be encouraged to be a bit more innovative and yeah, just to explore, ’cause that’s what they’re going to have to do as soon as they start getting out into industry.

The accessibility of digital textile printing and opportunities for textile designers to start new business ventures using digital textile printing was commented on by Spencer

> You know what’s interesting, I’d say even in the last few weeks I’ve had a lot of people contact me from our course saying, ‘Oh, I’m starting up my own business now.’

In terms of colour management, Mosley felt it is important for students to understand colour management at each stage of the digital textile printing process, and how the variables involved can affect the final printed fabric. For example, how different fabric substrates may affect the colour output of a print (this is discussed in more detail in Chapter 3)

> …if an undergraduate has a specific idea of the type of fabrics that want to produce or the type of look that they want their designs to have I think they would be hugely influenced by seeing how their designs came out on different fabrics, so I think that’s hugely important.

Mosley also felt that having an understanding of colour management issues gives textile design degree programme graduates an advantage in a range of future careers; this includes having a good understanding of the software used to create designs. Students should be given information about colour management from the beginning of the course. Clarke and Spencer also emphasised the importance of students having a basic grounding in technical aspects of digital printing at the start of the textile degree programme

> …being able to layout a design on the RIP software would be very useful as well, to know about the different colorants and the different requirements for the substrates and applications. I mean, I think just a basic knowledge of everything.

Students should be introduced to the basics of digital print from first year – rather than in second year... Having a good knowledge of the software, of colour profiles, working with layers etc. is really important.
When asked if they felt that the BSc programme had prepared them for going into industry by giving them a general background knowledge of digital print, Spencer replied

Yes and no. I mean, I think, not so much as a hands-on approach. I’m not sure if it’s changed now, but when I was studying we only had one CAD session a week, and then we didn’t have any at all in our final year.

Clarke commented, “we didn’t really have a huge amount of experience on it.” Mosley felt it is important for students to have realistic expectations about working with digital print to enable them to use it effectively; this includes the restrictions, constraints and cost implications of commercial textile design and print

...I think they should be mindful of all the things that can affect the difference from the initial image because you can end up feeling really disappointed, or, more importantly, just not understand why it’s turned out the way it has. So if you’re informed about all of the variables that can help you.

Throughout the interviews, the graduates emphasised the importance of not overlooking what might appear to be basic or obvious facts about the digital textile print process; their comments about this included

Practice would help students to understand the processes more – at times the teaching content goes into too much detail before students have understood the simple things – they’re almost scared to say anything. The subject should be put into perspective to give a basic understanding first, for example, understanding that printing onto different types of paper gives different results.

Definitely get back to basics. I think that’s the thing with the BSc, we have so many lectures as well, there can be so much information it is easy to forget the little things.

I think I would have preferred to be given simple explanations first and then gone into more detail. I think practical lessons and experimenting would have helped me put into practise what I had learnt

The comments from the graduates supported earlier comments from interviews with educators (see 6.3.1) who also felt it was important for teaching content to start with simple basics before moving on to more complex areas.

Having this input from BSc graduates who now work specifically with digital textile print in a commercial application was invaluable; the graduates’ views were in common with the views expressed by both students, staff, and the other industry professionals who participated in the study.
6.9 Discussion

As reported previously, each of the three stakeholder groups who participated in the study (educators, students and industry) reviewed the same list of topics relating to potential teaching content for digital textile printing and were asked to rate the importance of each element (see section 5.10.1). For comparison purposes, the results from the rating exercises with each stakeholder group are shown in Figures 68, 69 and 70. The data has been converted to percentages to ensure compatibility, and then presented in bar chart format to illustrate visually the differences between the constituencies’ opinions; the charts should not be viewed as having any statistical validity. The topics have been grouped into technical, theory and application subject areas, as discussed in section 6.5.

6.9.1 Technical

![Teaching Content: Technical](image)

Figure 68: comparison of the perceived value of teaching content as prioritised by educators, students and industry.

Figure 68 above illustrates comparisons between the perceived values each group of respondents attached to topics relating to technical aspects of digital textile printing. In comparison to the student and educator perspectives, it can be seen that industry respondents attached higher values than the other groups to every given topic. This indicates the high expectations of industry that every aspect is of high importance and should be included in the teaching content. The educators’ perspective indicates a more pragmatic approach, with more differentiation between the relative importance of the topics. Educators prioritised information on different substrates, colorants used in textile printing and innovations in digital
printing technology as being the most important technical information to deliver to students. The student perspective does not clearly align with either educators or industry perspectives; for pre and post treatment of fabrics the student views align with industry, but for how a digital printer works and the evolution of digital textile printing, the students’ views are more aligned to those of educators. Perhaps this could be attributed to the students’ incomplete knowledge or inexperience.

6.9.2 Theory

![Figure 69: comparison of the perceived value of teaching content as prioritised by educators, students and industry.](image)

Figure 69 above illustrates comparisons between the perceived values each group of respondents attached to topics relating to theoretical aspects of digital textile printing. As in the previous chart for technical content, the industry perspective places a higher value on every given topic than the educators and students. Educators prioritise topics, ranking communicating colour and principles of colour management as the most important topics to deliver to students. These two topics could be said to be the most important as they deliver a basic knowledge on colour management, whereas principles of calibration and principles of colour technology could be said to go into the subject in more depth, and, therefore, be less crucial. The educators’ perceived value of communicating colour and principles of colour management align with the views of students, indicating that students also view these topics as priority.
6.9.3 Application

Figure 70: comparison of the perceived value of teaching content as prioritised by educators, students and industry.

Figure 70 above illustrates comparisons between the perceived values each group of respondents attached to topics relating to applied aspects of digital textile printing. As in the previous charts, the industry perspective rates each given subject as being of a higher value than the educators or students, with the exception of the benefits and limitations of digital textile printing and the importance of sampling. For these topics, both educators and industry rate them as having a high value. The student perspective on the value of the importance of sampling is markedly lower than educators and industry; perhaps this is because of the educators and industry respondents having more experience of digital textile printing and, therefore, a greater understanding of the importance of sampling to colour in the final printed output. A similar pattern can be seen when comparing the students’ perceived value of how digital textile print is being used by designers to the views of educators and industry; this could be another instance of educators and industry attaching more value to this topic because of their experience. Alternatively, perhaps students feel that it is more important to focus on the work they themselves are producing rather than the work of others, as they are working towards achieving their degree.

6.9.4 Summary
Figures 68-70 indicate that industry responses show the least differentiation between the perceived values of topics, reflecting high expectations of what should
be included in teaching content. Students’ and educators’ responses show more differentiation in the perceived values attached to topics. Overall, the student and educator responses are fairly matched, although there are discrepancies; student and educator opinions differ on the value of certain topics, for example, the importance of sampling, how digital print is being used by designers and innovations in printing technology are considered to have a much higher value to both educators and industry than to students. On the other hand, pre and post treatment of fabrics, principles of calibration and principles of colour technology are considered to be more important by students and industry than educators.

Comparing the viewpoints from the three groups in this way creates a foundation from which the central research questions of the study (see section 1.3) can begin to be addressed. Table 4 and Table 7 present the results of the rating exercise from the group interviews with educators and students (see section 6.3.3, 6.5.3), where participants were asked to suggest what they felt were the most appropriate methods of delivery for teaching and learning content relating to digital textile printing and colour management.

By comparing the opinions of all the participants in the study (educators, students and industry) an outline structure for teaching content relating to digital textile printing for undergraduate students was created. One outcome of the group interview with educators (see section 6.3.2) was the generation of a list of teaching content and the chronological organisation of topics in each year of the degree programme. Additional topics suggested by participants in the study were added to the overall list of teaching content as they emerged from the data gathering stages. Figures 73, 74 and 75 (pages 164-166) illustrate the complete series of topics that emerged from the study, arranged chronologically in years one, two and three of a textile design programme. The topics are grouped together according to topics relating to technical, theoretical, or application of aspects of digital textile printing technologies. Delivery methods included in the illustration are appropriate for encouraging deep learning, and also relate to the preferred learning styles of design students as discussed in Chapter 4.

These points directly relate to two of the research outcomes of the study (see section 1.4), namely, to identify and compare the most relevant issues relating to colour accuracy and colour management in digital textile printing for undergraduate textile design students, educators and industry and to develop a teaching model that can be used by educators to improve students’ knowledge and understanding of all aspects of colour in the digital textile print process.
6.10 The teaching model

The teaching model, shown in Figures 73-75 on pages 164-166, illustrates teaching content for every stage of the process from creating a design to finishing a digitally printed fabric. The outline structure also places digital textile printing in a wider context by looking at a range of textile printing processes and how digital print might be combined with other methods, how professional designers are using digital print, environmental issues, commercial applications, and production costs associated with digital textile printing and other printing methods.

The discipline of textile design promotes and enhances an aptitude for both science and art in its students, and therefore combines teaching and learning styles associated with both these academic areas (see section 4.5). The importance of this blending of art and science is supported by the interview data gathered in the study from both educators and students. The research findings show that it would be most advantageous for students to receive information about colour management at the start of the degree programme in order to enable them to work more effectively with the CAD-to-digitally-printed-textile process. The potential methods of delivery shown in Figures 73, 74, and 75, reflect the research findings, namely that the interview data gathered from primary research indicates that a combination of delivery methods is preferred to reinforce knowledge and lead to deeper understanding. In Figure 73 for example, principles of colour management is indicated as being delivered by a lecture plus a workshop, to accommodate the preferred learning modes of convergent and divergent learners (see section 4.3). As the convergent and divergent learning styles are particularly relevant for design students (Sayer and Studd, 2006) this blended approach to content delivery encourages deep learning by putting the theory from the lecture into practice.

6.10.1 Year 1

In the first year of the programme, the teaching content relating to technical aspects of digital textile print includes an introduction to the software programs used to create textile designs, for example, Adobe Photoshop. The introduction to the software would incorporate an overview of the various file formats used in CAD, for example, TIFF, Jpeg. The technical content would be delivered in a CAD workshop providing both concrete experience and active experimentation; The concrete experience learning mode is favoured by students with a divergent learning style, providing “practical exercises” (Richmond and Cummings, 2005:48) in an affective learning environment (see 4.5). The active experimentation learning mode is favoured by students with convergent learning style, and involves “actively applying knowledge or skills to a practical problem” (Richmond and Cummings, 2005:48) in a behavioural learning environment. Other topics relating to technical
aspects include colorants used in textile printing, and pre-printing and post-printing treatments of fabrics for digital print. Both of these topics could be delivered in a demonstration to students; demonstrations provide concrete experiences and are favoured by divergent learners as discussed previously.

The theoretical content if the first year comprises an overview of the history of printed textiles and how digital print has evolved within this history; it also includes information on the environmental impact of textile print processes. These two topics would be delivered by lectures to students. Lectures are favoured by students with a convergent learning style, providing abstract conceptualisation within the symbolic learning environment; in this scenario “information is abstract” (Richmond and Cummings, 2005:48). Theoretical content also includes an introduction to the principles of colour management, which would be delivered to the students in a demonstration, giving students a concrete experience and favoured by divergent learners.

The teaching content relating to the application of digital textile printing would include information about the benefits and limitations of digital textile printing. This content would be delivered in lecture format, in the abstract conceptualisation learning mode favoured by students with a convergent learning style. Other topics relating to the application of print would be delivered either by a demonstration or in a workshop. Information about the impact different substrates have on colour in the final printed output and an introduction to different textile printing methods would be delivered through workshops. In this scenario, the students have both concrete experiences and active experimentation, favoured by both convergent and divergent learners. Information about different applications of digital print for different substrates, and a comparison of how colours are mixed in traditional printing methods with colours for digital print could be delivered by demonstrations to the students, providing concrete experiences favoured by divergent learners. An alternative delivery method for how colours are mixed in different textile printing processes would be a laboratory class, which is an active experimentation learning mode favoured by convergent learners.

6.10.2 Year 2
In year two of the programme, teaching content relating to technical aspects of digital textile print include an overview of how a digital textile printer works, and information about colour separation and device profiling. This content would be delivered to the students via demonstrations, giving concrete experiences favoured by divergent learners. A CAD workshop would be used for the delivery of more in-depth information about software programs used to develop designs for digital
print, and using these programs to create designs in repeat. The CAD workshop provides both concrete experiences and active experimentation for students, as previously discussed, which are favoured by both divergent and convergent learners.

Theoretical content in the second year includes an introduction to colour communication. This content would be delivered in a lecture plus a workshop, to reinforce learning. The lecture format is an abstract conceptualisation learning mode in the symbolic learning environment favoured by convergent learners, while the workshop provides both convergent and divergent learners with concrete experiences and time for active experimentation. Information about the principles of colour calibration from computer screen to digitally printed textiles would be delivered to the students in a demonstration, providing concrete experiences favoured by divergent learners.

Teaching content relating to the application of digital textile print includes making comparisons between textile printing methods (for example, rotary screen rotary printing and digital printing), considering the challenges and opportunities in recent developments to the future of the textile printing market, and looking at the speed and reliability of digital printing and its commercial implication for the industry. Content would also include considering how CAD is being used in industry to develop designs for digital print. All of this content could be delivered via a field trip to an industrial textile print facility, with an accompanying guided tour and commentary. This would provide a concrete experience in an affective learning environment for students, favoured by students with divergent learning styles. Other topics relating to the application of digital print include entrepreneurial opportunities for using digital textile printing, and business contexts for using digital print (how it is being used by designers; how it is used in the textile printing industry). Both of these topics could be delivered to students through talks from a visiting textile designer and/or a visiting commercial textile printer. Talks from experts provide a reflective observation learning mode in the perceptual learning environment, favoured by students with a divergent learning style. An experimental workshop would be the delivery method for post-printing treatments, embellishments and special effects. The workshop scenario provides concrete experiences and also allows time for active experimentation, favoured by both divergent and convergent learners.
6.10.3 Year 3
In the final year of the programme, technical content includes information about innovations in digital textile printing technology, what advances have been made in techniques and equipment. This content could be delivered by a lecture followed by a talk from a visiting industry expert. The lecture format is an abstract conceptualisation learning mode in the symbolic learning environment, favoured by students with a convergent learning style; the talk by a visiting expert is a reflective observation learning mode in the perceptual learning environment favoured by divergent learners.

In the final year, teaching content relating to theory includes information on environmental issues connected to textile printing, and also planning of the printing process. Both of these topics would be delivered in lecture format. The lecture format is an abstract conceptualisation learning mode favoured by students with a convergent learning style, as previously discussed.

Content relating to application includes business contexts for using digital print, and how digital textile print is being used by fashion and/or interior designers and companies. For up-to-date commentary and to give the students the most current information as they prepare for graduation, these topics could be delivered by a lecture followed by a talk by a textile designer or a commercial printer. The lecture format is an abstract conceptualisation learning mode favoured by convergent learners, while the talk from an expert is a reflective observation learning mode favoured by divergent learners.

6.10.4 Summary
An analysis of the learning styles and learning modes for each level of the programme shows that in Year 1 the key learning style is equal between convergent and divergent; the key learning mode is concrete experience. In year 2, the key learning style is divergent and the key learning mode is concrete experience. In the final year of the programme, the key learning style is convergent and the key learning mode is abstract conceptualisation. Perhaps this can be accounted for by the greater emphasis in the final year of the programme on self-directed and self-generated projects as the student specialises in their chosen strand of textile design, with less emphasis on more generalised taught elements.

Chapter 4 reviewed learning and teaching styles and found that the textile design student’s preferred learning style is a combination of divergent and convergent, combining learning styles associated with both the arts and science because of the creative and technical nature of the discipline (Adams et al., 2013; Igoe, 2010;
Leak, 1998). This is discussed in more detail in 4.5 and illustrated in Figure 42. Figure 71 illustrates the key learning styles across all levels of the teaching model; as a ratio of divergent to convergent learning styles in each of the three years of the proposed programme. Similarly, Figure 72 illustrates the key learning modes in teaching model as the ratio of Abstract Conceptualisation to Active Experimentation to Concrete Experience to Reflective Observation across the three levels.

Figure 71: Key learning styles for each level of the proposed programme

Figure 72: Key learning modes for each level of the proposed programme
LEARNING STYLES:

CONVERGING

DIVERGING

LEARNING MODES:

Active experimentation
Concrete experiences
Abstract conceptualisation

TEACHING CONTENT: TECHNICAL

- CAD: Introduction to software used to create textile designs e.g. Photoshop
- Introduction to digital image file formats e.g. TIFF, Jpeg.
- Colorants used in digital textile printing: what they are & how they are used
- Pre-printing and post-printing treatments of fabrics for digital print

TEACHING CONTENT: THEORY

- The printing process: history of printed textiles & how digital print has evolved
- The environmental impact of textile print processes
- Principles of colour management

TEACHING CONTENT: APPLICATION

- The benefits and limitations of digital textile printing
- Substrates: paper/fabric and differences between
- Different applications of digital print for different substrates: e.g. direct/sublimation
- Introduction to textile printing methods: digital, silk-screen etc.
- Comparison of how colours are mixed in traditional printing methods with digital print

Figure 73: Teaching model: first year of textile design programme (by the author).
LEARNING STYLES:

DIVERGING

CONVERGING

LEARNING MODES:

Reflective observation
Active experimentation
Concrete experiences
Abstract conceptualisation

CAD workshop
Lab Class; Demonstration; Workshop
Lecture; Lab Class; Demonstration; Workshop
Lecture; Demonstration; Workshop

TEACHING CONTENT: TECHNICAL

- How a digital printer works: overview of process
- Colour separation
- Device profiling
- CAD: in-depth knowledge of software programs to develop designs for digital print, e.g. Photoshop, Illustrator, AWA
- Designing in repeat

TEACHING CONTENT: THEORY

- The printing process: history of printed textiles & how digital print has evolved
- The environmental impact of textile print processes
- Introduction to colour communication: e.g. RGB/CMYK/CIE L* A* B*/Pantone
- Principles of calibration from computer screen to digitally printed textile

TEACHING CONTENT: APPLICATION

- Comparisons between printing methods e.g. rotary screen printing & digital textile printing
- The challenges and opportunities in recent developments to the future of the textile printing market
- Speed and reliability of digital printing and its commercial implication for the industry
- Industry use of CAD to develop designs for digital print
- Entrepreneurial opportunities for using digital textile printing
- Business contexts for using digital print: how it is used by designers; how it is used in textile printing industry

Figure 74: Teaching model: second year of textile design programme (by the author).
LEARNING STYLES: CONVERGING DIVERGING

LEARNING MODES: Reflective observation Abstract conceptualisation

TEACHING CONTENT: APPLICATION
- How digital textile print is being used by fashion/interior designers and companies
- Business contexts for using digital print

TEACHING CONTENT: TECHNICAL
- Innovations in digital textile printing technology: advances in techniques & equipment

TEACHING CONTENT: THEORY
- Environmental issues and solutions
- Planning: when to print, how to print

Lecture; Talk by visiting textile designer; Talk by industry professional

Lecture

Lecture; Talk by visiting textile designer; Talk by industry professional

Figure 75: Teaching model: final year of textile design programme (by the author).
6.11 Chapter summary

The aim of the data collection stage was to gather the opinions of students, educators and industry professionals. This data directly relates to the core aim of the study (see section 1.2), which is to establish the issues related to colour management in digital textile printing experienced by educators, students and industry, and propose a teaching model to address these issues in HE.

Data gathered from interviews with educators and students addressed a number of the study’s objectives (see section 1.2). Students expressed their opinions on what they felt the most important content was and their preferred delivery methods (6.3). Educators expressed their views on what teaching content they considered should be included and what they felt would be the most appropriate methods of delivery (6.4). These views aligned with the work done in Chapter 4 on learning and teaching styles. Participants from industry also contributed by expressing their views on what they perceived to be the most important topics to be included in teaching content for digital textile printing 6.7); the industry respondents also included graduates from the BSc programme who participated in interviews as well as completing questionnaires (6.8).

The same set of topics relating to teaching content for digital textile printing was used to construct rating exercises for group interviews with educators and students, and for the questionnaires to industry professionals. These enabled comparisons to be drawn between responses from the different groups who participated in the study (6.9, 6.9.1, 6.9.3, 6.9.4). The data gathered from all three stakeholder groups (educators, students and industry) informed the design of a proposed teaching model for digital textile printing over a three year degree programme (6.10). Each year of the proposed programme was discussed in detail, showing how the teaching content and delivery methods use different learning environments to encourage deep learning and reinforce understanding by accommodating different learning styles (see sections 6.10.1-6.10.4).

The primary research data contributes to the intended research outcomes for the study, which are to identify and compare the most relevant issues relating to colour accuracy and colour management in digital textile printing for undergraduate textile design students, educators and industry, and to develop a teaching model that can be used by educators to improve students’ knowledge and understanding of all aspects of colour in the digital textile print process, and therefore better equip them to work more productively with digital textile printing. The next chapter concludes
the study by summarising the research findings, their implications and limitations, and by discussing suggestions for further research.
Chapter 7
Conclusions

7.0 Introduction
In this chapter, the results of the study are summarised and reviewed in relation to the original research aims and objectives. The research outcomes are presented, and the implications and limitations of the research findings are discussed. The study concludes with suggestions for further research.

As digital textile printing has been identified as a growth area in the manufacture of textiles (Bowles and Isaac, 2009) it is highly relevant for textile design students going into all areas of the textiles and fashion industry to have an understanding of the key issues regarding colour. This view was endorsed by educators, students and industry participants in the study. The central research questions identified in Chapter 1 (see section 1.3) are below.

- How is colour management in digital textile printing experienced by students and educators on undergraduate degree programmes?
- What are industry expectations of graduates' understanding of digital print technology and colour management?
- Can an effective model be developed to optimise teaching of colour accuracy and colour management of digital textile printing within undergraduate textile design programmes?

7.1 Research aims and objectives
The primary aim of the study was to establish what issues related to colour management in digital textile printing are experienced by educators, students and industry, and to propose a teaching model to address these issues in HE. In order to achieve this aim, the main objectives of this study were as follows.

1. To determine the context and significance of digital textile printing with regard to its history, colour management, basic colour theory and colour communication.
2. To review aspects of learning and teaching styles specific to design education.
3. To determine the current status of colour management in digital printing in the textile industry.
4. To identify what colour management issues exist for undergraduate textile design students and educators working with digital textile print.
7.1.1 How the objectives were met

The objectives were met by carrying out contextual reviews of secondary data and by gathering primary data via questionnaires to, and interviews with, students and educators at HE institutions and industry professionals.

**Objective 1: To determine the context and significance of digital textile printing with regard to its history, colour management, basic colour theory and colour communication.**

This objective was met by carrying out research into the development of textile printing from the earliest patterning by dyeing and block printing to the current state of digital printing worldwide. An outcome was a timeline of some of the key dates in the history of printed textiles (see Figure 2 on page 26). A review of the literature available was undertaken to determine the current colour management options available (see sections 3.4, 3.6). The review highlighted the intricacies of colour management and the difficulties involved with trying to achieve continuity of colour in digital print. It was found that there was a significant amount of information and technical support for industry regarding colour management. The growing importance of digital print within the textile industry is reflected in the number of journals, online resources and specialist trade fairs that exist; new events such as the European Digital Textile Conference held in January 2014 reflect the importance of digital technologies to the textile industry (see 1.1).

The expansion of digital technologies in the textile industry, the projected market growth of the sector, and the fast pace of development in digital techniques and processes, is reflected in the data gathered in the study. Educators and industry participants acknowledged the importance of digital print for the textile industry as an increasing area of growth. Graduates from the BSc programme interviewed for the study particularly noted the increase in entrepreneurial opportunities digital technologies offer. They stressed how important it is for textile design students to maximise those opportunities by being given time to experiment with innovative textile finishes and to be kept informed of new techniques and equipment that are available. All of these points directly informed the development of content for the teaching model.

**Objective 2: To review aspects of learning and teaching styles specific to design education.**

This objective was met by carrying out a review of literature relating to learning styles and teaching styles (see Chapter 4). The review focussed on the Myers-Briggs Type Indicator, Kolb’s experiential learning model, and Honey and Mumford’s
Learning Style Questionnaire (see sections 4.2, 4.3 and 4.4). Each of the learning style models was discussed with reference to the requirements of design students.

Kolb’s Experiential Learning Theory was found to have particular relevance for design education. Research carried out by Sayer and Studd (2006) found that the learning styles of textile design students relate to both Kolb’s convergent and divergent learning styles as the discipline comprises elements from both art and science. The blend of technical knowledge and creativity within the textile design discipline creates an environment for potential innovation and experimentation; the importance of this to the textile industry is acknowledged by Leak (1998) and Britt (2013).

The blend of arts and science within textile design requires combined delivery methods that incorporate both theoretical and practical activities, for example, lectures and workshops. The review discussed the relationship between learning styles and delivery methods and how this influences approaches to teaching content (see section 4.5). Analysis of the data gathered in the review, combined with the data from interviews with industry, educators and students, enabled the prioritising of learning styles and modes for each year of study. Order of priority was informed by data gathered from interviews and questionnaires.

**Objective 3: To determine the current status of colour management in digital printing in the textile industry.**

An abundance of information produced by the manufacturers of commercial digital textile printing machinery was found. This objective was met by documenting the current range of machinery available, the capabilities of these machines and how manufacturers and industrial users address colour management and colour matching issues. This is discussed in detail in Chapter 2. The key colour management issue is achieving and maintaining continuity of colour throughout the printing process. Methods used to address this issue include the use of commercial colour matching systems, such as Pantone, who produce colour guides, software packages and calibration equipment; alternatively, a completely integrated system such as Stork-U-See may be used, which requires that every individual element of the printing process (equipment, dyestuff, fabrics, software etc.) is supplied by Stork. Colour management is at the forefront of industrial applications of digital textile print.

In contrast to the colour management methods used in industry, methods used in the HE institutions featured in the study tend to be more *ad hoc*. This can be attributed to a number of reasons, for example, available budget for updating
equipment, and constraints on staff time. Nevertheless, in HE colour management is considered to be an essential subject for textile design students to have a fundamental knowledge of, to prepare them for their careers in the industry following graduation. The educators, students and industry stakeholders who participated in the study emphasised the need for colour management to be included in teaching content. The emphasis given to the importance of colour management in industry in conjunction with the views of the participants in the study directly informed the proposed teaching model discussed in detail in Chapter 6.

**Objective 4: To identify what colour management issues exist for undergraduate textile design students and educators working with digital textile print, in order to develop a strategy to address those issues via a teaching and learning model.**

This objective was met by collecting and analysing primary data gathered via questionnaires and interviews with participants from HE and industry. This data, along with the review of learning and teaching styles, informed the collation of topics for teaching content and delivery methods in respect of colour management for digital textile printing. This is discussed in detail in Chapters 4 and 6. A proposed teaching model was suggested that combines theoretical, technical and applied aspects of digital textile printing across the three years of an undergraduate textile design programme.

Figures 73, 74 and 75 on pages 164-166 present the proposed teaching model showing how the teaching content is delivered using a range of learning environments to support different learning styles.

**7.2 Summary of findings**

The findings from the primary research undertaken to answer the central questions and fully discussed in Chapter 6, are summarised below.

**Conclusions from questionnaires and visits to HE institutions**

The findings from the questionnaires and follow-up visits to HE institutions are given in sections 6.1, 6.2 and 6.3. From these findings the following conclusions were drawn. The student experience of working with colour in digital textile printing is broadly the same across different types of degree programmes; there are similarities between equipment, software, colorants and finishing processes used. There are different approaches across the programmes to teaching students about working with colour, however, the issues with colour encountered by students working with digital textile print are the same irrespective of the programme,
namely the many variables involved at every stage of the printing process that impact upon colour in the final printed output. These are also the same issues faced by commercial textile printers.

All textile design students require a good understanding of colour management issues to ensure successful outcomes. Because of the similarities in the student experience of working with digital textile print, the BSc programme included in the HE case studies was used as an exemplar, and was the focus of primary data gathered for the study.

Conclusions from the individual and group interviews with educators

The research findings from the interviews with educators are discussed in sections 6.4.1, 6.4.2, 6.4.3 and 6.5. From these findings the following conclusions were drawn. Interviewees felt it is important for students to have a good understanding of colour management issues throughout the whole of design process; they also felt that the programme should include more teaching content about working with all aspects of colour, including colour management, colour technology, and calibration of equipment. Teaching colour management issues is crucial and this should be done holistically to ensure the students see it as meaningful.

There was consensus of opinion between the educators and graduates interviewed as both groups thought that students’ introduction to digital printing should start from absolute basics; for example, the effect different paper and fabric substrates can have on colour in the final printed output. Having a grasp of the most fundamental information from the start will ensure that students are more prepared when they encounter colour management issues. Educators and graduates also agreed that students should have time to experiment, exploring the possibilities of combining digital print with other textile printing techniques to create innovative surface effects.

Conclusions from the individual and group interviews with students

The research findings from the individual and group student interviews are discussed in sections 6.6.1., 6.6.2 and 6.6.3. From these findings the following conclusions were drawn. In common with educators and graduates, students also felt that there should be greater emphasis on teaching colour management and that this should be introduced in the first year of the textile design programme. This would help them to understand why there are problems in replicating specific colours across a range of computer monitors and digital printers. Students also agreed that a basic knowledge of the technical principles and processes involved in colour management would be sufficient to prepare them for issues with colour they
might encounter; starting from the basics of how substrate choice can impact on printed colour output. In common with the educators and industry respondents, students felt that a grounding in using software programs used in textile design, most commonly Adobe Photoshop, is essential; in particular, how colours in a design viewed on a monitor screen can shift during the printing process. Students felt that there should be more time allocated for practical sessions working with digital print to allow time for experimentation.

**Conclusions from the questionnaire to industry**

The research findings from the questionnaire to industry are discussed in section 6.7. From these findings the following conclusions were reached. In comparison to the educators and students responses, the responses from industry reflected their high expectations of what should be included in teaching content. Figures 68-70 on pages 155-157 show a visual comparison between industry, educator and student perceptions of how topics were rated by each constituency. Industry responses showed the least differentiation between the perceived values of topics; they considered it important to include everything.

In common with the graduates interviewed, industry respondents felt that there should be more emphasis on CAD included in teaching content, to prepare students for going into industry. Both educators and industry respondents agreed that it is important for students to know about commercial applications and production costs associated with digital textile printing and other printing methods; a visit to a commercial print facility to see digital textile printing on a production scale would enable students to gain first-hand experience of industry applications.

**Conclusions from the interviews with graduates**

The research findings from the graduate interviews are given in 6.8. From these findings the following conclusions were reached. It is important not to overlook the importance of starting from the absolute basics when introducing digital print to students; emphasising the impact of the many variables involved at every stage of the print process on the colour in the final printed output is essential. Digital textile print is an area of fast-paced growth and innovation. In order to produce innovation in textile design, students should be given time to experiment with digital print and other printing techniques and effects; it is also important for students to be proficient in the use of appropriate and up-to-date software, as CAD is an integral part of the digital print process.

**7.3 The teaching model**

The conclusions drawn from the questionnaires and interviews with the three stakeholder constituencies who took part in the study (educators, students and
industry) informed the development of a teaching model for digital textile printing across different types of textile design programmes. Students from different textile design programmes will encounter the same issues when working with colour in digital textile print: for example, discrepancies in colour between designs viewed on a monitor screen and on the printed output; variations in colours on different substrates; shifts in colour intensity after the finishing process. Because the basic requirements to understanding colour management in digital textile printing remain constant, the proposed teaching model may be applied across different programmes. Figure 76 on page 176 shows an overview of the teaching content across a three year textile design programme model.

7.3.1 Learning styles and learning modes
The learning style preferences of design students were discussed in detail in Chapter 4. Textile design as a discipline was found to be particularly interesting as it combines both scientific and artistic elements, requiring a teaching approach that accommodates learning styles associated with both areas; the divergent learning style commonly associated with art and the convergent style commonly associated with science. This is reflected in the proposed teaching model, discussed in detail in Chapter 6 and illustrated as an overview in Figure 76. The model incorporates learning modes associated with both divergent and convergent learning style preferences. Practical activities that offer concrete experiences for the divergent learner (for example, practical workshops) are included in the model, along with activities that offer abstract conceptualisation for the convergent learner (such as the lecture format of content delivery).

7.3.2 Teaching content
In the first year of the programme, students are introduced to basic information about digital textile printing that will prepare them for the colour management issues they will inevitably encounter; for example, understanding that different paper and fabric substrates will produce variations in the colour of the final printed output, and a basic introduction to colour management. The teaching content in the second year of the programme builds on the knowledge gained in the first year and goes into more depth about colour management; for example, looking in more detail at colour communication, colour modes and calibration of equipment. The final year of the programme focusses on applications of digital textile print; for example, how fashion and interior designers are using digital print to create innovative surface pattern and textures on fabric; business opportunities for using digital textile print.
Figure 76: Overview of teaching content over 3-year textile design programme (by the author).

**Final Year**
- Engineering and special effects for printing technology
- Safety in the printed textile industry
- Historical developments of printing technology
- Overview of current digital printing processes

**Technical**
- Introduction to digital printing
- Overview of current digital printing processes

**Application**
- Introduction to colour management
- Evolutionary changes of colour in textiles
- Introduction to colour mixing in traditional and digital printing

**Theory**
- The environmental impact of textile printing
- Evolutionary changes of colour in textiles
- The history of digital textile printing
- Introduction to colour management

**1st Year**
- Introduction to textile design
- Introduction to textiles and printing
- Introduction to colour mixing in traditional and digital printing
- The environmental impact of textile printing
- The history of digital textile printing
- Introduction to colour management
7.4 Research outcomes

The intended research outcomes from this study (see section 1.4) were as follows.

- To identify and compare the most relevant issues relating to colour accuracy and colour management in digital textile printing for undergraduate textile design students, educators and industry.
- To develop a teaching model that can be used by educators to improve students’ knowledge and understanding of all aspects of colour in the digital textile print process, and therefore better equip them to work more productively with digital textile printing.

The first outcome to identify the most relevant issues relating to colour accuracy and colour management in digital textile printing for undergraduate textile design students was achieved during the data gathering stage of the study. Primary research identified a common set of elements relating to teaching content for digital textile printing. The list of elements (see section 5.10.2) was compiled as a result of information gathered during the initial stages of the study, from questionnaires and interviews with staff at HE institutions, and interviews with educators and students from a BSc programme in textile design. The primary data generated as a result of using these common criteria across different groups of participants enabled comparisons to be drawn between each of the sources. This led to a greater understanding of what were considered to be the key elements essential to the teaching of colour management in digital textile printing to undergraduates on textile design degree programmes.

The second outcome to define an effective strategy for teaching colour management of digital textile printing within undergraduate textile design programmes to optimise the teaching of this important developing technology has been mostly achieved. This has been done by comparing the opinions of all the participants in the study - educators, students and industry professionals - and using the findings to create an outline structure for teaching content relating to digital textile printing for undergraduate textile design students (see Figures 73, 74 and 75, pages 164-166). The potential methods of delivery shown in Figures 73-75 reflect the research findings, which demonstrated that the students interviewed preferred practical ‘learning by doing’ teaching methods to learn about processes, and lectures and group tasks to learn about background theory (see 6.6, and Table 8 on page 142).

The proposed teaching model encompasses every stage of the process - from creating a design to finishing a digitally printed fabric. The outline also places digital textile printing in a wider context by looking at a range of textile printing processes.
and how digital print might be combined with other methods, how professional designers are using digital print, environmental issues, commercial applications, and production costs associated with digital textile printing and other printing methods. The research findings show that it would be most advantageous for students to receive information about colour management at the start of the degree programme. This would enable them to work more effectively with the CAD-to-digitally-printed-textile process at an earlier stage.

7.4.1 Additional outcomes
Two lectures have been developed and delivered by the author as a consequence of this research to explicitly address some of these issues in her current practice. One lecture was on colour calibration issues in digital textile printing (see Appendix D, page 298), and one on contemporary designers that are using digital print for interior design and fashion fabrics (see Appendix D, page 289). The lecture on colour calibration was a direct result of the research interview process, which identified a requirement for more information about colour issues in digital textile printing. The content of this lecture included information on the different colour modes encountered when designing a print for textile on computer, and then printing the design onto a textile. This was intended to give the students an awareness of some of the variables involved in the printing process, to enable them to be more informed in their own design work.

While a lecture on contemporary designers using digital textile printing had been delivered by the author prior to this research being undertaken, as a direct result of the research undertaken, the content was revised and improved. The content included examples of contemporary designers using digital textile print in their collections, illustrating the many and varied applications of digital print that are being used in contemporary design.

Feedback from students following the delivery of the lectures was positive with students indicating that the information gave them a more in-depth understanding of the colour management issues in digital textile printing. Students commented that the lectures had an immediate effect on their own practice.

A journal article was written, entitled, ‘What You See Is Not (Always) What You Get: Colour Accuracy in Digitally Printed Textiles.’ The article was accepted following peer review. It was published in Volume 9 of the Journal of the International Colour Association, in October 2012. The journal article can be found in Appendix E, page 305.
7.5 Research limitations
Data gathered from the primary research came from relatively small, localised samples. Because of this, the study has not amassed the kind of data that enables the research findings to be subject to full statistical analysis. While this could be viewed as a limitation, this is a qualitative study of relatively small populations of interest, and, as such, the purpose of the primary data collection was not to generate statistics per se, but rather to gather information that would provide an understanding of the participants’ experiences and their opinions about digital textile printing in a HE environment. The study has generated rich, in-depth data about the participants’ personal experiences of digital textile printing, and has, therefore, been successful in that respect.

7.6 Research implications
While the study predominantly features data gathered from educators and students from the BSc programme, other degree programme structures (BA, BDes) are represented by information gathered by interviews with and questionnaires from, staff at other HE institutions. Other participants in the study who were working with digital textile print in industry provided an additional, objective perspective. Even though this was a qualitative study with small, purposive samples of participants, the research findings are clear and unambiguous and suggest a structure for the development of a learning resource about colour management and digital textile printing applicable to undergraduates in general. The research findings have identified that this learning resource should convey basic information that explains all of the variables involved in the digital textile printing process, from CAD to finished fabric. As such it would be relevant across a range of degree programme structures, not just design programmes.

7.7 Suggestions for further research
Time could be considered to be a factor that has limited the study. The primary data gathered came from the final year students on the BSc programme and was restricted to one cohort; with more time, students could have been interviewed periodically as they progressed through their degree programme and more than one academic year of students questioned. In this way, comparisons could have been drawn between different cohorts’ experiences of colour management in digital textile printing across the programme and over more than one academic year. The research could be widened to gather opinions from students from other textile design programmes and more designers working in industry.

The research findings could be developed further in a number of directions. Data has been generated giving insight into the student, educator, and industry
professional point of view. The research findings have been collated to create a potential framework for the delivery of digital textile printing on an undergraduate textile design programme. From this, further work could be done to develop a complete module, comprising lectures, practical sessions, demonstrations, and visits. Alternatively, the research findings could be developed into a digital textile printing study resource for both students and educators on the fundamentals required for understanding the digital textile printing process as a whole. The format for this study resource could either be a handbook, or an online resource, or a combination of both.

For researchers, the study may instigate further research into a number of areas. For example, the research findings indicate that equipment in digital textile print studios in HE commonly includes a variety of hardware, software, and consumables (see section 6.1.1). One possible avenue for further study would be to focus on the configuration of digital textile design studios in HE, carrying out a comprehensive survey to identify what issues are raised, and what potential resources and facilities could be developed to counteract any issues.

From an industry perspective, the research findings give an insight into which elements relating to colour management in digital textile printing are considered to be important for a textile design graduate to have an understanding of. This knowledge could be useful in developing course content and relationships with industry; visits to HE institutions by industry professionals and professional designers to give students information and insight about working with digital textile printing could be reciprocated by students visiting digital textile print design studios and industrial print facilities. With the purpose of these reciprocal visits targeted towards gaining a greater understanding of colour management in the digital textile printing process, this would be mutually beneficial to all parties.

The future of textile printing is digital, making it increasingly more relevant for textile design education. This initial analysis of how colour management is taught is a starting point for others to continue research. Innovations and developments in digital technologies are fast-paced and dynamic; therefore the proposed teaching model will have to be periodically reviewed to meet the ongoing requirements of industry.
References


CIE, International Commission on Illumination (2011) Advancing knowledge and


indicator in predicting academic major selection of undecided university students. ' Journal of Career Assessment. 16 (4), pp. 441-455


Appendix A: Questionnaires

Questionnaire to HE institutions

Digital Textile Printing Questionnaire

1. What make/s and model/s of digital textile printer/s do you have?
   Mimaki TX2

2. What make/model of steamer do you have?

3. What colorants do you use to print with?
   • Reactive dyes ☒
   • Pigments ☐
   • Acid dyes ☐
   • Other (please state)

4. Do you use:
   • Manufacturer’s sealed cartridges? ☒
   • Refillable cartridges? ☐
   • Bulk feed system? ☐

5. What software runs your printer?
   Smartprint

6. What software do you use for creating designs?
   Generally photoshop

7. Are your computers:
   • Apple Macs? ☐
   • PCs? ☒
   • Both? ☐

8. Which colour mode do you use when creating designs?
   • CMYK ☒
   • RGB ☐
   • LAB ☒
   • Other (please state)

9. On a scale of 1-5, how important is accurate colour reproduction to you?
   (1 = very important, 5 = unimportant)
   • 1. ☐
   • 2. ☒
   • 3. ☐
   • 4. ☐
   • 5. ☐

10. Do you have any issues with achieving accurate colour reproduction?
    • Yes ☒
    • No ☐

If 'yes', how do you deal with this?
   Sampling

11. Is your digital printing equipment calibrated on a regular basis?
    • Yes ☐
    • No ☒

If 'yes', how often is it calibrated?
   if 'yes', what method is used to calibrate?

12. Any other comments
Digital Textile Printing Questionnaire

1. What make/s and model/s of digital textile printer/s do you have?
   1600X

2. What make/model of steamer do you have?
   WILL INVESTIGATE

3. What colorants do you use to print with?
   • Reactive dyes ☒
   • Pigments ☐
   • Acid dyes ☐
   • Other (please state)

4. Do you use:
   • Manufacturer’s sealed cartridges? ☐
   • Refillable cartridges? ☒
   • Bulk feed system? ☐

5. What software runs your printer?

6. What software do you use for creating designs?
   ADOBE PHOTOSHOP

7. Are your computers:
   • Apple Macs? ☐
   • PCs? ☒
   • Both? ☐

8. Which colour mode do you use when creating designs?
   • CMYK ☐
   • RGB ☒
   • LAB ☐
   • Other (please state)

9. On a scale of 1-5, how important is accurate colour reproduction to you?
   (1 = very important, 5 = unimportant)
   • 1. ☒
   • 2. ☐
   • 3. ☐
   • 4. ☐
   • 5. ☐

10. Do you have any issues with achieving accurate colour reproduction?
    • Yes ☒
    • No ☐

   If ‘yes’, how do you deal with this?
   REDUCE STEAMER TIME SO COLOURS ARE NOT TOO DARK.
   WE LIGHTEN COLOURS IN PHOTOSHOP ALSO.

11. Is your digital printing equipment calibrated on a regular basis?
    • Yes ☐
    • No ☒

   If ‘yes’, how often is it calibrated?

   if ‘yes’, what method is used to calibrate?

12. Any other comments

   WE EXPERIENCE VARIOUS OTHER ISSUES/PROBLEMS REGARDING FABRIC WILL CAN DISCUSS THESE
   DURING YOUR VISIT
Digital Textile Printing Questionnaire

1. What make/s and model/s of digital textile printer/s do you have?
   tx1 and tx2 (mimaki)

2. What make/model of steamer do you have?
   Jacquard Steamjet

3. What colorants do you use to print with?
   • Reactive dyes ☒
   • Pigments ☐
   • Acid dyes ☐
   • Other (please state)

4. Do you use:
   • Manufacturer’s sealed cartridges? ☒
   • Refillable cartridges? ☐

5. What software runs your printer?
   Mimaki and AVA drivers

6. What software do you use for creating designs?
   Adobe Photoshop, Illustrator and AVA suite.

7. Are your computers:
   • Apple Macs? ☐
   • PCs? ☒
   • Both? ☒

8. Which colour mode do you use when creating designs?
   • CMYK ☒
   • RGB ☒
   • LAB ☐
   • Other (please state)

9. On a scale of 1-5, how important is accurate colour reproduction to you?
   (1 = very important, 5 = unimportant)
   • 1. ☐
   • 2. ☐
   • 3. ☐
   • 4. ☐
   • 5. ☒

10. Do you have any issues with achieving accurate colour reproduction?
    • Yes ☒
    • No ☐

   If ‘yes’, how do you deal with this?
   We rely on profiling through AVA. Our colour management is pretty accurate.

11. Is your digital printing equipment calibrated on a regular basis?
    • Yes ☒
    • No ☐

   If ‘yes’, how often is it calibrated?
   When necessary.

12. Any other comments
    Good luck!
1. What make/s and model/s of digital textile printer/s do you have?
2 Stork Sapphires (Mimaki TX2), 1 Epson 4000

2. What make/model of steamer do you have?
Star Steamer (RASmart)

3. What colorants do you use to print with?
- Reactive dyes [x]
- Pigments [ ]
- Acid dyes [ ]
- Other (please state)

4. Do you use:
- Manufacturer’s sealed cartridges? [ ]
- Refillable cartridges? [x]

5. What software runs your printer?
(from the previous question: the answer is neither - we use a bulk feed system with continuous cartridges)
Our RIP software is the Stork RIP

6. What software do you use for creating designs?
Photoshop, Illustrator primarily

7. Are your computers:
- Apple Macs? [ ]
- PCs? [x]
- Both? [x]

8. Which colour mode do you use when creating designs?
- CMYK [ ]
- RGB [x]
- LAB [x]
- Other (please state) I typically work in RGB (Colormatch RGB profile), then convert LAB

9. On a scale of 1-5, how important is accurate colour reproduction to you?
(1 = very important, 5 = unimportant)
- 1. [x]
- 2. [ ]
- 3. [ ]
- 4. [ ]
- 5. [ ]

10. Do you have any issues with achieving accurate colour reproduction?
- Yes [x]
- No [ ]

If 'yes', how do you deal with this?
Mostly through experience with knowing what I am going to get…. we can colour match to solid colours. But we always build our profiles through to steamed, washed and dried fabric.

11. Is your digital printing equipment calibrated on a regular basis?
- Yes [x]
- No [ ]

If 'yes', how often is it calibrated?
weekly - but mostly through visual analysis, not through building new profiles every week.

12. Any other comments
Digital Textile Printing Questionnaire

1. What make/s and model/s of digital textile printer/s do you have?
   - Mimaki TX2 / JV22

2. What make/model of steamer do you have?

3. What colourants do you use to print with?
   - Reactive dyes
   - Pigments
   - Acid dyes
   - Other (please state)

4. Do you use:
   - Manufacturer’s sealed cartridges?
   - Refillable cartridges?
   - Bulk feed system?

5. What software runs your printer?
   - Smart Print

6. What software do you use for creating designs?
   - Photoshop

7. Are your computers:
   - Apple Macs?
   - PCs?
   - Both?

8. Which colour mode do you use when creating designs?
   - CMYK
   - RGB
   - LAB
   - Other (please state)

   * Students generally work in RGB, and convert to LAB for print. My personal work in created in CMYK.

All information provided will be treated as confidential. Thank you very much for your time.
9. On a scale of 1-5, how important is accurate colour reproduction to you?
(1 = very important, 5 = unimportant)

1. 
2. 
3. 
4. 
5. 

- depends on quantity of work to be printed and how I see as the outcome!

10. Do you have any issues with achieving accurate colour reproduction?

- Yes
- No

If ‘yes’, how do you deal with this?

See below

11. Is your digital printing equipment calibrated on a regular basis?

- Yes
- No

If ‘yes’, how often is it calibrated?

if ‘yes’, what method is used to calibrate?
I have a copy of EyeOne but do not have time to calibrate all our machines!

13. Any other comments

Yes!

I am very conscious of the importance of colour management, however as the staff are very busy and a paper cutter and a paper printer simply do not have time to colour manage all this equipment!

Students are encouraged to produce a ‘sample strip’ of the files to print before committing to a length.

I also have demo swatches on the lab wall showing how colours are affected by the steaming process. I think it very important that students are aware of the need to sample, just as they should in other areas of textile dying and printing.
print.

Students are encouraged to keep a copy of their files in layers so that any colour adjustment can be simplified.

From personal experience of digital print, I have found that the fabric tension can affect the outcome. For example, a coated wool is very yellow in tone compared to a habotai or cotton voile.

I think there is a belief that digital print is instant and a quick option, hence to do it well and get good results, like most other areas of textile practice it still requires time and patience.

Finally, students should be given a very good grounding in Photoshop skills before attempting to understand colour mapping the own files.
**Questionnaire to Industry**

Thank you very much for your time.

Information from this questionnaire will be used anonymously.

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**Do you have any other comments or suggestions?**

Please add anything you think is missing from the list:

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<tr>
<th>Question</th>
<th>Option 1</th>
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<td>Your current position in the industry:</td>
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<td>How do you plan to use this information?</td>
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<td>For my colleagues</td>
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<td>Are you interested in learning more about digital textile printing?</td>
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Thank you for your time and participation.
Digital Textile Printing in Higher Education

From interviews and focus groups the following elements have been identified as potential teaching content for an undergraduate textile degree programme featuring digital textile printing.

- Please tick those elements that you think textile graduates should have knowledge of & indicate how important you think each one is on a scale of 1 – 5;
- There is additional space for you to add anything that you feel is missing from the list.

<table>
<thead>
<tr>
<th>Element</th>
<th>Required</th>
<th>1: very important; 5: unimportant</th>
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<tbody>
<tr>
<td>Colours used in digital textile printing: what they are and how they are used.</td>
<td></td>
<td>1. 2 3 4 5</td>
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<tr>
<td>Substrates: how different substrates impact upon achievable colours, i.e. on papers and on fabrics.</td>
<td></td>
<td>1. 2 3 4 5</td>
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<tr>
<td>Pre-printing &amp; post-printing treatments of fabrics for digital print.</td>
<td></td>
<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>The evolution of digital textile printing: how it developed from paper printing technology.</td>
<td></td>
<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>The mechanics of how a digital textile printer works.</td>
<td></td>
<td>1. 2 3 4 5</td>
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<tr>
<td>Comparison of traditional printing methods with digital textile printing: how colours in designs are mixed in each process.</td>
<td></td>
<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>The benefits &amp; limitations of digital textile printing.</td>
<td></td>
<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>Digital textile print methods for different applications &amp; substrates: direct &amp; sublimation methods.</td>
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<td>1. 2 3 4 5</td>
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<tr>
<td>Innovations in digital textile printing technology.</td>
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<td>1. 2 3 4 5</td>
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<tr>
<td>How digital textile print is being used by fashion/interiors designers &amp; companies.</td>
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<td>1. 2 3 4 5</td>
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<tr>
<td>The importance of sampling.</td>
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<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>Basic principles of colour technology: additive/subtractive/descriptive colour mixing &amp; how this impacts on digital textile printing.</td>
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<td>1. 2 3 4 5</td>
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<tr>
<td>Communicating colour &amp; different colour spaces: e.g. RGB/CMYK/CIEX Lab/Platone etc.</td>
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<td>1. 2 3 4 5</td>
</tr>
<tr>
<td>Basic principles of colour management: colour gamuts/device profiles.</td>
<td></td>
<td>1. 2 3 4 5</td>
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<tr>
<td>Basic principles of colour calibration from computer screen to digitally printed textile.</td>
<td></td>
<td>1. 2 3 4 5</td>
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</table>

Please add anything you think is missing from the list:

- An element relating to costs and efficiencies of scale (this could relate to benefits/limitations). For example, with use digital? - flexibility - cost. These are all costly attributes even in a digital environment, so it is important that the end-user and the designer are designing for the correct market place. You cannot get a single water exclusive print at the same cost as a ten thousand metre production run - digital or otherwise!

Do you have any other comments or thoughts?

* The relevance of colour technology, especially important, is somewhat lost in the digital textile print environment, your teaching element relating to the digital textile printing environment is more relevant to how digital textile printing and design is perceived and communicated.

You find that these elements are more technical, issues relating to the optimal output of the environment and environment would be good for the final output of the environment and environment were not relevant to communicate the final outputs to students or relevant to the design of successful digital prints unless to colour, and the design of successful digital prints unless you are an artist or designer to set up the environment and environment and make the decisions about the environmental functions impacts and make the decisions about the environmental functions impacts available on the printer in relation to designing specific outputs.
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Digital Textile Printing in Higher Education

From interviews and focus groups the following elements have been identified as potential teaching content for an undergraduate textile degree programme featuring digital textile printing.

- Please tick those elements that you think textile graduates should have knowledge of & indicate how important you think each one is on a scale of 1 – 5.
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Please add anything you think is missing from the list:

Please note: My response are for VG Design course.

Do you have any other comments or thoughts?

Good question: what is the relevance of digital print in terms of my creative objectives?

Good luck.

Information from this questionnaire will be used anonymously for my own research purposes only.

Thank you very much for your time.
| Element | Required | Very Important | Important | Not Important | Not Important
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Are you ready to move on?

If you have any other comments or questions?

Please add anything you think is missing from the list.

Do you have any other comments or questions?

Thank you very much for your help.

For more information, please visit our website at www.abc.com.
### Digital Textile Printing in Higher Education

From interviews and focus groups the following elements have been identified as potential teaching content for an undergraduate textile degree programme featuring digital textile printing:

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**Please add anything you think is missing from the list:**

Potential pitfalls - printing, steaming, washing.

Difference with small production runs and manufacturing.

**Do you have any other comments or thoughts?**

- Environmental impact - flight miles
- I'd like students/designers to use the waste ink for screenprinting if you know anyone who needs some I have lots and lots, but not it anywhere!

---

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Digital Textile Printing in Higher Education

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Please add anything you think is missing from the list:
A stronger focus on computer aided design work to prepare students for work in industry.

Extensive experience should be gained on various computer software systems.

Students should become familiar with RIP software.

The challenges and opportunities in recent developments to the future of the textile printing market.

Recent developments in inkjet printing and inks.

Speed and reliability of digital printing and its commercial implication for the industry.

Do you have any other comments or thoughts?
Digitalised textiles are a rapidly evolving world. Students need to be kept up to date with state-of-the-art inkjet printing technology and to be confident with computer aided design.

Graduates need to understand, be able to put into practice and promote the specific print process they are overseeing. It is important to be confident and to be able to sell the process/product to the customer.

Going from university to working in industry, I became the first and sole designer at a leading stretch fabric supplier. Finding myself in charge of one and then a second digital printer.

Naïve to the technicalities of colour matching, I took a simple approach of printing off an RGB and CMYK colour chart for reference to achieve colour accuracy. As the company predominantly supplied to the dance industry bright shades were favoured. I used this method for the best part of two years, pipetting the brightest shade of each hue to work with in Photoshop.

After the addition of the second printer my PC was upgraded to a Mac and AVA was introduced to calibrate the computer monitor and digital printer. Although coming across AVA at university, but never being taught, the training I received at the AVA headquarters was invaluable.

Now running my own online clothing company, I still print all of our fabrics at the same supplier and therefore have a good knowledge of the colours available due to endless sampling. However, occasionally taking on freelance work the problems with colour matching still rear their head. The issues need to be explained and the importance of colour matching made clear to the customer.
Digital Textile Printing in Higher Education

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Please add anything you think is missing from the list:

The expense of digital printing. Often if a company is digitally printing for production it can be cheaper if it is a small number of units to be printed as you do not have to pay the initial start-up cost for screens to be opened. On the other hand if it is a large quantity of fabric screen printing is a cheaper option.

Colours can often differ when using different fabric bases.

The range of fabrics that you can digitally print on. Eg. Jacquards, sheers, matt and shiny sides of Silk satin and the difference to the print. We often fuse fabrics together after digitally printing to give effects.

Do you have any other comments or thoughts?

I think when I was learning the above topics on the [BSc] course we went into too much detail in terms of the science behind everything. I could answer questions about the in depth knowledge of fabric specification but if a fabric was presented to me I wouldn’t know what it was. I think I would have preferred to be given simple explanations first and then gone into more detail. I think practical lessons and experimenting would have helped me put into practise what I had learnt.
Appendix B: Code of ethics

Interview Code of Ethics

<table>
<thead>
<tr>
<th><strong>Anonymity</strong></th>
<th>Unless otherwise agreed with participants, I guarantee that I will not use any names and addresses in the final report, or store or categorise information using names and addresses.</th>
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<tr>
<td><strong>Confidentiality</strong></td>
<td>I guarantee that I will not disclose directly any information provided in this interview to third parties, unless permission has been granted to do so.</td>
</tr>
<tr>
<td><strong>Your right to comment</strong></td>
<td>I agree to keep you informed about the progress of the research if requested. If at any stage you wish to comment on the emerging results or final report you may do so. I agree to listen to your comments and make relevant alterations, if appropriate.</td>
</tr>
<tr>
<td><strong>The final report</strong></td>
<td>This research is funded by The Cotton Industry War Memorial Trust. A copy of the final report will be sent to this organisation, to the University library and to anyone who has taken part in the research who has requested a copy.</td>
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<tr>
<td><strong>Today’s interview will be recorded - for transcription purposes only</strong></td>
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Appendix C: Interview transcripts

Transcripts of individual interviews with educators

Q.1 What are the BSc textile design students taught about digital textile printing?
AC: So, what are students on the BSc programme taught about digital textile printing?

OK. Well basically they’re taught about our system, the Mimaki printer system, and the software that runs it, so that’s AVA. By me they’re given a basic introduction to the process including taking the design into the system, printing it, and then the after processing of it, which could involve steaming and washing since we’re using reactives. This is for the 2nd year students. So that’s their basic introduction really, and including some explanation of the advantages and disadvantages of digital printing as opposed to conventional printing. So that’s more or less all I actually teach them. Other than that it’s more practical things, actually showing them how to use the machine, but there’s not a tremendous amount of theory from me.

Q.1a what are delivery methods?
AC: So how is all this delivered to the students? Your part?

My part’s delivered… I’ve got some notes, which are bullet point notes, of what I intend to deliver within the sessions. These are only small sessions, when I say small I mean small groups, the groups split into four, so I only get 6 or 7 people per session we give them at the start of the session a sheet with what we intend to cover, and then basically work through it and invite them to ask questions at any point during the session.

Q.2 What are the students taught about colour management?
AC: OK, thanks. What are the students taught about colour matching issues in digital textile printing?

Well, I certainly cover the basic problems that they’re likely to run into when you transfer files created on one machine, for instance and then used on another, by machine I mean computer, and in one system and then transferred to another, and the difference between monitors and also I do go into some, not in great detail, but discuss the printer gamut and how that might vary from that of the gamut of the monitor. So they gain some idea, I also show them some examples of prints on different substrates including paper as well. So it shows how you can print the same thing out and get a different effect depending on what substrate you use. So that’s basically it, I think.

Q.3 Why is it important for colours to match?
AC: OK. Why is it important that colours in digitally printed design on a textile match the colours of the same design on screen or on paper?

Well I guess that’s what people want - they don’t want to create something on one computer then print it out and it look completely different so they’re looking for consistency across all systems, whether that’s another monitor or another printer.

Q.3a is student work less important?
AC: Do you think it’s less important if it’s student work or as important to have colour consistency?

Well, obviously I think it’s important to have colour consistency, because they do flag it up with me when it’s not consistent. Particularly, for instance, the […] project or the final year designers when they’re trying to create something that’s going to be used for their show, so I think that it is important. Sometimes it is more important than others, for instance I think that if we were doing more commercial work then that probably would be more important than some of the student work shall we say.

Q.3b is this reflected in industry
AC: Is that because it reflects what would happen in industry more?

Yes, I think so, and with the students sometimes I think they think it’s important and other times they aren’t so bothered themselves, but I think you should strive to try and get it right where we can. Also, say, for the […] project they incorporate weave designs from the weaving labs, so they’re all supposed to match, they’re all supposed to work together, so you don’t want it coming out completely different colour.

Q.4 Why is digital print in BSc programme?
AC: Thank you. How do you think digital textile printing fits in to the BSc programme – why is it included? What do you think its function is?

I’m not an expert on the whole programme to be quite honest, I don’t know what’s included and what’s not included in the programme, I only deal with the digital print side. But I think digital print is going to be used more and more by students and industry so I think it’s important that students are fully conversant with it. It’s taking over to some extent from conventional printing, and I think as the
equipment becomes faster which is, I think, what’s holding it back currently, then it’ll become more important still, so it’s important that the students are aware of this.

Q.5 Is digital print a tool for design or technology?
AC: OK. And do you see the digital textile printer for the students or is it a learning tool to help them understand the complexities of colour matching issues – you know, if they go on into their careers, or is it both of those things?

Well I think it’s both, but I think the colour matching aspect is probably not one which is over-emphasised shall we say, that they’re really using it as a means of getting their designs from their imagination onto a substrate. So I think it’s just a means to an end really, the actual printer itself. They obviously wouldn’t be able to create those designs and get them produced to the same level if they were to use a different method, like a wet printing method, for instance.

AC: Is it there to complement the other methods that they’re taught such as screen printing, to show them a different way of doing things?

I think it’s definitely there to complement the traditional methods and shouldn’t be used to the exclusion of the other methods, but I think it provides a relatively easy way of getting something form the design stage onto a piece of fabric and onto paper as well.

Q.6 How does BSc differ from BA? AC: How do you think the digital textile print differs on this BSc programme than it might do on a BA programme?

I don’t know how it would differ – I’m not conversant with BA programmes at all, so perhaps you’re asking somebody who doesn’t know the answer.

AC: No, that’s fine, I was thinking that here’s the science bit there and I think that makes a big difference to what the students do here than how they might do digital textile print in [...], the technology side is there.

Yes, you’re probably right, and people like myself are from a science background, so will probably emphasise the science aspects more than somebody who came from the design side or the arts side. So I’m constantly going on about colour profiles and things like that, whereas perhaps somebody more from an arts background perhaps would emphasise more the design side of it. I rarely comment about students’ designs, the actual design aspect of them, I’m just interested in getting them reproduced to the right standard really. But I can see where you’re coming from with the arts side.

AC: Yes – it’s an interesting programme because it’s got the creative design, but it’s also got the technology and the science as well, and I just wondered about the balance between those. But I can ask other people about that.

Q.7 What else should be included? AC: Is there anything regarding digital textile print that you think should be taught to the students that’s currently not?

I don’t know about things that are not taught, but I think maybe there should be more emphasis on certain aspects, some of the things we’ve talked about actually. Such as the colour management side if it - because I find that most of the students who come in don’t realise that designs are going to look different depending on how you view them or where you view them or how they’ve been printed. They just assume that if they create something, say, on their computer at home and they bring it in here and print it out its going to be just as they expect, when it’s not. They quite often don’t appreciate the importance of the colour management side of it.

Q.8 Any other comments? AC: OK. Are there any other comments you’d like to make about digital textile printing?

Well, I’m not going to go into a sermon about the state of the facilities and things like that because you’re probably not interested in that, but obviously I think we could make better use of the facilities if we had a better and faster printer which would enable students to use it more, probably, because to some extent now they would be restricted on time even if they wished to use it more, in terms of it only printing at one metre an hour. I would like to see students make more use of not just the printer but the software that’s in here, to come in and try things. Now they only come in and really use it when it’s an actual project that they’re doing, like the [...] for instance, they don’t use it any other time really other than when it’s laid down ‘we’re doing this now’.

AC: I suppose if the set-up is supposed to give some idea of how things work in industry, having a faster machine would be a truer reflection of that wouldn’t it? Because the machine that we’ve got here currently is obsolete, isn’t it?

The machine, as we both know, is obsolete and potentially we won’t be able to get parts for it within a couple of years.

AC: So do you think that’s important for the facility, to try to keep things a bit more up to date..?
I think it’s important for the facility itself, and also for the impression it creates for the students in terms of how committed we are producing a world-class facility.

AC: That’s true, I’d not thought of it from that point of view but you’re absolutely right. We can’t just have something and have it static – it needs to be renewed and updated.

It needs to be renewed, especially when it’s a technology that’s changing quickly. For instance with the wet printing, it’s sort of reached the level it’s going to be at and it doesn’t change from one year to the next and maybe not even in ten years. So if you’re doing a hand screen print, that’s the same now as it was ten years ago. Whereas all the time with digital printing, and things that are based on computers in general, they move on so fast that it’s difficult to keep up with. As you know if you buy a computer by the time you’ve plugged it in, it’s obsolete.

AC: And with the University having a very strong technology base as part of the programmes, that makes it important to keep up to date with equipment because it’s got a reputation for forging ahead and innovation and research...

Yes – that’s the stated aim, whether the reality lives up to that is a different matter.

AC: Once all the interviews are complete with all the individual staff, I’d like to get everyone together and have a group discussion – picking out some of the points people have said and throwing them in anonymously and getting everyone together and talking about this facility and what happens here. It would be a good thing for everyone to know what everyone else is doing.

Yes it would – I don’t think there’s enough if that in general...

AC: Would you be up for that?

Yes – I’d be up for it. AC: I think that’s about it.

[End of interview]

Q.1 What are the BSc textile design students taught about digital textile printing?

AC: I’d like to start with my first question – which is, what are students on the BSc programme taught about digital textile printing?

In terms of digital textile printing they are taught about how a digital printer works, different types of digital printers, how they deliver ink to the textile. They are also taught, in their first year primarily, how different dyes interact with the fibres, so they are reminded at that stage what sort of dyes or pigments can be used in digital printing, how they are then fixed onto the textiles, we also tell them what system that we have – the reactive dye and they are reminded how it works obviously then there’s also all the fabric preparation, so they’re taught about that. What the fabric is coated with for the dye or pigment to fix. They are told about the processing steps. They are also taught about where the technology lies at present so we’re comparing how it’s going faster and faster. We tell them about the development of digital textile printing... I had something else in my mind it’s just escaped me... we tell them how to do it, tell them how it works...

AC: Yes – you were talking about the different colorants, preparation processes, finishing processes...

There is something else - it will come back to me...Oh, we compare traditional methods with digital printing so they are told about the benefits of digital printing, in terms of the fact that it is fully tonal, you have more flexibility, the short runs etc.. they are also told about limitations such as speed, and that sort of thing, and initial cost to the company etc. so that fits in with the development and how eventually this won’t be an issue as much, we’re hoping. What else... they are taught about some of the colour managing issues so working in the interface between designing and the actual print and how it should relate but it doesn’t always relate, we mention colour gamuts, possibly mention where the limitations in colour gamuts are... try to give them an appreciation of what the issues may be in terms of colour matching, let them know that people are working on it, so there is colour management software, that sort of thing. They’re also told – I’m not sure if it is related to your question – but in terms of the software that you can use and how they link to the digital printer. So, whether you draw it and scan and print, or whether you draw it on the computer all the different steps you might do, and the fact that you don’t need to do any colour separation unless you want to then use it to sample and only then you use traditional methods to print, so they are also made aware that it is very flexible but it depends on what the actual use that you make of the digital printer is – is it just sampling and then you’re going to transfer it – or are you using it to actually produce?

Q.1a what are delivery methods?

AC: OK. How is all this information delivered to the students - in what format is it all delivered? Is it a mixture...?

It’s a mixture... now, about the technology how it works, there’s a lecture, or a few lectures, the colouration, how the colorant works, there’s lectures and they had labs the previous year that they can relate to in theory. So there are a lot of lectures. We show them the digital printer. I know they’ve had a session to show them how the design software interface works, last year – I can only talk for last year –
they had an EBL where they had to investigate the colour gamut achievable for our printer and how the
colour appearance on different screens and different substrates are all linked together and what it means
for them...

AC: And these are 2nd years aren’t they...?

Yes – these are all 2nd years. This year we’re having a little bit of new method of delivering all this
information and it is not set in stone exactly what we’re doing. It will be a mixture of lecture, EBL or
labs.

Q.2 What are the students taught about colour management?

AC: OK. You’ve kind of answered one of the questions I was going to ask you, but could you give me a
little bit more detail about what students are told about colour matching issues in digital printing?

Based on last year again, I mentioned there was an issue and I gave them an EBL where I gave them a
design digitally, gave them a few prints, got them to do a few prints, and really leaving them to notice
the fact that because you see a colour on the screen is not necessarily going to be the same colour
printed. I also mention the fact that there is a colour management programme on the computers. I
remember showing them the colour management interface on the computers showing the colour spaces
and how the screen colour space and the printer colour space...

AC: ...so this is in AVA?

In AVA, yes. The gamuts in CMS. So I used that to show them that there are discrepancies between the
two, and making them aware that there are things like colour management software to counteract the
fact that what you print and what you see on the screen can't match. I also told them, I was trying to
get them to find out for themselves, the fact that we have additive colour mixing and subtractive colour
mixing going on and so obviously we limit... you complicate things by trying to have things matching
that way. Also I think I was trying to get them to understand how in lighter colours, especially with our
printers which are a bit less flexible than latest models, how we struggle to have full range of colours if
you go into very light shades. I don't think I went into details into that this is due the dots that are put
down, the droplets are too big – that sort of thing. And I did not concentrate on specific areas, so I didn't
really tell them that we have issues with this range or this shade, because that would vary from printer
to printer, whatever software you have, whatever inks you start with. But when I do tell them about the
development in digital printing and digital printers I do let them know that there are printers with more
print heads, with more different colour ink cartridges so you expand your colour gamut.

Q. 2a

AC: OK. So is that something that you are going to plan to do again – repeat that exercise again with
the students – to vary it...?

Unfortunately I found that the EBL with the students did not work very well. So I do intend to get them
to work on the same line of idea, but I am having to rethink how I get them to come to the conclusions

Q.2b

AC: Have you got any thoughts about why it didn’t work so well?

I’m still in the process of analysing the data. It’s quite hard because obviously I know what I expect of
them, but for them for actually to draw this information out is quite difficult, you need to lead them, but
not tell them everything. So after the EBL every time we had a session to discuss what they’d found or
what we should have found and so then everybody’s made aware of what they should have found, but its
just trying to get them to get there themselves which is the real important factor isn’t it...

Q.2c

AC: Do you think it was just that kind of reluctance for them to take responsibility, to take ownership
take initiative and take responsibility for their own learning?

I think they went for easy information. They probably did a Google search, found a bit of information,
and almost copy and pasted, maybe give them the benefit of the doubt and actually retyped it in their
own words, and thought ‘that’ll do.’ I don’t think they really went for investigating what it really meant.

Q.2d

AC: Is that because they didn’t associate a value with doing it – I don’t know how... in terms of how it
was going to be marked – but did they associate it with a low value exercise in terms of what they would
get back...?

In terms of marks? Probably. And it was group work, so they had to co-ordinate; I think that takes a lot
of their own energy as well. And it was one of three or four EBLs that I set so in theory they should’ve
really got the gist of what they were doing by that point.

AC: Was it just that particular one out of the three or four EBLs that didn’t go very well?

No they all struggled. But a lot of it’s in the wording...
AC: It’s difficult – communication...

Difficult to set something… you want to give them enough of a challenge but not too much. They need to be able to find the information and remember it. And it’s just setting that, and also making it interesting so they want to research it. And also because I come from a very technical background, I’m interested in the fact that you have additive and subtractive colour mixing, how they work, how its difficult to get them to match, I’m interested in how the printer works, and because your droplets are too big and you can’t get a lighter shade. But they come from a design perspective and perhaps they didn’t want to look into all this technical aspect.

Q.3 Why is it important for colours to match?
AC: I wanted to ask you why it is important to colour match screen and textile in digital textile print?

For a number of reasons – one of them being the fact that we are living in a digital world and the designer and printer could be anywhere round the globe so you want to be able to communicate the colour that you want, you choose the colour on the screen at home or wherever you are, you want your sample that’s printed somewhere else to be exactly the same thing. So obviously you need colour matching all the way through. Also for the actual designer even if they are in the very same room it makes it easier if what you see on screen and you can actually visualise your design and when you are actually printing it is the same thing so digital printing is used for sampling but you wouldn’t want to sample the sample really, it’s kind of counterproductive. I cannot think of any other reason why colour matching is important… not off the top of my head…to make sure that you get what you want.

AC: OK, that’s fine – thank you.

Q.4 Why is digital print in BSc programme?
AC: Yes… but it is a BSc degree as well, which quite nicely leads into the next question, which is: how does digital textile printing fit into the BSc programme - what’s its function do you think, and why do you think it’s included? Is it for example – is it a design tool? Or is it there as a learning tool for the students to learn about that technology and a bit about colour matching issues – or is it a bit of both? What’s its function - why is it in the programme?

It is a good design tool and something that’s very valid. However I don’t think it’s the most important aspect. One of the things is obviously we are trying to create graduates who have the skills for the industry otherwise there’s no point is there. And digital printing is an up and coming printing method it will be the printing method of tomorrow so they do need to learn about this. Because it’s a BSc we do ask them to understand rather than just use things. I think it is great that they do understand - it empowers them. So because it’s so relevant to printing or design, textile printing, then they definitely should learn about this. But you also mentioned or asked whether it was a good …what’s the word … method … to teach them about other aspects like colour management… I think you’re right - it’s approachable, digital printing is an approachable technique it’s easy to just print something and you can use that to base a lot of things around it like colour management, make them aware of that and make them aware of technical challenges, and make them aware that things are not as easy as they look. And give them an appreciation of what we’re achieving – hopefully inspire them as to what they can achieve, how they can use the technology and push it further, but also getting them more aware of what we can expect from the technology in the future. So letting them know it works this way, and they need to know how it works, to be able to know why we can’t do this with it at the moment but looking at it from different angles that sort of thing.

AC: Yes. Because I know that in other areas of the programme in spin and knit and weave, they have a more practical introduction to the equipment and the machinery, in a lab class or a demonstration … and I don’t know if they… they’re shown the printer, but maybe not in as much technical detail as they are with other technical equipment.

It would be great wouldn’t it to have a print head that you could show them – and say ‘look it fires through these holes’ and this sort of thing. I show them a diagram on a slide but it’s not quite the same as actually opening the printer and seeing it happening.

AC: Somebody pointed out to me that its maybe more important to know the machinery for knit and weave more intimately because they are operating the knitting machines and the weaving looms themselves in a lot of cases and it not quite the same with digital textile printing.

Because the computer does everything, you don’t need to. In fact if you interfere you’re probably going to break it. It’s only in a very rare case that it needs...

AC: Yes, but on the other hand, it’s the Bachelor of Science that differentiates the course and by definition includes the technology and the science as well as the design aspect, so they almost are obliged to have that part of the … the information to know how it works...

Q.6 How does BSc differ from BA?
AC: Because then from this course they’re going to go into industry and they’re going to be in situations where they may need to deal with colour discrepancies or other situations in industry and if they know why something has happened, rather than just know it’s happened, but know why it’s happened they’re better placed to deal with it. It’s interesting because my next question was going to be: how do you...
think digital textile printing as part of the BSc programme differs from a BA programme? – It might be a
difficult question to answer or not – it might be a simple one.

How does it differ here to than if it was a BA... I have no experience what’s in a BA but I wouldn’t expect
the student to learn how the printer works...

AC: ...sorry - I was going to say, it would be maybe just purely a design tool rather than...

Yes, it’s just you do your design and print it and here you have it on textiles, rather than understanding
where it comes from or where it’s going...

AC: Yes, but at the same time maybe you’d still need to know a little bit about colour matching and
management issues... if you were... you’d need to know how to deal with it, to sample your work
before... but not the intricacies of how the printer works...

But then surely knowing how the printer works empowers you once you do your sampling and you go
‘the colours are wrong, what do I do?’ Knowing how it works you have a better idea of what to do...

AC: ...exactly...

Q.7 What else should be included?
AC: Is there anything that you think should be included or given more time or more definition in the
teaching content that isn’t already there?

No - if I think it’s worth it I put it in in...

AC: Or is there something that maybe you think should be delivered in a slightly different way – take a
different approach – I don’t know, should be a practical session or a lab class or an EBL – is there
anything you think should be included or given more emphasis to?

Not really – I mean we’re revising how we’re delivering this, that’s exactly what we’re trying to do –
make it work – so no – there’s nothing I can think of that needs to be included that we’re not already
trying to include.

Q.8 Any other comments?
AC: Have you got any other thoughts or comments on digital textile printing in this particular
programme?

Yes – one of my dreams for the future, and this is obviously looking into the future I am trying, because
I am a technologist because I look at colorants, I’m trying to create new things through digital printing
and in the future, obviously based on my results and the wonderful things that I’ll be able to do, I have a
dream that we’ll be able to push this towards the designers and let them have access to some of those
things and unleash their designer skills on that and possibly even feed the other way round, you know –
what do they want to do...? Maybe in second year they’re still not really clear as to what they want to
achieve with digital printing but at some point you could go ideally I’d like to do that and that would feed
into the research...

AC: That sounds fantastic! I think at the moment the way things are there are a number of restrictions
that maybe rein in the possibilities because of the model of printer that we’ve got at the moment – it’s
quite slow – and also I think...

I think access to the software is maybe something that is not clarified, I think in answer to your previous
question what we need to do is hopefully train AVA earlier and I know [...] is already doing some of that.
Give them more access perhaps.

AC: That’s one of the things I was going to ask about as well – what do you think about the choice of
software and how that impacts upon the student’s experience of digital textile printing because
there’s...?

There’s a lot of choice...

AC: There’s a lot, but most people are familiar with Photoshop and they use that for doing their textile
designs because they have that on their home computers and to have... it’s prohibitive to have AVA or
Lectra...

But I think, because... I can’t speak for Lectra because I’ve never really used it, but AVA is very well
suited for design into print, digital printing, but I think it’s really good and important to have that, it’s
impossible for the students to have their own. However I think there are ways round that, one is giving
them some access but also maybe giving them the right information so they can design parts of their
design in something that they have such as Photoshop, and tell them... I was going to say a foolproof
way... but perhaps you know we have to be reasonable but, tips on how to design in Photoshop and then
import different pieces of design and finish the design in AVA so that their time on the AVA software is
minimised, they can do a lot of groundwork on their own computer, come and do a lot more on AVA.
AC: Maybe part of that would be to create colour libraries that are consistent between Photoshop and AVA so that they could be... they would have a palette to work with...

Yes, maybe...

AC: Because if they design in Photoshop, a lot of times they transfer into AVA and it doesn’t match.

Because apparently the way they remember colour is very different, isn’t it, between Photoshop and AVA - again, colour physics - I don’t know much about that.

AC: But if you were to have a consistent colour library, even if it was a Pantone library that could be specifically for textile designing in Photoshop, and that same library was used in AVA and all the colours were checked out to make sure that they were within the printable gamut, whichever... then they could design with confidence and know it will print out and there would be some kind of interface between the two platforms of Photoshop and AVA.

Either that or they need to... I forget how it works – its layers in AVA, channels in Photoshop, again I don’t know about Photoshop or how you design, but if you are able to design using those channels then you can change the colour in AVA with no problems. So then you could say, 'I want this purple' and you have it in your head, it looks very different when you put it in AVA, but you could reselect using the colour wheel and have it the right colour, and obviously that’s all colour managed.

AC: Yes, something like that...

So then you can link both...

AC: Exactly, because at the minute students are going off and grabbing colours from wherever, from Photoshop... and then doing this straight transfer and maybe being a little bit disappointed with how things turn out and that might be some way to counteract that.

Yes, give them the tools to be able to do that.

AC: Yes, and it would also increase their understanding of colour matching issues, and why... you’d have to explain why you were doing that in the first place... so it would maybe reinforce that as well.

That is a very good idea... another thing to consider – how I can do that.

AC: Digital textile printing – just out of interest – I don’t know what percentage of the whole body of work it represents – in terms of chunks of subjects that the students do – is it a tiny chunk or is it quite a big chunk?

I can only talk about what I personally teach in my lectures/labs, digital printing in my printing lectures we look at traditional methods and how they work, we look at digital printing, at printing pastes and printing inks, so... I would say it’s about half... no, not really, because I remind them how different colorants interact, so it’s kind of related but directly digital printing possibly just a third of what I teach.

AC: I suppose it depends on what students specialise in because it can become everything for one student and nothing for another if they get into their third year and decide to do print and specialise in digital print then it becomes 100% of their work. So it might be a smallish chuck but it can grow to become everything depending on the student...

Yes - what they want to do how they take to the technology.

AC: So it is important and like you say it is of growing importance in the printing world, but also because not least because of environmental concerns as well. Because as a process, that’s one of the things that people are looking at because there’s less waste and the colorants themselves have to be greener – there are more regulations that control those nowadays I believe – they have to comply with certain criteria for disposal and content. Thank you very much; I think that’s enough to be going on with and plenty to think about there.

[End of interview]

Q.1 What are the BSc textile design students taught about digital textile printing?

AC: Can I start by asking you about the digital textile part of the BSc undergraduate programme – and my first question is, what are students on the BSc programme taught about digital textile printing?

On the programme they’re taught from the 2nd year onwards, the basics of the Mimaki digital printer, what its functions are, why we have one, why it’s used, how to use it, how it links in with CAD, how it’s primarily a printed textile facility, it is part of the whole CAD centre. They then have an induction with a number of members of staff and then there’s a live project that they do in the 2nd semester where they will be getting more to grips with understanding the digital printer and using it as an output for their digital prints for that project, which is a furnishing project - contract interiors for hotels. Then in the final year they become they specialise in an area and those people that do specialise in print tend to lean more towards the digital print area than wet screen printing, for many reasons, one of them probably
because a lot of them use CAD and it’s the obvious way to take it forward. Some of them use it in conjunction with wet screen printing; primarily the students will work on designs in Photoshop and submit them on a disk or a USB pen to be printed. In the final year the aim is that they get much more hands-on with the printer, maybe not physically doing all the functions and pressing all the buttons and stuff but actually really understanding how it works. The aim is that they have a really good basis of how the digital printer works.

Q.1a what are delivery methods?
AC: You mentioned quite a lot of elements there to digital textile printing. What methods are used to deliver these – all the different elements that you were talking about - to the students?

Some of the teaching is on a one to one level particularly in the final year; obviously we supervise them individually so there’d be one student per tutor. In the second year it’s a bit more within groups, they have their induction within groups, and I think some of them get put into smaller groups for this. I don’t deliver that particular side, and obviously in the CAD lab when they’re designing for the live project which is [...] in the second year that’s all group work as well, and that tends to be myself speaking about digital printing and how they can develop their work for the Mimaki, to a group and then seeing them individually; talking to them very much about colour as well and making them more aware of the fact that a computer screen has got a light behind it and it’s going to make the colours more luminous, much brighter, and think about the weave of the textile that they’re printing on to. Sometimes I tell them that basically they will lose elements on the digital print because the fabric tends to eat up things as it prints; with the texture of fabric it’s very different from printing out on paper so I talk to them about that as well, and I talk to them about the fact that they won’t necessarily always get exactly the right colours. In the final year now what we actually do is ask them to submit a colour palette for us to print before we go forward. Final years have 4 metres of fabric that they can print on for their final project and what we try and do is limit that because giving them endless metres doesn’t really help their process of understanding the printer – it’s about getting good quality prints.

Q.1b Why is it important that colours in a digitally printed textile match the colours as seen in the on screen design or on paper?

That’s a really good question! Why is it important that colours in a digitally printed textile match the colours as seen in the on screen design or on paper?

Q.2 What are the students taught about colour management?
AC: So the part in the CAD lectures about colour management - is that delivered as a formal lecture - a specific area of colour management is given to them?

No, it isn’t, and that’s something which I think as a team we’ve talked about a little bit more. It’s something which we’re definitely working towards and a lot of these things come around quite slowly and we assess what’s happening over a matter of years and then establish something that’s hopefully going to help. Something that’s going to make things change I think is this new software that we’re getting which is another Lectra programme which is Kaleido Print and we’d like to really integrate students into using that in exactly the same way as Photoshop so that they have an equal knowledge base in both of the programmes - that’s our aim. And with Kaleido Print it’s specifically for printed textiles and there’s lots of colour management functions and I think eventually it’s all going to feed into digital printing and there will be some kind of formal teaching on how to actually transfer colours across in the most successful way and it won’t be so vague and woolly that it kind of is at the moment to be honest, but I think these things take time.

Q.3 Why is it important for colours to match?
AC: OK. Why is it important that colours in a digitally printed textile match the colours as seen in the on screen design or on paper?

That’s a really good question! Why is it important that colours in a digitally printed textile match their initial - their final print... Because the student or anyone that’s working on the computer for a long amount of time developing a design or even drawing one out and wanting to scan it – you’ve got a colour palette that’s set by a member of staff, or it’s set by industry, or by WGSN, colour is absolutely integral to print, it’s integral to textiles, they’ll be working on colour ways which have very sensitive colour balances and it’s all part of what we do here, it’s absolutely paramount that colours come out as we’ve designed them and it’s very, very frustrating when that doesn’t happen.

Q.4 Why is digital print in BSc programme?
AC: OK. Why do you think, or how do you think, digital textile printing fits in to the BSc programme – what you think its function is, why is it included?

Digital printing for the BSc programme in particular, is seen as being the most current piece of computer equipment that we have within [the programme]; it’s still one of those areas that’s only 10 -15 years old. It’s still seen as a kind of relatively newish piece of technology in comparison to a lot of the other stuff that we’ve got in knitting and weaving for example. It’s also got the whole kind of thrill, I think, that students find that they can actually – well anybody that I talk to about digital printing – the idea of actually working on something in Photoshop and then seeing it come out with all its detail onto fabric is still quite an exciting thing to see happen and it feels like it takes very little effort, in actual fact it takes a lot of effort to keep the machine going and to members of staff that know how to use the machine and know all its difficulties and issues and what makes it work better and I think we’ve got to the point when actually everything’s ok in that respect. I think it’s seen as a contemporary way of working in textiles and print, and it’s got the catwalk, in fashion particularly you see the photographic prints coming out which are really exciting, you don’t see them so much in furnishings, but that’s still relatively new aesthetic as well – photographic prints on big coats – and there’s some, and it is still quite a new area, when you go to find books there are a couple of really good ones but there is loads of stuff written on
digital printing. Also, it's something that students don't know about at college and school – the teachers at college and school might be teaching them different processes in all sorts of areas – embroidery, knitting weaving, but they probably won't know very much about digital printing unless they're completely clued up about that area. It's something that our students, when we tell them about it, it's brand new knowledge for them, which is quite nice. In terms of it fitting into the programme, it links very much with our industrial bias to the programme, where we are a BSc and we want to be seen to be echoing what's going on in industry. We're not art based so it's very important to have things, have facilities that do represent what happens in the outside design world, and I think the digital printer is a key element of that and it also helps a lot of people who want to work in a CAD manner and maybe screen printing isn't the road for them, so it opens up two divisions in printed textiles which I think is absolutely needed because there is digital weave and digital knit as well, so it's another element really.

Q.5 Is digital print a tool for design or technology?
AC: So – you mentioned that it is a Bachelor of Science Programme, so do you see the digital print element as being a design tool or an opportunity to learn about the technology behind digital textile print or is it a mixture of both – is it delivered as a mixture of both?

It's absolutely a mixture of both. I would think that some of the students would actually become quite interested in the technology. Our students are very diverse; they tend to have primarily art and science subjects at A Level. More and more students that come in are interested in the science area as much as the design area and that's what makes us kind of quite unique. So I think, it's a really good point that actually and I think it gets delivered to some of the technical textile programmes in a slightly different way, so they learn about the digital printer as a technical tool, whereas our students, obviously everything they do is applied then to design so it's a bit of both really.

Q.5a keeping up with technology
AC: Do you think because the technology involved in digital textile print is advancing very rapidly, do you think it's important to echo that in the facilities that are available to students, just for example in the age of the machine, it's performance in terms of what's available now and how it compares to that?

I think I'm not too worried about the age of the machine. I realise that some other colleges, art colleges, have slightly newer machines. For me, if students can achieve good digital prints from the digital printer in a reasonable timescale without the computers or the Mimaki breaking because it's too old, well then there's absolutely no problem whatsoever. We're not trying to mimic exactly what high speed printing that maybe you will see at […] or whoever else – we're just trying to give the students an example of what it might be like and the procedure that you go through, and make them aware of what the facility is. I think if we're trying to continually keep on a level with industry it would become a very, very expensive operation and we have to equalise what we spend on what across the board, so knitting and weaving as well, the three areas are meant to be seen as equal. However, I do think there is scope to push digital printing forward and I think we are due some new machinery, but it's finding money...

AC: Yes, I was just saying that because there's going to become an issue - because it's an obsolete machine now – with maintaining it in terms of parts and things, because they're not going to be available...

That's something to think about, definitely.

AC: It's the same with all technology isn't it – in the same way the software needs to be updated, the hardware needs to be updated, and the digital printer is becoming more and more out-moded...

Definitely, that's something that's going to be on the agenda today in our meeting.

Q.6 How does BSc differ from BA? AC: How do you think, you've kind of answered this in other things that you've said, but how do you think digital textile printing as part of a BSc differs from a BA programme?

OK. I would think on a BA programme, or even an MA programme, there would be much more emphasis on printing from the outset. So students will have more opportunity to print on the digital printer, I would think, on a BA or an MA, because they are literally immersed in the design activity exercises all the way through the whole three years. Whereas with the BSc programme that we have here, as I've said previously, they have to have equal amounts of knitting, weaving and printing. We will have less students specialising in print than we would do at say Manchester Met down the road where they might have a good twenty students specialising in print and that's all they'd be doing for two years, as opposed to us for one year, averaging around ten students per year doing print. I think it's volume that's the main difference. I also think that potentially the students at somewhere like […] – I'm just using that as an example as it's just down the road – might potentially be more rigorous with their desire to get exactly the right print I would think; our students, they have very good design skills but it's not always their priority to get exactly the right fabric out. They're not as visually versatile and sophisticated as a BA student would be. So I think if I'm being entirely honest that's my answer to that question.
Q.7 AC: OK. Is there anything regarding digital textile printing that you think should be included in the teaching content that isn't at the moment?

Yes – I think the colour thing is very important, and calibration. It’s an issue because we need to get the technology right before we can actually teach what we want the students to understand, observe and realise in their classes. So it’s down to the staff really to set the goalposts of where that happens, and for me, colour is absolutely essential and it’s something that I’d like to become a bigger part of their teaching and their awareness. I don’t think that textile designers need to know too much more about the Mimaki. I’m always really ‘pro’ that they understand that it runs through AVA, they understand some of the key functions, they understand how to put a roll of fabric on maybe, bits and pieces, which side of the fabric to print on and what happens after it gets printed. But I also realise if they were designing in industry that wouldn’t be an essential part of their job to actually see the print go all the way from design through to output on the Mimaki – so little bits of information that they’ll need that they can take with them into the world of work and that they can build on depending on which role they’re in, definitely.

Q.8 AC: OK. Thanks. Is there anything else – any comments that you have about digital textile print?

Not really, no – I think it’s going to carry on getting bigger and faster, but I’m still very aware that some people want to see a really good screen print. I still think there’s a massive difference in the output. I also think that there can be a disassociation with the fabric when it comes to digital printing – students don’t fully appreciate the cloth that they’re printing on – they don’t fully – quite a lot of the time I’m having conversations with the students about what silk do you want to print on – and it just tends to be ‘silk’ because they’re not necessarily getting to grips with how they might put that particular type of silk or that particular type of cotton. And I wonder if that’s to do with digital print as well – they’re not handling the fabric in the way that they would do if they were screen printing.

AC: I think you’re right – it’s important to have an understanding of both processes because both processes have their own characteristics and appropriate applications and they always will – there’ll always be a place for both. I don’t ever think that digital textile printing will become the one process – there’ll always be a place for hand block printing, screen printing, whatever.

I think something that I’d like to see brought in to the programme, and just talking to you now has reminded me about this – is the working of the two together and maybe that’s a conversation to have in the summer, but I think that would work really well. I can see a group of students being split into half and some them doing digital and then passing them on entirely different to screen printing on top. I think that’s exactly where it needs to go to keep it new and to keep it relevant, and to make it exciting as well, and it’s this thing about also that we are supposed to be the cutting edge of technology within design here, that would feel like a good way to take it forward.

AC: OK, thanks very much!

[End of interview]

Q.1 What are the BSc textile design students taught about digital textile printing?

AC: What are the students on the BSc programme taught about digital textile printing?

Well, in [...] in the second year, in the first semester the module is actually being divided into 2 sections and previous to this year I dealt predominantly with wet printing and, well, there were various things the students wrote a report on all different types of printing which included digital printing as well as sublimation printing, engraved roller printing, screen printing, block printing and so on. And [...] also did a lecture which was more on designers who use digital print as an output for their work, and that ranged from designers who work as sole traders, freelance practitioners and designer-makers, to companies who were beginning to use digital print within a mass production scenario, although obviously within things like furnishing textiles particularly, it hasn’t been adopted for mass production because it’s still far too expensive and that was delivered in a lecture format so the students went off to research it in small groups as one of the print methods for a report in [PD]. They also had the lecture on digital design as well in P for D. because of the nature of the module – as an exam-based module – and the coursework element has to be fairly limited, there wasn’t really the opportunity because it was being delivered in one semester and we had to put everything in, including things - print finishing and so on – and all the chemical print recipes for illuminated discharge printing and devoré printing and all that kind of thing and workshops to do with that all had to go into P for D in that one semester, so because we were covering all these different printing methods, there wasn’t a lot of that could cover digital print particularly in terms of students being taught software and taught more about the digital printer, we used to take them into the digital print room and show them how the machine ran and that kind of thing. This year, now that [...] is on board, the module is now running over 2 semesters so it’s running for an entire year. [...] has been allocated for semester 2 as technical support for the module, and [...] has been allocated for semester 1 as the technical support for the module. So that’s now meant that semester 1 really becomes more of a digital print focused semester while semester 2 focuses on the wet finishing print methods and so on, and [...] is doing more of that and she’s also incorporating some elements from a different module that used to run in the first year that [...] used to run, and she will have the details of that if you ask her. So that’s meant that this semester for the first time really, we’ve been able to look at addressing more issues to do with digital print and more teaching to do with digital print so we’ve tried to schedule a series of workshops to introduce the students to how the digital printer works, but again to limit the amount of time that they have to prepare work we’ve asked them to, say, bring in existing designs and
just alter the colour balance of the designs - they can print out samples. And that’s so that for the next design project they’re aware of what the relationship is between what you see on a computer screen, what you print out on paper, how it prints out on the digital printer, and then what it’s actually like after it’s been steamed. So that hopefully in the next design project when the students are printing their own large scale furnishing designs digitally, they will have a better understanding of how to work with colour on screen, when they’re designing in Photoshop or AVA, to get the right colour combinations that they want out of the printer; But that was because we can only have a small amount of students in the digital print room working with the computers and the printer, the group had to be split into 4 groups and rotated around 2 weeks during the 2 hour session. There are also lectures that needed to be delivered in that semester, one by […] on colour calibration and one by […] on designers who use digital print. And all the other things and the notes that they used to have about wet printing have all gone across to […] to semester 2. What I’m hoping to do if P for D was to continue as a module, I don’t think it will be, but if it was to, what I was hoping to do was get together with […] and review how we could actually get the students working with AVA software during the P for D module to actually get them more up to speed with digital printing and design for digital print ready for the semester 2 design project. The problem, as I’ve said, is student numbers and only being able to have a small number of students sat at the computers in the digital print room during a workshop session, and the amount of time that we’ve actually physically got in the module. We’ve had 2 sessions of AVA demonstration as well, but that 2 hour session had to be split into 2, one hour sessions to again get the student group numbers through – to have the group small enough to see what was happening and get the information. I think one of the issues the logistics of actually teaching things like the AVA software to the students so that they can then actually go and work in the digital print room independently and theoretically then operate the printer themselves. But personally, I think students operating the printer themselves is going to lead to a lot of problems with fabric jams and blockages with the ink cartridges and things like that, knowing the problems we’ve had in the past and the problems we currently printing out fabrics, I still feel that the actual operation of the digital printer in terms of output of fabric is best done by someone like […], and for him to have that as part of his rôle.

AC: Thank you – that was very thorough!

That was probably about five questions worth!

Q.1a what are delivery methods?
AC: My next questions was how are all these elements taught to the students – how are they delivered - and you’ve said that it’s a combination of workshops and lectures across all the different staff involved, so they’re given practical demonstrations and hands on activities as well as the lecture programme and the projects they have to work on, so it’s a combination...

Well, obviously in P for D, this semester we’ve just initiated some workshops and the lectures are there anyway, but we’ve again cut down on the number of lectures so that they can do the workshops. […] obviously covers digital design teaching in her module as well. Then CAD is actually input into the design module in terms of the students taking what they’ve learned and actually working with it in a design project – the student would then, for example, with the […] project that we’re running next semester, in the past students have brought their own laptops in and I can sit with them in the studio and if there’s something that they don’t know how to do in Photoshop I can run through different ways of tackling that issue, different ways to do that in Photoshop, so that’s quite helpful, because the students have got a body of knowledge about using Photoshop and I probably have some different ways of doing things so I can just show them different ways of achieving things there and then in the studio, but if they’re working in the CAD rooms I can pop up there during the design slot and see them when they’re working.

Q.2 What are the students taught about colour management?
AC: OK. Can I ask you what students are taught specifically about colour matching issues in digital textile print?

Up until this year not very much really and I think it’s been a missing component of the programme, probably. One of the things that I think is very difficult here, particularly for print and issues related to print design and production, is it’s difficult to find out what is going on in other peoples modules – what’s being taught – and so there may be some technology modules where that kind of information perhaps could be delivered and I think it’s one of the things we have to address in the restructuring, particularly with print is what’s actually being delivered in terms of information about colour calibration and so on, in modules that are to do with coloration and finishing and so on.

Q.3 Why is it important for colours to match?
AC: Thank you, why is it important that colours in a digitally printed design in a textile match the colours as seen on screen or on paper?

Well, first of all, when a student goes out to work in industry and files have been sent digitally, possibly from a studio base to a printer, you’ve got to know that the colours that you have on screen are going to be what you receive back on fabric. If you’re working in-house in a company you can actually go and check with the printers in the company that that’s going to work and so on and so forth, and you can do test match prints and sample prints and so on. But if you’re working as an independent sole trader and you’re having to output fabrics, say through Belfords or the Silk Bureau or wherever, then you need to know that – because you’re paying per metre for the fabric - that what you’re going to get back is going to be the right colours especially if it’s for a specific client and it’s also got to match in with, say screen
There are probably loads of things actually about digital print that could be included. Probably a lot more personally to me creates a very, very flat 2D surface – every texture, every mark is completely pared like optical illusion, tromp l’oeil, kind of effects very photographic type images as well. But digital print, visual lectures about it. You’re talking to a designer here rather than a technologist, so from my point of view it’s included and what’s its function in the programme?

How it fits in to the programme is that it’s I would say it’s literally half if not more now – three quarters – of the print output that the students do – particularly in the final year. And because the industry is becoming increasingly digitized the students and the course need to move with that. I think there’s at the moment, there is probably too much in the [BSc] programme which is one of the reasons that I’ve tried to develop a new programme that focuses on printed textiles and surface design. One of the reasons for that is that so we can tailor the teaching more towards the 2D elements of surface fabric manipulation and print and hopefully actually get more involved in the digital printing aspects and also provide students with more of the CAD training that they need to be able to work with digital print, and also combine digital print with other things in terms of wet screen printing as a kind of post treatment to designs, to add value and so on.

Q.5 Is digital print a tool for design or technology?
AC: Do you see the digital textile printer as a design tool or more as a learning tool to help students understand the complexities of colour matching for their future careers - so basically is it a creative design tool or is it a technological learning tool – or is it a bit of both?

I don’t see it as either actually. I definitely don’t see it as a design tool. It’s a machine that outputs what you put into it. So what you get out of it is only as good as your compositional capabilities, your colour way arrangement capabilities as a designer - again, as a learning tool it can facilitate learning but it’s just one of the vast array of pieces of equipment in terms of technology that we have here, so I very much see it as a piece of kit, it’s a piece of equipment that we have and it really is only as good as what goes into it, and that’s what we need to address, because it’s actually about how we teach students to design using computer aided design programmes that we have here, such as Photoshop and AVA and Lectra and how students understand what print design is about in terms of composition and colour ways and colour arrangement within designs and scale and texture and getting visual texture within a "d format, all those kind of things, those are the important things that students need to learn in order to really work with the digital printer.

Q.5a keeping up with technology
AC: OK. In digital printing the latest software – it’s important to have the latest versions of software – do you think it’s important to look at the printer itself in terms of its performance and its capabilities – and its possibly obsolete the model we have downstairs – do you think that’s something that needs to be looked at also?

Yes I do think it’s very important to keep up to date with the advances in digital print technology and to be able to afford the get absolute best piece of kit that we can in terms of a digital printer or printers, and ideally it would be good to set up 2 or 3 different printers to deal with different dyestuffs and different materials and do things so that then we could possibly conduct research just using one of the printers with certain dyes, certain materials, and so, I’m really interested to know what might happen if you could put devoré paste through the printer, what might happen if you were to put illuminated discharge dyes through the digital printer - a comparison between maybe that and laser marking fabric, which can give you almost a discharge printing effect. So I think it is quite important that you have the right amount of kit and the most up to date kit that the university can afford really.

Q.6 How does BSc differ from BA?
AC: Thanks. How do you think digital textile printing as part of this BSc programme differs from a BA programme?

On a BA programme there is a lot more output of digital print that goes on because there’s a lot more design that’s taught, therefore the demand for digital output is greater. It’s required more in the projects, so the students get more experience of digital print and the CAD software used to create designs for digital print within a BA programme.

Q.7 What else should be included?
AC: Is there anything regarding digital printing that you think should be included in the teaching content that isn’t at the moment?

There are probably loads of things actually about digital print that could be included. Probably a lot more about how it’s being used in industry and as well as how independent designers use it. I try and cover some of that all within one lecture and I think that that could be split down certainly into 2 separate visual lectures about it. You’re talking to a designer here rather than a technologist, so from my point of view it’s very much about getting the students trained up in the software so they can use the digital printer effectively but also understanding what’s going on out there with innovation in digital print. Digital print is excellent for things that screen printing can’t do - for things like graduated tone, almost like optical illusion, tromp l’oeil, kind of effects very photographic type images as well. But digital print, personally to me creates a very, very flat 2D surface – every texture, every mark is completely pared
down to one visual plane, and it’s post-treatment of the fabric, through extra screen printing, flocking, surface treatments that can combine screen print with digital print and hand treatment effects combined with digital print to create really interesting fabrics I think that’s really what I’d like to see more of going on, and that’s why the proposal for the printed surface design programme has been put forward.

Q.8 Any other comments?
AC: Thank you. Do you have any other comments about the digital printing aspect of the programme that we’ve not talked about? Let me think...I’ll come back to you on that one.

AC: That’s fine. Would you be happy to be involved in a focus group with other staff involved in digital print?

Absolutely. That’s fine.

AC: Thank you.

[End of interview]

Q.1 What are the BSc textile design students taught about digital textile printing?
AC: I’d like to start off by asking you what are students on the BSc programme taught about digital textile printing?

Right...well I don’t actually teach them anything about digital textile printing, so I guess my answer is what I think they’re taught – they’re taught Photoshop, and they’re now being taught Lectra packages but it tends to be just about taking their designs and putting them into fabrics I don’t think there’s a huge amount of underpinning theory taught currently.

Q.1a what are delivery methods?
AC: OK, thank you. The second question is, how is the teaching content delivered - what form does it take?

The teaching content tends to be delivered in a slightly disassociated way I think, because students certainly in the past have been handing in discs with designs and just getting the printed designs back and they’re not actually seeing their designs go on to fabric, and the fabric come off and the difference in, for example, the colours in being printed, being steamed and coming back to the students as finished fabrics... I guess it’s delivered in CAD labs to put the designs together, but that’s as much as I know really. As I say a lot of it certainly in the past has been students handing in their designs and getting their design work back because it tends to happen at Easter periods or Christmas periods when they get a lot of fabric printed, which doesn’t really give them an opportunity to learn from the process and how the process actually works.

Q.2 What are the students taught about colour management?
AC: OK. What are the students taught about colour matching or colour management issues?

Again – I can’t give an answer for what other people teach, but I suspect very little really.

Q.3 Why is it important for colours to match?
AC: Why do you think it’s important that colours in a digitally printed design on a textile match the colours as seen on screen or paper?

Because otherwise you’re producing something on screen, on a monitor, that you’re not able to produce in practice, and it just seems that you’re trying to spend a lot of time getting your colours right and then what you print is completely different or substantially different, so there’s a big gap between the two.

Q.4 Why is digital print in BSc programme?
AC: OK. How does digital textile printing fit in to the BSc programme – why is it included – what do you think its function is on the programme?

...what is its function...I think its function has tended to be as a quick way of taking students’ design ideas and putting them onto fabric. I’m not sure it’s been terribly well considered in terms of how it is actually used in industry, which up to fairly recently been mainly to do with sampling and colour separations. We haven’t in the past really taught anything much about colour separation as far as I’m aware. We really should and I guess the other thing is there’s lots of opportunity now for students to use digital textile printing to create really exciting and quite different designs because they’re not limited by the number of screens. But again they really have to understand a bit more about what the process is about and how the process works to do that effectively.

Q. 4a
AC: How do you think that could be best achieved – to introduce more of that into the programme?

I think there needs to be some tutorials or lectures that underpin the actual process. I think students need more time to get involved which is difficult because of timetables. Whether we could actually look at some people specialising Maybe we could look at some people specialising – in the 2nd year everybody
does digital print, but the final years who want to do a significant amount of digital printing - do have a lot more contact with the digital printer, are able to work out better how to do things. Maybe we should look at what some other universities have - colour atsles printed out so that they know what they’re going to get, and it should be much more about – it’s a BSc degree after all – they should be much more informed about how they have to specify colours when they put the colours in and work with colours rather than just scanning colours in and having any sort of random colours.

Q.5 Is digital print a tool for design or technology?
AC: Do you see the digital textile printer as a design tool or as a technology tool in the programme or neither or both?
I think currently it’s just a design tool – currently it tends to be used as a way to get a design idea quickly onto fabric and I don’t think there’s enough thought into how that happens and the students haven’t really - they don’t really get that background, that underpinning in technology or information at the moment – or they haven’t - I think it’s getting better.

Q.6 How does BSc differ from BA?
AC: How do you think digital textile printing as part of the BSc programme differs from that of a BA programme?
I think that students should come out with an understanding and when they go into industry they should be able to say what’s good about digital printing what doesn’t work about digital printing, and they should have a much better understanding of colours - colour matching just generally not just on digital printing - they should have a much better understanding of colour and how colour works both on paper on monitor and on fabric

AC: ...so that the technology and the science...
The technology and the science is understood so that when they’re in industry they can actually solve problems - because a lot of work as a designer in industry – and not all of them will go on to be designers obviously – but is actually solving problems, you can’t solve the problems effectively if you don’t really understand the process.

Q.7 What else should be included?
AC: O.K. You’ve partially answered what my next question is already, which is - is there anything about digital textile printing that you think should be included in the teaching content that’s not currently included?
I think that we’re moving towards including more of the underpinning in technology but that definitely needs to be included – they need to know about things like printer gamuts, monitor gamuts ...

Q.8 Any other comments?
AC: O.K. Thank you. Have you got any other comments about that section of the programme at present?
Not really – I think that we probably could do an awful lot more, and I think the combination of screen printing and digital printing is probably something that’s important and we’re just not getting students exploring that very effectively at the moment, and it would be nice to see if that could happen.

AC: Thank you very much!
[End of interview]
Q.1a what are the delivery methods?
AC: How is the teaching content delivered to the students for digital print?

Again, as far as I’m aware I think there’s some formal teaching through probably [...] I would think, and to some extent I think [...] – the fact that its digital printing its all about, I’m guessing, image manipulation on the software initially till you get to the point where you’ve got something that then can be printed digitally onto fabric. And so I think there’s a certain amount of formal teaching with regard to how they put a design into repeat on the software – the normal printing process of getting a design into a form which is commercially acceptable and able to be reproduced as a fabric, but I think the other part of the education, if you like, on digital textile printing, is to do with practical experience and I think [...] and [...], people in the digital area, are actually exposed to those students, and do work with those students and advise those students in terms of perhaps technically how they go about getting their designs in the system, rather than maybe creatively, but I think it’s an essential part of that education and that background to learning about digital printing, at the end of the day.

Q.2 What are the students taught about colour management?
AC: Do you know what the students are taught about colour matching or colour management issues in digital print?

Not a lot – the only thing I’m aware of in terms of colour matching would be with [...] potentially, I suppose they would print off a palette of colours that they’re using on the software system and then put it on to fabric and have it steamed and then see whether or not in fact they’ve got a match. The students would build up a palette of real colours on fabric that had been processed and then could be confident that the colours that are on screen match those on fabric – are consistent. Colour matching – I’m not aware of any colour matching going on in the real sense – it depends what you call colour matching – I used to colour match with woven fabrics, where you get a piece of fabric and you would have definitive colour that you were trying to achieve, you would then match that in a UV cabinet and if it wasn’t right you would make an adjustment to it, but that’s more of a commercial thing if you try and maintain consistency of colour for a whole run of thousands of metres – I’m not sure that our students go through that process – they may be aware of the fact that you’ve got to have consistency of colour, but I’m not sure that it’s necessarily relevant to their work because they’re doing individual one-off designs, so provided its right for them, they will move that forward into having a system available to allow that consistency to happen.

Q.3 Why is it important for colours to match?
AC: Why is it important that colours in a digitally printed design on a textile match the colours as seen on screen or paper?

Because I think if you’re relying on the software to manipulate the design – that’s what you’ll see, that’s what you’re developing, that’s what you’re hoping is going to be the final result, so it’s important that a designer – whether it be a student or a designer - has confidence in knowing that those colours are actually reproducible, consistently reproducible on fabric, so it would be a hindrance to the system I think, if they developed a design on screen and were totally happy with it - all aspects of it including colour - and then to be disappointed because the colour on the fabric actually isn’t the same – it’s vital that it’s right.

Q.4 Why is digital print in BSc programme?
AC: OK. How does digital textile printing fit in to the BSc programme – why do you think it’s included – what do you think its function is on the programme?

I think digital printing is the way forward in a way - that it is the modern way of producing printed fabrics. People are arguing, I think, at the moment that it’s not a mass production method, that it’s more often than not with companies used as a sampling facility and therefore if it can improve – I think there are in fact machines now that can produce fabrics much quicker and it is becoming a mass production method. It certainly is a very quick way of developing designs to reproduce onto a piece of fabric rather than going to the expense of actually saying ‘OK we’ve got a 10 colour design here – we’ll have to make 10 screens and sample 10 screens’ – that is quite expensive. But I think the other thing that students maybe need to be aware of but perhaps aren’t aware of is the fact that there are limitations in terms of reproducing fabrics commercially if they aren’t using digital printing as a reproduction method, or a production method I should say, so if what we’re saying is you’ve got digital printing which is allowing you to create a design and to print it onto a fabric as a sample and that sample is moved forward into mass production and invariably at the moment that’s going to go through the rotary screen method and therefore that is certainly cheaper for mass production than screen printing, but it’s still something that’s students need to be aware of in terms of colours – you might have a design with 80 colours in it that might look fantastic as a digital print but is totally impractical and not cost effective either to try and produce that en masse and so they need to be aware of limits that other methods of printing that will limit their design capabilities to some extent and would require them to flatten the colours on the system to the point that they have a finite number of screens that they would need if they were to take that approach.

AC: That’s why it’s important to have the more traditional methods included alongside digital in the teaching content – to give the students an appreciation of how they cross over but also to have an appreciation of how different applications suit different production requirements.
Q.5 Is digital print a tool for design or technology?
AC: Do you see the digital textile printer as a design tool or as a learning tool to help student understand the technology behind the printing process or is it neither or a combination of both?

I think it’s primarily a design tool. I don’t see that digital printing as a system informs students about what printing’s about – all they would see is the software – the computer side of it as being a manipulating process by stating either by drawing an image on the screen or by scanning an image and developing it on. The physical printing on to fabric doesn’t really inform them at all of what’s involved in printing generally, because the fabrics are coated and so essentially you’ve got an image which is superimposed on top of the coating there isn’t any understanding of different print methods – that is an issue that the students won’t understand purely from the process of going through digital printing. I think from the students’ respect – it might sound a bit radical this – but I think they see it as a means to an end – it’s an easy means to an end. You’ve got the design on the screen and ‘bang’ there you are - you’ve got a piece of fabric with the design on. I think if they appreciated the traditional processes and that includes things like colour separations: that every colour separation you do involves creative process because it’s like identifying the areas within a design and then painting them out for every colour, when you bring all of that back again – that is a process that one person’s done which creates a certain design ultimately, but somebody else may go through that same colour separation process and produce a similar design but there will be some differences, so you’ve always got a semi-creative process going on in colour separation. But colour separation in digital printing is an automatic process, there’s no hands-on involvement in that it’s really just something the computer does automatically if you want it to do it, but by and large even that process isn’t necessary because you’re printing directly onto fabric with all colours at the same time and so therefore you don’t need that process in place. That aspect of traditional printing is taken away if you were to only use digital printing as a method for students to get a design off paper, through a system and onto fabric, and I think that would be shame because I think there’s a lot more to it than that. But that currently, I think, is the way that (BSc programme) is going – they very, very rarely produce a print through the wet printing method. They’re shown how to do it, but I don’t think they’re necessarily encouraged to do it and I think they should – that’s my opinion because I think there are things available through wet printing that aren’t available through digital printing I think the students that need to be aware of that. I think there are a couple of students this year who are thinking about having digital printing as a basic format design and then taking the fabric on and applying a screen printed design on top of that. So they do see there’s a difference in that respect, there are certain looks and aspects of a screen printed image that does differ from digital printing and therefore it’s important that they appreciate that.

Q.5a Is there scope to explore combining digital/screen printing?
AC: Do you think there’s more scope then to explore that further, that kind of combining the two processes to innovate – to create...

I think so – I absolutely think that (this is a naive approach) – but I’ve always felt that whenever you produce on a wet printed design, whether it’s commercial or not, that image can be scanned into a digital printing system and reproduced you can’t do it the other way. And so I think it’s important that students are allowed to experiment with traditional, formal processes, but be aware of those processes experiment with them and whatever comes out of that at the end of the day can be analysed and scanned in and manipulated through digital printing. That’s where I see it as an advantage, not as a starting point or an end point it’s a process which allows high definition imagery to be scanned into a system and worked through to provide the necessary digital information to reproduce it onto a fabric so I think it’s important that the students do go through those wet printing processes and experiment with them – not necessarily formally, I think they have to know what those methods are, but I don’t think they should be limited to purely using that process as it’s taught – they should think out of the box a bit – say ‘OK this process gets rid of colour and provides me with a facility to put another colour on a dark background’ – there must be other ways of using that process to improve the image that’s going to be produced at the end of the day. It might be that the material being used doesn’t fully bleach out an area for example so you get a bit of a colour left over and you print another colour on top of it and you get something that is quite unique and not may be commercially acceptable – but I don’t think it matters - I think a designer should be a creative thing and should be going through that process with a lot of freedom to work with those processes as they want to, in the knowledge that at the end of the day whatever image they produce can be reproduced through digital printing.

Q.5b Is it important to experiment?
AC: So it’s important then to allow time for experimentation and for failure?

Yes.

Q.5c Is there time to experiment?
AC: Do you think there’s enough time or any time in the current course structure for them to do that?

No – I don’t think there’s enough and that’s the problem. I don’t know how you fit it in – I think definitely the first years should be aware and I think they already are but they’re not given the opportunity to fully explore it, the only way that would happen I think is if a student – you could have a second year project – but a student in the final year having had the experience of printing through at
least two projects wanted to then specialise in wet printing and experiment as much as they can with all of those methods to create unique effects on fabrics that would probably be the route forward because the problem again with [BSc programme] I think is it’s a very successful course – people accept that but the students get to know a lot of everything really, but are not expert in any one field and I think the fact that they only spend a very limited amount of time in any one area is in itself a problem in respect to developing any one process far enough to be able to be confident to come up with something new – the only way you can do that is to have specialisation at a certain point, whether that is in second year, or as it is now we go to specialisation in the final year, I think that’s the only opportunity the students are actually going to have to take on board from previous years that technologies and thinking about how they would work with that on a process-led project in the final year. But I think that it’s vital that at least there’s some evidence even if it’s only samples of printed fabrics that combine some of these processes and produce very unique effects, that students can identify and say that’s the sort of thing I want to try and achieve. Given that information they can go along and do it and I think that’s something I’d suggest is a good way of moving forward with any process, whether it’s knit, weave, or print, to actually have samples of effects on fabrics having samples of fabrics that students can point their finger at because there’s no way there ever going to gain enough knowledge to be able to look at a fabric and work out how it’s done. So the tutors have to be able to almost short-cut that and say OK what you’re trying to create, let’s look at that and see how we can develop it in that medium. And I think that applies to print, provided you can have an example in front of you of the effect the student’s trying to create you can then analyse it and say ok we can specifically look at those processes that are going to create that and move them forward in it rather than them trying to attain all of that knowledge in the two years they’re here before they finalise, which is pretty impossible.

AC: Just as an aside that’s interesting what you’ve just aid because I’ve found a PhD from someone in America who’s tried to recreate printing methods like batik and discharge printing through digital printing – they’ve tried to replicate the cracks you get on a batik print and stuff. They’ve taken it out and shown it to people and got them to assess – it’s just interesting...

Q.6 How does BSc differ from BA?
AC: You’ve partially answered my next question - how do you think digital textile printing as part of the BSc programme differs from that of a BA programme?

Again, without prior knowledge, I’d probably say they would get more freedom to create on digital printing without having the commercial format in place. So the thing I’ve already said about numbers of colours and things like that wouldn’t be an issue on a BA course, because they’re not necessarily expected to understand and apply the technology of it – they are purely using it as a creative tool – I would think that’s the difference. But they would also probably experiment more on the wet printing side as well, so it’s not just digital printing it’s just the process of printing becomes a creative medium not a commercially orientated medium and therefore they would likely have more innovative results from their experimentation than perhaps we would. Not that it should be that way because I think that even on a BSc course you can still have the technology in place that allows those students to be better informed on how they can apply those techniques and that in itself is innovative because I think they’re in a far better position to use these techniques, come up with something new, and understand how it’s been done and reproduce it.

AC: I think you’re right because I think the technology that’s included in the programme that runs alongside the design aspect gives the students the edge because they can then go out and they’ve got more options open to them, they’ve got the understanding of the process from both sides – from the production side, the technical side, but also from the creative side as well.

Yes – I agree with you there.

I think a BA course and a BSc course are looking for different end games in a way - we’re looking to try and train and educate students who can apply themselves to a position in textiles whatever that means – in manufacture or in retail – I don’t think that BA students are equipped to do that to be perfectly honest and that’s where the difference is – we’re almost trying to create – how can I put it – it’s a vocational course if you like it’s something to do with building a career in the future and having the tools to do it – not just tools about textiles but tools just general transferable skills and things like that. And I think BAs lack that – they’re more into being completely creative that’s what accepted as being their ‘bag’. I don’t think they can immediately apply themselves to a commercial environment.

AC: They would need further training wouldn’t they…?
True.

Q.7 What else should be included?
AC: Is there anything about digital textile printing that you think should be included in the teaching content that’s not currently included?

I don’t think so. I think the thing that’s happening at the moment with regard to giving students some sort of ‘guide’ to how to use the system is being covered. I’m a firm believer in ‘idiot’s guides’, whenever I work on anything whatever it is I tend to write things like ‘turn the computer on’, that’s the way to go forward I feel, because if you go down the route of actually having a users’ handbook or manual they’re covering absolutely everything and they don’t necessarily do it in a ‘user-logical’ way. So if someone can
write something that starts with ‘turn the computer on’ to doing the absolute basic thing, say of scanning an image and how you would do that, how do you paint a line on the screen – stuff as simple as that. Then if that’s available to any student then it’s more likely, I think, that they would have success on the system and receive the minimum amount of supervision to do that. People have attitudes that manuals are on the web – just go out there and look for them – that’s OK, but if you’re looking for something very specific it can take time, and it also sometimes assumes prior knowledge in order to go down that route. I think if you can write a manual or a tutorial for the system that is a manipulation style of the system then that’s going to improve how it’s used and the usefulness of it straightaway.

Q.8 Any other comments?
AC: O.K. Thank you. Have you got any other comments about that section of the programme at present?

No, that just about covers it.

AC: Thank you very much.

[End of interview]

Q.1 What are the BSc textile design students taught about digital textile printing?
AC: I’d like to start off by asking you what are students on the BSc programme taught about digital textile printing?

I don’t deliver any content on digital printing to [BSc] or the technologists, yet the scientific colour management aspects of that do interest me, so in the last couple of years as part of undergraduate degree projects the dissertations we’ve had and a couple of projects – we’ve got one currently running – and one last year which looked at how veridical [truthful or accurate, especially concerning perceptions: OED online] – that’s a good word for you – how true the on screen colour display is compared to the final textile print. And that’s ongoing research – what we’ve found so far is that some colours match very well and other colours are nowhere near. Which I’m sure you could tell me anyway. So that’s quite interesting. The next steps in that research is to look at why certain colours aren’t coming out particularly well and whether we could improve them by using certain algorithms etc.

AC: Do you – are you involved in any of the online – eLearning parts…?

Nothing for – specifically for digital printing – so I don’t deliver any content in digital printing, although I’m very interested in it.

AC: It’s interesting though, because some of the questions you can answer because they’re generic questions but because of your expertise you’ll have an opinion on them.

Well, I’ll probably not know the answer to them to be honest!

Q.3 Why is it important for colours to match?
AC: I’ll move on to ask you why it is important that colours in a digitally printed textile design match the colours on screen or on paper?

Because colour is vitally important, as you well know, if you look at any of the studies in consumer behaviour – why did you choose that garment? Number one is usually style, number two is usually colour, number three is usually cost, or it’s one version of those three variables. So you should absolutely get the colour right, and its something we’re very good at doing in traditional screen printing – we can produce pastes that are very colour accurate. But there’s not so much research on digitally printed textiles. There’s lots of research being done on paper – paper’s a slightly different substrate to textiles. The way that you model how colour appears to people, how you specify colour, is probably a better way, requires a different set of models when you’re using something like a digital half tone, which is pretty much what your digital printer is doing – and again, hardly anything published on that really. There are a few books that take the technology we’ve used on paper and then use them on digitally printed textiles but very little else, and if, as we believe, these are going to become production level equipment machines, then really we should be investigating them to the full so that we can produce very accurate colour. The interesting thing about those machines up there is that you’re using the subtractive system but you’re not using the standard subtractive primaries and nobody can give me a good reason why we’re not. So I’d love to know the answer to that if somebody else has told you! That’s part of the reason why we’re not getting such good display-to-final-product reproduction.

AC: From what I’ve seen about the choice of colours in machines similar to ours, is there a variety – there’s not just one set of colours used across the board – some people might use a magenta and a red, some people might use a magenta and a light magenta, and interpose other colours into the available slots that they’ve got – so that’s interesting in itself.

But for the gamut mapping – because we know that the range of colours on an emissive display is different to the range of colours produced from subtractive mixing from pigments or dyes in our case, and usually the problems arise when the two are mismatched so the gamut of one, or your target colour, is outside the gamut of one of the devices, and the holy grail for colour science and colour reproduction is called device independent colour space where you specify a colour on this independent colour space and regardless of what device you’re talking about, it renders it to that precise colour.
AC: I’ve been reading a lot about CXF, so that’s kind of like the latest move in that direction to try and develop something like that – I can’t quite get my head round it! Because the information that I’ve read in journals is very general...

Yes – the difficulty you have, is that if you’re in the graphics arts industry, if you’re in the paint or plastics industry, if you’re in screen printing, they all use slightly different formats for things, so even if you go to the Society of Dyers and Colourists and you look at their standard file formats or if you look at the colour RAW type formats they’re all slightly different – they’re all trying to do the same thing but there’s no overall specification, which is what they’re trying to do more and more of now – they’re trying to say ‘OK – let’s have a look at all these international standards, where should they fall?’ – We should have an umbrella standard for many different disciplines. But people are quite resistant to that because they’ve always had a little part of that world that they control. I suppose that’s a discussion for another day. I mean we both know that actually producing that target colour is actually more complicated than people think it should be.

AC: And the more you look into it the more complicated it gets – it doesn’t get simpler at all – that’s what I’m finding anyway.

OK. If we go back to... Let me go back because there’s one thing that’s probably quite relevant – we are putting together a colour knowledge base, but it isn’t just specific to digital printing, it’s more like a colour science – it’s almost like a Wikipedia on colour science which all the students should be able to get their hands on at some point. Not overly-tailored to digital printing because, as you well know, doing your literature review and looking at all these different techniques of producing half-tone images etc. then the physical models as soon as you start going into those - droplets of dye – they’re like little filters on top of other droplets of dye, then you’ve got the optical gain from whatever’s in the substrate as well, so you start off with quite simple models and you build yourself up to ‘Neugebauer’ and ‘Doppler München’ things like that...

AC: ...You’re losing me now!...

...which are quite involved.

AC: So this module that you’re developing – is that going to be an online module?

I’m not sure it will actually be a module per se, I think it will be just be an information resource - when that actually comes online will be a different question.

AC: I think that’s really interesting, to hear that, that’s happening - I think it’s really good, the more information that students have - it can only enhance what they’re doing.

Very much so – I think the difficulty is in school most of our students are taught subtractive colour mixing so when they come to university and they start to look at coloration processes they assume that’s the be all and end all of colour mixing, but of course monitors work in a different way and capture devices might work in a different way, so you have to have that rounded knowledge.

AC: And you have to learn a whole new way of mixing - you’ve been taught there are three different primary colours - it’s a completely different ball game.

Absolutely – even to the extent that if you go into something like Photoshop you mix in RGB – you don’t mix in RGB as a kid! RYB probably as a kid, so you took a big can of poster paint – your red, yellow and blue and mixed them together in whatever amount you wanted to make yourself a big a range of colours as you wanted.

AC: And why is it when you mixed all your Plasticine colours together they make that sludgy brown?!

That sludgy brown! Subtractive mixing! Why do they have a black in CMYK because they’re not perfect – each of the primaries you use in that system are not perfect - they don’t remove a block of light in each part of the spectrum so what it actually leaves you with is sort of a muddy brown colour and that’s why they put a black into your printer so you don’t have to have a sludgy brown there.

Q.4 Why is digital print in BSc programme?
AC: Marvellous! You’ll have an opinion on this I’m sure – how does digital textile printing fit into the BSc programme – why do you think it’s included in the programme – what do you think its function is?

As I said to you before I think it’s the future and they will be production level machines. I know that the technology we’ve got up there is quite slow at the moment, but if you actually look at what’s available in the market place, it’s incredibly fast. It will replace the current huge production level machinery that we have. It will be faster it will allow you more flexibility in what you do, there’ll be less down time – it’s the future so it must be there really, and I think that it would be doing a disservice to our students if we didn’t give them the opportunity to see what is the next move forward.

AC: So do you think it’s important then to make sure that the kit, the machinery reflects more current developments in that the software that the students use in CAD for example, is constantly updated but in
some ways the machine that they’ve got to print their textiles on is pretty much obsolete at the moment – I know it’s fantastic to have a digital textile printer whatever its age, but it’s kind of a little bit out of sync with other aspects – with CAD aspects.

It certainly needs to be resourced properly, in that you can’t do something like this half-heartedly; you have to have the correct inks and the correct profiling software, and if you want to give students a realistic experience of what it will be like in industry then obviously as modern a set up as possible is desirable. I know what you’re saying – it would be lovely to have these new printers and I think it would be a nice step forward. But just to give them the skills in the first place would also be worthwhile – and is worthwhile, and I think the students who currently use the system benefit and I think they find it a flexible and enjoyable way of expressing their designs.

Q.5 Is digital print a tool for design or technology?
AC: Do you see the digital textile printer as a design tool or more of a kind of learning tool – the technology behind it – or is it neither or a combination of both?

I think it has to be a combination of both, I think most activities in this university now have to be research informed teaching. I think that the research does inform the teaching so that both sets of students will get benefit from using the kit even though they’ll get slightly different things out of it. There’s one thing understanding why you’re getting a certain colour specified and how that’s being achieved and the flexibility given to a designer who wants to produce a complex design, an interaction of these different colours. I’m sure that both students will get a lot out of understanding and improving that colour specification and also seeing the results of what they’ve designed in a correct and accurate way of being portrayed. I’m not sure what to say about that – it’s interesting, I think it’s a resource for both sets of students – I’m not sure that it’s being utilised effectively – it seems to be quiet for a lot of the time, where actually it’s a brilliant resource that not many people have and we should probably make more of – certainly in an open day I’ll take everybody around and say ‘we think this is the next generation of equipment – you’ve got the opportunity to have access to this.’ It just seems a shame for it to be quiet for so long.

AC: Like you say – hopefully things are going to change...
It is difficult because we are at a time of transition where a lot of the courses are being redesigned anyway – and it may be that the incorporation of colour across all the courses gives us an opportunity to introduce digital printing in a bigger way. It makes sense to do that because all the students, regardless of where they end up will be touched by that technology in the next ten years.

AC: So it’s the opposite of a vicious circle whatever that is – if the resource is subscribed to there’s more of an argument for maintaining it and improving it, so if it does touch more people in the School it would be a good argument for that.

Absolutely, very much so. And it’s not an isolated activity – printing per se – it’s quite an active activity throughout probably all of EPS – we’ve got people with interests in building cell scaffolds and all sorts of things over in Materials and we don’t really see much of those, we’ve got people with interests in commercial type printing systems in Chemistry. So it might be an idea to try and focus a bit more on these activities.

Q.6 How does BSc differ from BA?
AC: How do you think digital textile printing as part of BSc programme differs from that of a BA programme?

I would say in order for it to be part of a BSc you really need the rigour of allowing to try and understand the colour management aspect of what they’re designing on – so the display technology, but also to understand print technology as well, and also to incorporate both of those aspects actually when you look at the colour specification and reproduction aspect of that – that’s really quite heavy-duty colour management, and if you can understand that then you’ve got a good grasp of physics and mathematics as well, so even if it’s a fairly superficial overview, people should understand that these devices work in a different way and how they work, and then perhaps for the technologists the exact implementation of some of the algorithms as well – perhaps final year - because that is quit heavy duty stuff and it is the subject of a lot of peoples’ research, so obviously you can take that as high as you like. You can go from something superficial like quite easily talking about colour profiling the monitors using colour emitters and built in calibration routines, to having a look at how the printers produce particular colours and how they’re dealing with a substrate that isn’t actually neutral – it’s usually slightly yellow or if it’s got a coating on it – it’s a slightly different shade than neutral.

Q.5b Is it important to experiment?
AC: Do you think the students should have – I know it’s an absolutely jam-packed programme – but do you think there should be more time for students to experiment more with digital printing and innovating with it – maybe combining it with more traditional methods to come up with new techniques and surface designs? – the printing they do is very much project led for very specific outcomes and there doesn’t seem to be much room for trial and error – to try things and for them not to work, there always has to be a learning outcome with a presentation or an outside company comes in and leads a project and it has to be successful.
That sort of blue skies research helps people move boundaries I think, but it’s becoming less and less common. I completely agree with you but I’d probably go a step further – I would say that when we come to produce dissertations or projects or whatever it should be – they should be more widely circulated, so for instance if I’m interested in some aspect of colour, generally that will be circulated amongst the technologists for their final year dissertation, but there’s no reason why it couldn’t go to everybody in the whole year, and then they could come to me and give me some ideas – then you start to build different ways of thinking about colour or materials and I think that’s where - and we give great lip service to this technology-design interface – would really work, because you’d have a more rounded student, perhaps a more scared student, because one aspect, either the design aspect or the technology aspect they may find more intimidating, but certainly the students who were capable of doing that would get a lot more out of it.

AC: In terms of a medium it’s still an emerging technology – it’s still new, and what it can do will ultimately be decided by people who do push it and try things with it and allow failure to happen so they’ll learn from that. So it’s almost like students are in a position to do that but they don’t have the time to do it. They’re in an ideal scenario to try new things but they don’t actually have any leeway to do that.

It’s very difficult I think, as you said, there are such pressures on the syllabus for each year that actually cramming more in or allowing students a bit more flexibility to express their creativity is becoming more and more difficult. It could almost be a separate programme in itself. It could - I’m not sure you’d be able to ask this – how much do the masters’ students use it? The masters’ students using it would be very interesting as well.

AC: I think there are plans afoot to do something like that, but it’s always time –you can’t spread yourself so thin. I think in an ideal world the masters would be more involved with it and do more experimentation and put different crazy things in with the colorants...

Well this is it - those are the interesting steps forward, when you start to look at these effect chemicals and adding them in instead of just having these straight dyes. Having a look at overlaying different sorts of surface chemicals and interesting things.

Q.7 What else should be included?
AC: My last question was really to ask you if there’s anything about digital textile print that’s not currently included that you think should be included, but it’s not relevant now.

It’s a bit difficult! I’d like to include all sorts of things, but at the moment the only people who get a fairly brief visit into colour technology, colour science, colour management aspects are the second years – but hopefully we’re going to address that and everybody will get an appreciation of the colour, how much you can actually include then – it would still be quite a whistle stop tour, I think, of all sorts of different technology and coloration processes but I think we’ve both said it’s what we believe will be the future, so we have to embrace that I think because if we don’t somebody else will.

AC: Thank you very much.
[End of interview]
Transcripts of group interviews with educators

[Introduction to session – thanks etc.]

AC: [To someone writing in the ‘What’s missing?’ section]: Do you think they’re all essentials? – or desirables?

No – they’re all desirables – perhaps, and I think we’re doing some of it already.

I’m kind of thinking it’s done in a very haphazard way at the moment; it’s a bit *ad hoc*.

If anyone knows for sure whether any of these are already included – somebody must know! Somebody must know if any of these are already included.

Well obviously not – there’s nothing down that column!

I guess the only one I know for sure – and I’ve not stuck a sticker at it - is the one you did for the designers the other week, about colour management and gamuts – so should I have stuck that in? But it’s ‘already included’ in a very *ad hoc* way – it’s not embedded in the programme, in the unit yet.

AC: I think that’s what I’m after, yes.

AC: It might be worth re-mentioning that there is a column which is called ‘already included’ because people are concentrating on whether it’s ‘essential’ or ‘desirable.’

I ignored that...I’ll go back to that later.

There’s no ‘don’t know’ section.

AC: No what section?

‘Don’t know’ section...

Oh right...stick it on the line!

Well I guess if we’ve not stuck it on ‘already included’ it means we don’t know or it isn’t.

So if you do – if you deliver any of those bits yourself...

AC: OK. How are we doing for time – we’re OK, we’re on track. Just a couple more minutes then we’ll have a chat.

AC: OK. so thanks everyone, I should say that now that we’re going to start talking about what everyone’s done that it would be easier for transcription purposes if one person spoke at once. Though I realise that it may turn into a heated debate!

Do you want a hand up? We can do that.

AC: Yes, something like that – just to make it easier to transcribe, that would be great.

AC: And also to say that this is for my research so everyone can speak freely and say whatever they like –

And try not to swear too much –

AC: And try not to swear too much – but I will leave that out of the transcript! So we’ll have a look at these results then and have a chat about them. It’s quite interesting how there’s a few things there that people think aren’t really important to include – so maybe we could start off by talking about them. Whoever put those ‘non-essential’ stars in there might like to say how they came to that conclusion.

I think for the first one [colorants used in digital textile printing: what they are and how they are used] I put ‘non-essential’ because I’m trying to think what the student requires at the end of their experience and what they take with them, and I’m not sure if that’s essential at all in their future careers – I’d be inclined to put it as ‘non-essential’ for that reason.

Is the designer not one of the persons who should be saying – ‘this print must be done with a dye’, or, ‘this print must be done with a pigment’ bearing in mind the use of their final print?

I think it’s good if they can, but I think in reality in industry that’s not what happens.

I think they communicate with somebody who has the expertise to do it but not necessarily dictate that’s the route the design needs to go down.
But as you said– it’s good if they can. I’m striving for the best students ever. Because we all agree we have good students.

I put down that it’s essential because of what they do while they’re here as much as much as what they do when they leave. They need to know that if you print for instance, a reactive, that it isn’t finished when it comes off the printer, but if you print a pigment, it more or less is.

AC: Has anyone else got any thoughts about that?

I put ‘desirable’ because it is desirable – it’s not absolutely essential – it’s preferred, definitely.

And colorants are covered in first year, aren’t they – in the lab classes to a certain extent?

Yes – they are taught in Coloration – in Coloration in the first year.

And does that extend to digital textile printing at the moment, or…?

Well, they should then know the difference between a dye and pigment and what different dyes are for different substrates. However, I always – always she says! – I always do it briefly again with the students, because I do find that they do need at least a little bit of a reminder.

What unit is that taught in?

It’s […] units, in the first semester.

Is that like the Textile Processes – what used to be?

I think so – last year at least, and the year before that, it was the first year, first semester where he does all sorts of stuff.

AC: Has anyone got anything else for that one, or shall we move on – somebody felt it was non-essential to have a look at how digital printing has evolved – would that guilty person like to have a chat about that?

I think it was me – the evolution of digital textile printing per se, well in terms of digital printing – you’ve got a different substrate and actually the amount of research on digital printing on that substrate using ‘Drop on Demand’ – there’s not that much out there. They’ve talked about the technology since the 1800s, but it’s not until the 1990s that we’ve actually seen it being able to put into a proper production system. The way that the inks interact with the paper is different from the way that the dyes will interact with the fabric, so that’s why I put ‘non-essential’ there really. Although a lot of the algorithms you use are the same, and you get sort of ball park similar colours, there’s not really been – only by the printer companies themselves – they’re the only people who have done much work on looking at ‘well should we be using the algorithms we’ve developed on paper on here anyway?’ So that’s probably why I said ‘non-essential’, because there’s not that much work on it.

AC: What do people think who thought that was a ‘desirable’ element?

I think I put it was desirable because of trying to stress the difference between printing on paper and printing on textiles – letting them know that it evolved from printing on paper, but that there are differences for printing on textiles and what those differences mean. Because they are so much more familiar with digital printing on paper – it’s always a good starting point.

I think in a way the second question has come out as ‘desirable’ rather than ‘essential’ – I think it’s an essential element for students to appreciate the aesthetics, if nothing else, of the fabrics that they’re printing on so it is important I think that they can differentiate between fabric and paper as a substrate and particularly the more textured fabrics, and have an appreciation of how a textured fabric could affect the quality of the print, for example, if it’s a very rugged-surfaced fabric and you put a print on there it’s obviously going to break it down, and all of that is a design experience, effectively.

AC: Anyone else got any thoughts?

I’m just not sure how this actually works with the evolution of digital printing.

Just talking about how it...

compares or not compares –

How things had to be adjusted for textiles from existing machines...

...or possibly need to be adjusted for textiles in the future...

I look at some of these different categories and I think there is this overlap, so I look a the next section of how the digital textile printer works and I think, well they need to know that more than how to print on paper because that’s not really relevant. So there is a kind of overlap between sections.
AC: It was very difficult to actually separate things out...

Absolutely...

AC: Especially with the colour elements, because... you kind of have to do one – you can’t really you know – one very small thing leads on to a domino effect and you need to know surrounding information to get it. But hopefully it will spark off some interesting discussion and some thoughts.

In some respects it might be actually quite interesting to say what’s the most important element and the second, you know, almost in order, to rank them...because things like how a digital printer works – yes, it’s helpful to know, but actually, our students haven’t got a clue, most of them, how a digital printer works.

I’m hoping they do by now!

Well hopefully, yes!

It’s already included!

It depends how much depth you go into.

I think I was the ‘non-essential’.

Actually I haven’t taught it yet.

It’s proposed for part of the BSc programme?

Yes.

AC: We’ll talk a little about – in the next activity we’ll talk a little bit more about that. So we’ve got down here that someone thought that it perhaps wasn’t important to include principles of colour technology, different types of colour mixing and the impact this has on digital textile printing. Would someone like to have a chat about that – why they thought that?

Well, it’s specifically about digital textile printing and I think there’s a difference between digital textile printing principles of colour technology and everything else. I think generally textile printing – they do need to know all the principles.

What – they don’t or they do?

I think they do.

You mean for silk screen printing...?

That sort of thing – this is for digital printing specifically.

Well I think it links well with them understanding the colour management on the ground, because the way of creating colour by digital printing is quite different than through traditional methods where you use spot colours, so it was trying to draw that out so that they can really understand there is a difference and link that with difference maybe in the sampling, that sort of thing.

It’s true; I think that’s a point really worth making. When you’re looking at dyeing – straight dyes – or even if you’re using screen prints or whatever – the way that you’re colouring fabric is completely different compared to dropping a small amount of dye onto there which will act like a filter and then get some sort of – well I’d say optical dot gain, but you can’t say that because it’s not paper – so it’s treating these little dots as filters and if they overlap then there’s extra sort of colour mixing going on that you don’t usually see in these methods which we would teach them before these colour mixing systems. So yes – I mean – as soon as you start to look at printing, especially with these small dots on a substrate it’s a completely different situation which is – I don’t quite know how you’d fit all that in – because that in itself is sort of masters level type stuff.

AC: OK. That follows into talking about communicating colour and how you get these different languages depending on which device you’re using. Is this the same person? – I’m looking at you, I don’t know why I’m looking at you! -

I think the reason I put ‘non-essential’ – and I did put ‘non-essential’ - is that I get confused by the simple fact that there are so many systems, and I think that students would be confused by the fact that there are different systems, explaining – essentially to give the same thing, trying to work out how a colour is made up. But I just find because there are so many systems, and there doesn’t appear to be a standard other than Pantone – I recognise Pantone as a standard - that in itself is confusing, so ‘non-essential’ means – ‘is it confusing?’ and could it be done in a different way that would be more important and more relevant to the student as it is at the moment – I don’t know.
I think it depends on – we’re talking about [BSc] here and not [technology], so it depends on how much technology you wish to include in this type of a course.

I think with a lot of them, and ... made the comment that it becomes masters’ level if you get into it, they don’t need to know that depth but they need to know that there is something almost to know about – I know that sounds a bit silly...

No – that’s right.

They need to know what additive colour mixing is, they need to know what subtractive colour mixing is – they don’t necessarily need to know all the science behind it, but they need to know about it so that when somebody in industry says ‘partitive colour mixing’ they’ll go ‘Oh – I remember that little slide that went up with the dots...’ you know?

I think they need to know what the differences are so that when they are digitally printing a fabric and they’ve saved it as CMYK or they’ve saved it RGB or Lab, that they might get some colour difference and why this is happening. And they also need to know about Pantone because it’s an industry specification that everybody matches to Pantone.

If you’re talking scientific colour management you have to specify any colour – any colour that you can make – use CIE Lab If you want to start using physical colour order systems or colour naming systems, use Pantone, or use NCS or use something else. If you’re starting to look at the data formats then you look at RGB, CMYK and there are all sorts of others as well that you can use.

I think... because depending on the software you’re using as well, because I think Lab colour is the colour Lectra uses.

I know down at […], which is now the university college, they digitally print in Lab colour whereas we don’t up here, so certainly with students, different colleges and universities use different colour management systems.

I think the important thing really... and your software, you can have RGB or you can change it - I think the important thing for them is if they use RGB those figures mean something to them, and when they want the same colour they use the same RGB values because one of the huge – well I know it doesn’t always come out the same – but one of the huge problems that we have is when students are using the same computers even and doing designs like for […] – they don’t match the colours in RGB – they actually just visually colour match and it doesn’t work. They should be working to a palette of something on the computer.

There is software now where you can just actually scan in your photograph, you can Pantone spec all the different colours in the photograph, so you could equally do it with a yarn or a piece of knitting that you’ve done, and that way you can actually get the same Pantone colour for your print that you’ve got in your yarn, in your photograph...

You’ve still got to calibrate your system.

…yes – what I was going to say is that if you use RGB we call that ‘device dependent’ – it depends on what screen you’re looking at the RGB, what it’s settings are – the lightness, brightness, what different way it’s making the colours up – so that’s device dependent...

But basically – say students in […] – if they’re working as a group they should use the same printer and actually the same computer with the same values, and then they would get the same colours.

What you have to try and do, is you have to produce an ICC profile – an International Colour Consortium profile for each machine – so they act in the same way...

But you could do it with one machine, and if they all did a design and to get it to match they have to come to the same machine, put the designs on, get the RGB values the same, then they would get it to match wouldn’t they?

That’s what CIE Lab is for - CIE Lab is supposed to be independent, so you’ve got this CIE Lab space and then it doesn’t matter what machine you’re using, it’s supposed to map onto the same co-ordinates...

They don’t need to use the same computers if they’ve got the RGB values...

I think they do.

They do...

From this conversation I think it’s something that the students essentially need to know!

I think the point was made before that when I’m looking at these elements I’m looking at them in two ways – or I am now – what does a student need when they go out, what does a student need when they’re on the course – you’re talking about precisely that – this is what a student needs on the course in order to go through the process, not necessarily what they need to know when they go out into industry, and there’s a balance there.
Well I’m not sure because I think they need to know about colour calibration and printer gamuts and the whole thing here to be able to effectively work as a group and to get anything like the same sort of colours together, and I think they also need to know that for industry...

Yes – particularly if they’re communicating with a factory in India or somewhere, and they get their printed sample back and think this is nothing like what it is on screen...

And interestingly enough, people have chosen that as a ‘desirable’ rather than an ‘essential’ part of the content...
I think it also depends on what you are looking at – understanding how you communicate colour or is it having an understanding or an appreciation of communicating colour or colour management?

It’s specifically relating to the colour in digital textile printing, so they can make the links between why things are different on screen or on paper than on textiles and having some knowledge behind that.

We need to think about the depth, how much we go into detail, that’s probably the most important thing – because, all of this needs to be communicated in some way or another but as you say, there’s [technology] and [BSc] and actually what we can physically give to them as well.

AC: Funnily enough, that’s what the next activity’s going to be about! But if we can just wind up this one by looking at this – it’s quite interesting I think – there’s a bit of a split between whether someone thinks the calibration process for the Mimaki here would be useful for the students to do. Some people think it’s rubbish and most people think it might be useful, so...

I think I put ‘desirable’ because I’m just so concerned about who’s going to do it, and actually it’s quite a big job isn’t it? And it’s actually finding that – you know it’s not absolutely essential for them, all the things we should be doing as a group.

I think they need to know that it is calibrated...

...Yes

...they don’t necessarily need to know how it’s calibrated but they need to know there is a process we go through to try, and I say ‘try’, to get the colours to be as near as possible. It links into gamuts and everything – they’re not really all separate those things I don’t think.

That’s what I was saying it’s very difficult - but if I had just put ‘colour management’ or something...

...I think it’s kind of part of the one above really – about the principles of colour calibration, that it would come into that.

They’re quite surprised some of them when I say the printer can’t print that colour – you can view it on the screen but the printer won’t print it and they need to know that type of thing, the printer gamut is probably smaller than the monitor gamut – well ours is anyway, on the Mimaki certainly.

AC: OK. Let’s move on to Activity 2, which also involves refreshing your drinks and eating more biscuits – and it does involve you getting up and doing something!

That’s OK – that’s fine!

AC: So what I’d like you to do this time is to have a look at what we’ve just been talking about and then have a think about what the most appropriate or the most effective way of delivering that content would be to the students. You don’t have to choose just one thing – for example – it could be a lecture backed up with an eLearning module, or it could be a demonstration backed up with a work book that students can take away and continue to learn from. I’ve got number ‘1s’ and number ‘2s’ (I don’t want any jokes – no schoolboy humour!). So for example, if you think a lecture and a practical demo is relevant to that and they’re equal weighting, you can put two number ones or you can put a 1 and a 2. Is that clear?

Am I being thick here – practical demo and lab class, practical demo I’m assuming is a demonstration by a member of staff to the students as opposed to the students actually doing something?

AC: Yes.

That’s fine.

AC: Right – come on then! I’ve not done this for the good of my health you know!

And are we defining what a tutorial is?

AC: I’ve put an example of a group task – so for example if you were to set them an EBL task – something like that.

Right.
AC: You can have two 1s, or you can have a 1 and a 2, or you can just have one 1. Is everybody happy? OK, you can have a couple of minutes to do this...

A couple?!

AC: Well, five minutes to do this one.

You're a hard task master!

[general chat amongst group for 5 minutes]

But you've got to have a '1' and you might not have any '2's?

AC: Yes – exactly. You've got to have a '1' – you don't have to have a '2'. Unless you think you don't have to teach it at all – then I guess you don't put anything.

Can I just say that you know where you've got 'Tutorial', e.g. 'group talk' and then 'practical demo',

No – 'Group work', 'Group task' like setting up an EBL task with them...

Right – OK, because I'd say within a practical demo it’s a tutorial anyway.

AC: I think I was trying to put as many different things down as possible.

It's weird that – that people are going for things like 'practical demos' instead of... it's interesting...

The problem with a lab class or if it's a demo, it's logistical really.

Numbers isn't it?

Yes – you could probably do a series of demos in a two hour session with the students, you could probably do 3 or 4 demonstrations.

AC: It's quite interesting - the differences that have come up. There's a bit of a difference of opinion in how things should be best delivered so let's find something that clashes and have a chat about it. So we've got – I can't make sense of it all! This is an interesting one...

There's no individual projects been picked up by anybody.

That's probably a good example actually, because it's very difficult I guess to have a lecture explaining how a printer works it's far easier for it to be a demonstration of what happens on the machine, so I can understand...

AC: This is interesting, one person's chosen eLearning as a possible way – would you like to have a chat about that?

Well yes, because I like the fact that you can have videos or animations in eLearning which I think would work really well in showing what happens when a piezo crystal changes shape and expels a drop, that sort of thing, I think it would work really well.

Yes – definitely.

AC: Who chose eLearning again as a way to show the latest developments?

I think that was me. I chose that because again I think that eLearning, especially if you're doing historical things, you need diagrams just to show things it’s just an interesting way to show things.

And it backs up the lecture on the subject.

Yes.

AC: This is interesting here – the differences in choice of priority across the whole group about how best to deliver 'why sampling is important' to students. Would people like to say a little bit about why they've chosen...

I think I put 'Tutorial' for that one because I thought it’s quite difficult to do it in a big class, and I'm kind of thinking lectures are quite big classes, and it was easier to pass things round and show the differences within a small group. And I guess one of reasons that lectures are so popular is that they're actually a really good way of getting across information to a big group of people. It’s efficient, the information’s there and I guess most of the lectures have been backed up in some way – because the lectures are nearly all '1’s, apart from the digital printing's a '2' and the calibration process is a '2' and I can see why the calibration process would be – but most of them are '1’s – and then they're backed up quite often by '1’s, or the odd '2'.
I think in that one my allocation of numbers went across more practical things and I’ve also noted obviously a small group project they carry out would be a good idea, because one of the things we try to do in Printing for Designers was to get the students to do some sampling using different colour ways so that they could see the difference between what they had on screen, what they had on paper, what they had on fabric actually came out with an example of their own work using an example of existing work so they didn’t have to generate a new piece. I think when you actually see what it does to something that you’ve created, you start to realise how important things like colour calibration and colour management actually are in your own design work and the effect that they’re going to have on your work if you get it wrong and so that’s why I think that with sampling, and the importance of sampling, it’s quite important for the students to actually carry out some work themselves and see it for themselves with some of their own work, so they can see it happening before their very eyes, so to speak.

And it’s quite a practical thing to do really that as well, thinking about how things can be done, that is something that can – relatively easily – be done. Some of the other things are probably where they are because you think you can’t do it – it would be better to do it in a particular way but it’s not really practical sometimes.

I suggested that perhaps this could be illustrated by a talk by a professional because I think they would have a lot of little stories to tell, showing the importance of sampling and it would bring it home to the students perhaps.

Can I ask a question about how you’ve broken everything down? It all seems quite technical – I just wondered if there was anything specific in terms of the design that’s targeted just on this technology? I suspect not.

AC: Well, I’ve left out kind of putting in design in repeat and stuff because the principles are the same whatever print process you use – there still has to be a balance and whatever – I suppose what comes into that is colour separation and if you’re preparing a design in repeat and using digital print to prepare your samples, then if that design was to go into production on a rotary screen printer then that would have an impact on the design process, but I’ve kind of left out the creating the design bits and tried to concentrate on the technical bits to do with digital textile printing – but maybe that was a mistake...

I think that is an important point – you’re saying basically that design is ultimately going to go through rotary screen printing, and therefore the facility allows designers to be creative, but ultimately the system is going to be reduced back down again for the benefits of reproduction.

Well that depends on the product that you’re creating.

Sure.

If it’s going into mass production or if it’s going to be small scale...

I think also the evolution of digital printing is quite important here because it’s so fast now, it’s actually changed tremendously over the last couple of years, it’s as fast – I think the thing that’s stopping digital printing being used in mass production is the cost of getting rid of all your old machinery that works, to replace it with new machinery that works not really any faster, and actually a lot of people are quite happy with limited number designs in terms of colours.

No – I know that, but what I’m basically saying is that if you’re creating a 60 colour design on the digital printer, unless you’ve got an alternative method of reproduction – at the moment I’m talking about – then you reduce it down to what is economically feasible.

And it’s different again for what the students produce on the course – one off designs.

Yes – they don’t seem to do colour separations.

Well is it – should it be?

That’s another debate isn’t it?

The digital printers used in industry are used mainly just for sampling, aren’t they?

They are at the moment.

Either sampling or short runs. So its short runs of things, but it’s becoming much faster and it will actually change quite soon. [...] PhD about China is quite interesting, well it’s actually Taiwan, why Taiwan manufacturers aren’t buying into digital print – although they’re starting to – one of the problems is the reinvestment really. But the speed isn’t actually – you can’t use the speed as an excuse anymore.

And it’s not just the equipment it’s the training, staff training, all the software – it’s the whole kit that goes with it – the front end with all the CAD systems as well.
AC: There's quite a lot of discussion being generated but we are kind of running out of time, so I'd just like to wind up by thanking you again for coming and to say that what I intend to do from today is - for your information – is to do a summary from the transcript of what's come out from today and also from the results from everyone's thoughts on here and to get that to you by the end of the month. There are some post-it notes on the desk and they're for you to write any thought you've got about what you'd like to happen next – if you'd like, for example, to get together for a network meeting in three months' time or how you'd like to see this moving forward.

I think it's been really useful because I think it's something that – you know – we don't have discussions enough as a group to know what we're doing or even to know what we mean by what we're doing because of sort of language and communication is one of the most difficult things in the world and given that we're now restructuring the programmes what we need to do in ensure that these things are actually going in, and not just for the Textile design students because clearly a lot of them need to go in, I think all of it needs to go to the technologists just about, maybe not quite, but a lot of it.

Am I right in thinking that you think this principle should be applied to other areas of textiles?

No – that's not what I was saying - I think that's a good idea but that wasn't what I was saying. What I'm saying is I think we need to take this and make sure that it goes into the restructured programmes. And I think because print is one of the areas where actually the technology develops much faster and it's quite different technology - from screen printing to digital print is quite massively different – weaving is weaving – knitting is knitting –

I think the principles are the same that if you list a series of elements, you can still list them – I think it's a good exercise for everybody to go through. I know it's a different issue to what we're talking about today.

I think with the restructuring, one of the things that's come out from today is that there probably will be some overlap in terms of what people are teaching, and it's almost like with the restructuring you kind of need to know what everybody's delivering – and almost like spread it all out and just see where the commonalities – where the common areas are.

Well if you think that would be a worthwhile activity put it for a suggestion for what happens next. Have a massive mapping session and do that, or have a follow up meeting – include more people – if you think of anything at all just whack it on a post-it note.

But you're particularly thinking about digital print.

Yes.

Because I'm not sure what exactly gets delivered in terms of coloration and textile print for screen print or for digital print, I mean I know some of what [...] does, and likewise, some people might not know what's delivered on the design side about digital print. But that scenario I think will be mirrored by lots and lots of other programmes. It's this kind of finding out process about what everybody's delivering to ensure that we can streamline things. Whether it will happen or not, I don't know. But thank you it's been very useful – it's been good.

It would be good to take the results from this and then to move it on a stage to map exactly what we need and how it could be delivered, and then we could slot it into the new structure and we can see where it could be put.

The ideal ultimately is to come up with the perfect digital print package for BSc students.

I think the other thing that maybe worth mentioning is the expectation of students – how much should they know, how much should they apply to physical digital printing themselves – because at the moment they're learning about it, Dave's showing them and going through the process, but actually they don't have any access to it, and whether they should have it's just a question really – should they have an opportunity of interacting with the machine?

You mean should they be trained to print?

Yes – essentially – should that be part of the process?

I think, myself and [...] think, that's quite problematic...

I think the problem there is the amount of time they have – if they were on a design programme and they were doing nothing but digital design for a year, that's fine – you would train them you would go through a proper process with them and they would almost get certified to use it and that would be it. There's no way they can - I mean how many hours do they spend on digital printers in the final year - six?

Between four and six.

I mean, it's nothing.
It's probably for specialising.
The equipment can be temperamental.
The potential for disaster is huge really.
If fabric gets trapped or doesn't feed through properly it can cause all kinds of problems.
If they were in industry it would be a very specific job they'd have wouldn't' it?
Oh sure, I'm just saying what are the expectations of students - how far should they take it? What level should they be at, given the nature of the course?
I don't think they've shown any real interest in wanting to operate it anyway – if they had we would've looked in to it.
I think they like the instant-ness of it and they just want to get it back and that's part of the problem.

AC: Thank you very much for coming!

[End of interview]

AC: Thank everyone for coming. This is a continuation of the previous interview with everyone to go into the topic in more detail. And the big outcome of today, what I'd like to do is to get everyone's thoughts about what the students need to know about digital textile printing and colour management when they leave here and go out into industry. I was going to begin by asking you to shout stuff out and then we'll take it to the next stage. OK?

Photoshop.
Illustrator.

Are we going to do it in a similar way to last time?

AC: Firstly I just want to try and compile all the components that you think they need to know and then we're going to break that down.

Sorry – what was the question?

AC: What students need to know about digital textile printing and colour?

They need to know Lectra, Primavision

So CAD?

It's CAD isn't it

But within that it's quite specific isn't it?

AC: Anything else?

The printing process.
The actual process, yes.

Digital?

Presumably they need to know about repeats, even though it's digital printing in particular.

I was going to say should there be a limitation in terms of colours - numbers of colours?

They should know about that.

Have an awareness of it.

They have to consider it for certain projects.

They need to know about print gamuts and things.

AC: So that's quite a broad – we've been talking about colour in terms of colour that makes up the repeat pattern but also the science behind colour as well. They need to have an understanding of how colour in the printing process works.
I think that the digital printing side is a means to an end – that if they go into a company, that they assume that if they go to a company they’re going to be doing nothing but digital print...

Yes – I’m not entirely sure what we’re supposed to call the topic – is it printing – just digital printing?

Yes.

It’s what they need to know about digital printing. To do digital printing they have to understand printing first of all.

I think it’s quite important for them to understand relationships – if they’re working in a company and they send a digitally printed sample off to a screen printers on the other side of the world, what they are likely to get back, in terms of the cloth. So if they’re sending a digital sample over to, you know, to a company in India or wherever and it’s getting mass produced through screen printing, what the colour relationship might be like. And I think that’s quite a difficult thing to probably get across, but it’s something they’re likely to have to either have some understanding of or learn on the job.

But what would you call that though?
Colour specification I would say.

Yes...

They should have separation because...

They need to know how the digital printer is going to be used because there are different ways of using digital printing – it can be an end in itself or it can part of the sampling process.

I think they also need to know about cloth, don’t they?

Yes. Making decisions about substrates.

I think that’s the point I was trying to make before, that they’re being reproduced on rotary screen printers...

Yes – it’s about the relationship between what can be achieved digitally and what can be achieved through screen print, and the students having an understanding of what the boundaries and parameters are with those two processes – the relationship really between those two processes in terms of industrial production.

It’s almost the limitations of rotary printing really isn’t it, in comparison with digital...

Yes...

And the other way round.

I was going to say – with surface treatments it’s the other way round.

We’ve got productivity issues with digital printing.

Also it’s really important for students to understand those basic issues about taking design from their computer, or whichever computer they’re working on, through to digital print, and issues to do with resolution, dots per inch and so on...

Colour mixing...

Tiffs or Jpegs...

File formats...things like Lab colour and RGB...

LZW...

What about what happens after it’s been digitally printed as well?

Finishing.

Pre and post finishing treatments.

I think they also need to have some understanding about the costs of digital printing. Maybe as compared to screen printing, on an industry level, and where digital printing might be more cost effective than screen printing and what scenarios that might be applicable to.

Yes – because I think if you are reproducing something very, very complicated say an all over design that’s got lots of different colours but it’s for a one-off, then maybe it is actually more cost effective to digitally print it and not even think about going down another route.
Possibly the only way to do it...

Yes.

AC: So that comes back to applications as well, doesn’t it? It’s thinking what your end product’s going to be used for and that dictates the printing process and the cost will impact on that as well.

I also think it’s good for them to know about some of the environmental issues, again because of modules like [PD] I’m thinking about the benefits of digital printing as opposed to screen printing, you know, because I talk to them about the pros and cons and one of them is about the environmental impact, cost effectiveness, but also it enables individual designers to work as sole traders, so students could actually go out now and literally set up a business straightaway. They could set up a website, if they’ve got a digital print bureau they use they can get help with their cloth and if they’ve got someone who’s good at making up then they can get garments made up. So they could actually literally graduate and have their own small business set up immediately, even before they leave – if they had a decent business plan and they got those things in place. So I think digital printing provides quite a lot of opportunities – new opportunities – which students need to understand on a micro level for themselves as designers if they are working for themselves, and on a more macro level, an industry level – what goes on in industry with digital and screen print.

AC: Does that come under – because it’s a very broad...?
‘Benefits and applications.’

And ‘Cost’.

I think this kind of question relates as well to what type of jobs we think they’re going to do when they leave, because that’s going to impact upon what’s taught within the programme - about how much they need to know about colour management, colour accuracy and so on.

Yes – I was saying before we’ve had an enquiry from a printer, they want someone to do digital printing over the summer and all they’ve asked for is knowledge of Photoshop and Illustrator – that’s all they want. And I don’t know if they intend to train that person...

So what was the job?
Designer.

On what level?

Design for digital print.

In that case, they don’t need to know anything, do they, if they’re a designer, do they? - They just need to know how to design.

AC: They do – you still need to know that you’re going to get a successful output, so you still have to know the rudiments of it, so you’re not just bashing away...

Yes – but I guess what’ll happen if it’s design for digital print, if that’s actually the role, they’re not going to be handling that much to do with the printing – they’re going to be designing. I think also – somebody asked the question a minute ago – what jobs do our students going to?

We don’t know –

We don’t know, and in some ways don’t what we teach leads them into certain jobs as well – they don’t come with a job idea so we can define essentially what jobs – have a lot of impact on the jobs they’re looking for.

I think we can say ‘these are the sorts of jobs you can go into’, but that doesn’t stop them going into any other jobs.

No.

There’s nothing to do with where digital printing’s come from, I think that’s quite important as well. Because when the first years come in, they don’t know whether we’ve had the digital printer for 40 years or whether we’ve just got one...

I think that fits in with ‘the printing process’ to be honest...

And you know we still introduce people to digital printing as a relatively new technology and it’s not – it’s not really that new is it?

I think they need to know something about practical device profiling as well. So they don’t necessarily – they’re not actually going to understand the models, but they know the models exist and roughly what
the models do – for a screen, for a printer, on textiles, for a printer on paper, for a scanner – whatever it may be.

Yes, because actually that’s a really good point. Even some of our final years they get to the point where they’ve done some really lovely art work and they come to me and say ‘what do I do with the artwork to get it printed?’ It’s like, what have you been doing all through the second year – you should know about that.

I think that’s a crucial point just talking about the second year – their second year is going to encourage them to be more and more involved with the process, so I think the second year is quite crucial an experience and they can build on that in their final year.

AC: OK. What I’d like to do is take this – what I’d like you to do is take this and based on your own experience, how would you break this down into what they need to know first – what’s the first thing they need to know? And after that what’s the second thing they need to know, and I’d like you to write things down on your post-it notes and place them on the timeline.

Oh right – so a sort of overview of printing processes generally and how they’ve developed through history is something they’d need to know in the first year?

There are some really broad titles there.

AC: Yes there are, but you can break it down.

- Write lots of post-it notes.

AC: Something doesn’t necessarily only have to appear once – it can be continuous and be repeated throughout – but basically we’re breaking it down now into the building blocks, your basics – where do you start, what’s your starting point? And then build from that throughout the course. If it’s any help, what I’ve got from what we did last time is – I’ve developed a list here of elements - and these are the elements from our first interview, they might spark off thoughts as well.

[General chat for a few minutes as everyone works on the task]

So can we break this down in a similar way to the programme restructure – so first year: theory; second year: strategy; final year: application?

AC: Yes – there’s the 2 semesters as well, so you can place it wherever you want in that – break it down however you want. And then we’ll look at what everyone’s thoughts are.

[Everyone continues to work on the task for a few minutes]

We were just saying that there used to be a phrase we used – I can’t remember what it is now – but basically it’s theory, application and strategies, first, second and third year, essentially. So the first year’s all about the theory of everything, about digital printing, and then you’re applying that in second year – the students are working with it. And then you’re strategising if you like in your final year, deciding which way it is you want to go. I don’t know if that makes it easier to put these things in order?

I think with design it’s sometimes difficult because they learn through application and so sometimes the application’s got to happen a bit earlier with design teaching than it would in other subjects.

But that’s how it’s sort of biased towards – it’s biased towards theory in the first year, it’s biased towards application in the second year – it doesn’t mean that there’s no application in the first year, and it doesn’t mean that there’s no theory in the second and third year – that’s the bias.

You couldn’t really do it all theory in one year could you?

No – they’d go mad!

And you need to build on it because again - it’s a foundation isn’t it – using the skills and more knowledge...

Can we group those so we get clusters of them together, where people have agreed?

Yes.

AC: That’s one of the things that came out of the student interviews; they all said they wanted to learn by doing stuff and by seeing that colours came out wrong, or...

Well, it’s only when it really happens to them that they learn about it.

AC: They also said they needed the theory and to have that backed up with practical work.
When they digitally print in the second year it’s very controlled isn’t it? They get their prints in at a certain date, [...] prints them, steams and washes them and then here they are. There are some bad ones and some good ones, but then they move on to the next project. Whereas in the final year they have that kind of coming and going and trying things out.

AC: They certainly said that they needed to know about the colour management side of things before...

It should definitely be in the second year – it shouldn’t be left until the final year.

In which case, we need to give them more time to try things out in the second year.

What do you mean by colour management?

Gamuts and things...

For example, that the printer wasn’t capable of printing all the colours in their designs...

They get the information but they don’t realise it. They just want to get the designs as good as possible and if it’s not they don’t query it - they’re just like – Oh it hasn’t worked.

I think a big issue is that they’re not holistic in the way they actually take on board...they say they get everything they need but they say it’s not in the right order or they can’t join it up; that’s actually an issue for them in many respects that they don’t look at the ‘whole’, because you will look at things like printer gamuts in Printing for Designers...

But that’s the nature of students...

I don’t think it hits home to them until it actually happens to them.

Until they do it, until it effects on them and their grades they’re not really going to do much about it – are they?

I think the reason I asked the question, for example if we take on board what [...] do: they print directly onto fabric, they don’t steam it, and they’ve recalibrated the system so that what is on the screen is on the fabric – that is it. That works very well for them because they have a library of samples...

Is that just a prototype thing?

No – it’s creating a sample that’s...

[Background noise makes it difficult to hear words clearly at this point]

They’re going to get a better match, a more immediate match to what they’ve got on the screen.

I don’t think it’s realistic across the industry but... It doesn’t have to be.

They would get that, because you take out a set of variables doing that – but I’m not sure that it’s practical for what we do.

I think then when they get to the final year they’ll want to start – are you talking about doing that across the board?

I’m talking about doing that as a means of producing fabrics with designs on...

For the final years and second years?

For the second years and final years.

I think they have to understand that is one way of doing it...

Sure – they still need to know the theory of what happens when a colour is applied to fabric and the process of steaming and everything.

But I think they need to see, I think they need to experience that.

I don’t have a problem with them seeing it – it’s whether if we use that as the norm...

With all its problems...

I think it should be because that’s the norm in industry - a digitally printed fabric would be finished in industry. I think the thing is that [...] use the digital printer as a sample for the rotary screen printer – they don’t digitally print.
As a prototype... The thing is, as educators we’re meant to give them the full picture.

Yes – they need the full picture.

What we need is a pigment printer to sit beside the reactives – that’s what we need.

I think we need to see [...] separately, personally, to see what they are doing. It works for them.

But they’re not doing digital print. They’re digitally printing samples for screen printing; they’re not producing digitally printed fabrics for the industry.

But that’s what this is all about – we’re not producing digitally printed fabrics for the industry – we’re going through the process.

Yes – I see what you mean.

But we’re teaching them aren’t we? We’re not a business and that’s where the difference is.

OK, so what I’m saying is, where do you pitch it? How much knowledge do our students have to have when they go out into industry? And that’s exactly what we’re trying to do today.

I understand exactly what you’re saying - they need to know that [...] do that, that’s probably the most important thing they need to know, and then and this is how other companies do it, and then we make a decision on what we’re going to do based on what resources we have and what time we have...

That’s what we’re trying to teach them, because if we’re focussing on teaching them about colour and managing all that side then we definitely need to go through the processes.

I think it would be very, I just think something that we haven’t mentioned is maybe they do need a visit somewhere, and that a field trip should be part of their training.

Also when I was doing some digital printing recently for my own work... I found a company in Bury and I went to visit them. I just wanted to hand my design in because it was quicker and he showed me round the whole design studio. They had two Ronsons – is it Ronson? – pigment printers, and the speed in which it was coming out and that’s it – it’s done. I’ve got the fabrics now and they’re getting made into garments and you would not tell the difference at all.

AC: OK, so where would that come do you think?

Second year. Start of the second year.

It’s interesting that it’s pigment printing rather than say reactive dyes. Because if you’ve got an output through a digital printer with pigments, then it’s much more likely to be a colour accurate match...

Well that’s what he was saying; basically he was selling me this process quite a lot and saying it was better. What was interesting was he was talking a lot about the fabrics – I was saying I just want it on this particular cotton and I took a cotton to match it to the nearest one he had, and he had all these different cottons and he said if we print on that one it will look like this, and if we print on that one it will look like this, and this was just within cotton, and I just thought ‘wow’, the knowledge here is huge and we’re just kind of hit and miss with the reactives.

Well you’ve hit on something else haven’t you – basically if you take one design and you print it on to say – a canvas – and you print it onto a very flat cotton – you are going to get completely different looks. And the students have to understand that.

I mean on saturated prints the ones that have one colour all the way over, like a yellow print, he said you are going to have to put them on a slightly thicker fabric and then we worked it out cost wise as well because it is more expensive.

I think industry visits like this though can really make the learning alive for the students....

Well I picked up loads...

...so they’re not just getting the theory, they’re actually seeing how it’s applied in industry and the value of what they’re learning.

And also, what digital prints are for as well. Like this little set up in Bury – why have they set up and who are their clients and who they work with, and the fact that they had a couple of women in the next room making up cushions, it was kind of like this direct next stage link that they could see for themselves.

Do they do canvas prints as well and stretch canvases?

Interestingly, I think they did, I’m not sure whether they do or whether they do more textile end products. They’ve grown significantly.
AC: Well, let's have a look at what we've got and maybe just for the last few minutes have a talk about how these things fit into the timetable in terms of how they'd be delivered. One of the things I noticed is that environmental issues are in – different people have put them in different years – so we've got them in the first year and in the second year and in the third year. So I presume that's just people thinking about different depths of delivery about those issues?

Yes – it's like Photoshop and various other things – you don't stop after the first year.

AC: Let's look at the very first stage in the first year – 'software' is there, 'history' is there and also very basic building your designs, file formats, image resolutions and stuff, colorants, and there's a lot there about introduction to the overall subject, about digital printing but also about the history of printing in general so there's a lot going on there. So I guess what we could do is have a look at how this could be further broken down into how this would then be given to the students.

In some respects it's a shame that we couldn't have done our restructuring like this, because some of these long units that we've got the units that are about deconstructing and going through all the processes with them, it would be quite nice if we could have done one of these exercises for every unit – it's a time schedule isn't it? What we kind of need to do is to take the restructured programme and say this is the restructured first year, the restructured second year and the restructured third year, and actually where would you put them into – which units would you put them into I guess – that would be the next stage.

I don't know...

The other thing is these are not just applicable to textile design students.

AC: We're looking at [BSc] because at the minute am I right in thinking that's one programme where digital printing is actually taught?

It should be taught on all of them.

Yes – but different details - the actual design aspects are not taught.

No – but in many respects a lot of these are not design aspects, not specifically design aspects, they're all part – a very important part – of the design process. The technology students would need to know about the substrates, the dyes, colorants they use, calibration.

They're not taught that though, are they? The [other] students as yet?

But they will be - the new first year has actually got printing in it, in quite a lot of the core units that everybody takes.

AC: And is this all set now – the restructure?

Yes.

So if you deliver to [the other programmes] they need to know the least amount about it, then you are presumably delivering it on a very basic level, which everybody needs to know anyway.

Assuming no knowledge.

Assuming no knowledge - so you've got a starting point is what I'm saying.

AC: Does this have any usefulness – doing this exercise – now that the new structure's set?

I think with the new structure what we need to look at is where all this things fit in the new structure, and what we need to do in the design programme is look at the units we're responsible for and make sure we build on or introduce things that are coming up for everybody else.

AC: There seems to be a clear consensus, there’s agreement about where things should be placed. There are no clear clashes that I can see there. I presume that’s a result of all the discussions...

And it's a sort of logical process - you're not going to do an overview of printing in the final year are you - it's got to be at the beginning because you're building on things all the way through.

AC: I guess it's deciding what's the starting point.

I think that's the point we're making in a way - of who delivers digital print to [the other programmes]?

Is it you guys? Therefore there may be some mileage in what you teach [on the other programmes].

I think the thing is that [on the other programmes], they're all taught together – that's the key with the new structure. Because if it's all taught together they've got design units, they've got fashion retail units and the idea is that they're 60 credits in the first year, 40 credits in the second year and 20 in the final year.
I think it’s a very different delivery based on whether there is any contact with the machinery or not. I think you’ll get a lot more ‘buy in’ from the students who are physically using the system. There’s one thing teaching theory, but actually applying that and seeing the results of that...

Because when it personally affects them in their own work it becomes critical.

But I suspect that most people who get some information about this will never use digital print.

But it will help them in other ways, even if it’s just understanding how their printer works at home better.

You know they say a little knowledge is dangerous but if you’ve got some student going into retail as a buyer, I think it’s very useful to be able to communicate on even a basic level, then I think it does help.

Also we’re looking at what to teach but we’re not looking at what we don’t need to teach. That perhaps would be something to consider, for example – do they need to be able to physically run the printer themselves – is it something we need them to do?

I don’t think we need them to do it, but I think it would be very desirable for final year students who are actually digitally printing as a project to be inducted through a proper programme to be able to use the printer.

Last year we did that to an extent in the second year.

With a degree of supervision.

In [PD] – they actually did print their own designs with supervision.

I think that experience could be built upon, couldn’t it? It’s like they did some kind of certification on it.

That’s right. I’m thinking of the 2, 3, 4 students a year that maybe use it.

AC: OK. Well, it’s 5 to now, so I guess we should wind this up as people have got meetings to go to. I’ve got a lot more information that I need to go away and think about so thanks very much for coming. And I hope you’ve got something out of it as well. Thanks very much.

[End of interview]
Transcripts of individual interviews with students

Q.1 What software used for student designs?
AC: I’d like to start off by asking you which software programs do you use to create your designs?

Mainly Photoshop – although when I was in industry I used Illustrator a lot more and I find that easier, the only thing that annoys me is that you can’t crop – well you can but it’s a lot more difficult to crop using Illustrator so I tend to use those two programs in conjunction with one another.

Q.2 More than one computer used to design?
AC: And do you use your own computer at own, or a laptop, as well as the Uni computers?

Yes I’ve got Photoshop at home, but I have to use Illustrator in Uni as I don’t have that at home.

Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?

I probably scan in colours from my colour palette and then match them with the digital colour – using the eyedropper tool – to colour match them to things that are online so that when I’m using different programs and different designs I can use the same colour. And I’ll create a colour palette using Illustrator.

Q.4 What colour space used when designing?
AC: OK. Do you know in what colour space you’re working on in your designs – whether it’s RGB or CMYK – or is it whatever the default is?

Whatever the default is.

AC: OK. So you mentioned that you use some specific colour palettes and libraries and that you check them online – what kind of facility do you use to check them with – or what are you checking them against?

Well I have - When I’ve been working in industry we normally use a Pantone swatch and a pantone book and references on the computer and that’s regularly updated, but I don’t actually know if we’ve got that facility in Uni, because I learned it last year but I’m not actually using it this year because my colours are so set. So I think if I had the facility I’d definitely use pantone references to get the right colour. Does that make sense?

AC: It does make sense – that would work if you were printing out on a system that was calibrated with the same Pantone references that your particular monitor is calibrated for. This is the kind of thing […] was talking about on Thursday last week - about how different devices have got different colour gamuts. So if you’re using a colour palette on a laptop, then that laptop and the printer and the substrates and the colorants have to be calibrated so they all work together.

So they don’t really work…? So in theory it’s a great idea but in practice it doesn’t really work… because when I was working we just sent it off and when we got it back it was like ‘yes – it matches the swatch’ so it was fine – so it was completely out of our hands – they probably had lots and lots of problems we didn’t know about…

AC: Or, they’d have calibrated all their software and printing systems to work together so that they’ve got the same colour references to work from. So the general idea of working to those colour references is kind of the whole theory of colour management so that each device in the process uses the same numerical reference for the colours… it’s a bit complicated but...

That’s why you’re doing a PhD!

Q.5 Any changes made to colour settings?

AC: Did you change any of the colour settings in the software when you were working in your designs - any colour settings in Photoshop? Or was it whatever the default was?

Whatever the default was – I’ve never been taught to do that so I wouldn’t change anything!

AC: That’s fine.

Q.6 Do you know if colours within gamuts?
AC: So do you know whether or not the colours in your designs are within the printable gamut of the Mimaki…?

Haven’t’ a clue! Just do it and hope!

AC: OK that’s fine! Have you had any designs printed out yet?
No - I had some printed out very, very early on because I wanted to over-dye them using indigo.

Q.7 Opinions on colour accuracy of printed designs?
AC: And how did you feel about the colour accuracy of the textile prints you got compared to the on screen colours you had?

Well, given my project, the colours vary considerably because of the nature of the dying, so although they weren’t exact matches it didn’t really matter as such for the related project. They were different – they were much darker and less vivid – but they were OK for what I wanted to achieve.

Q.8 Why is important for colours to match?
AC: OK. You’ve kind of answered my next question, but if you think of it more as a theoretical question that might help – rather than specific to the designs you’re doing now – is it important for the colours in digitally printed textiles to exactly match the colours of your designs on screen, and if it is, why is it important?

It isn’t really, really important, as long as they’re within a range of what you expect because you design – especially when you’re working on digital designs in repeat – it takes a long time to achieve it – and if you print out something that doesn’t look like what you’ve got on screen it’s a bit of a disappointment - you feel like it’s wasted work because you can’t use that print because what you worked on screen is what you expect it to look like, but you have to understand that there’s tolerance either side and unless the colours are really, really off, it’s understandable and acceptable.

Q.9 Personal discretion used to judge colour match?
AC: So you kind of ... the criteria that you’re using are from your own professional discretion as a designer? You’re deciding that ‘yes - that’s acceptable to me for my concept - what I’m trying to achieve as the final design’?

Especially if you are only producing a range of digital prints, because all the colours would essentially be the same when they were printed out - it’s only then if you were introducing constructed textiles that you would need to match yarns that you may encounter a problem.

Q.10 What info on colour on BSC course?
AC: What information have you been given about colour management issues in digital textile printing on the BSC course?

We had a lecture from [...] Not really that much in all honesty – we’ve been told to print out our colour palettes beforehand, but our CAD experience has been quite limited because the room is used by [other students] and we get about 2 hours a week in 2nd year – and I’ve forgotten all that we did then. It’s more about getting to grips with the software, that kind of thing, and colour management was something that was bottom of the pile really. Because when we got to do our own work we were lucky if it was printed off – it was OK if it was a paper design. So it’s not really been top of anyone’s priority to be honest.

AC: So you mentioned that you were advised to print off colour palettes first – was there any advice given as to where you could source the colours, or were you given free rein?

Personally no, I’ve not been given advice but I don’t know if individual tutees have been to the tutors and are having problems. I think it’s only if you were having problems you would get more advice and I think that advice is available. But I think everyone has their own process which is very, very different – some people are scanning in their designs, some people are working directly on the computer – and I think it’s difficult to advise everyone given that everyone is so different, so I think if we needed it, someone would be able to tell us what to do, but up until now...

AC: There was no specific lecture or workshop....?

Not that I can remember – I do vaguely remember in 2nd year [...] going through CMYK and RGB and what they mean, but I can’t remember or put them into use now – I’ve probably got notes somewhere.

Q.11 Any other comments?
AC: OK. Do you have any other comments about digital textile printing on the programme?

It would be good to get the opportunity to do more of it, because it’s becoming more and more popular and we don’t really get the opportunity to do a lot of it, or its always something that you would dye on top of, or print on additional processes – it’s never something that you would produce a final design. Also working in repeat – I don’t feel that I’ve got a lot of information on working in repeat and when you’re digitally printing that’s so important because it’s so vivid and when you’re working on a screen there’s not as much definition so if it’s not perfect it doesn’t matter as much, whereas in digital it does, so a bit more on repeat would be useful.

AC: Would you like to have more time to experiment with digital printing as a medium, because it’s still, in terms of textile printing, it’s still very new, still an emerging technology – do you feel that that would be...
I think in an ideal world that would be great but I don’t think there’s the time on the course. I think there’s a lot of other very valid techniques which we can use and spend time on – if it was a purely design course I’d say ‘yes’ but because there’s so many other things we’ve got to do there just isn’t time.

AC: Because it’s a BSc course – you’ve just mentioned the difference – do you get much information about the technology side of digital printing?

Yes, we do have modules for it – we have [PD] in the 2nd year, and that module’s useful, and there are people around to always give you advice. I think for [...] lecture we had to do a report on different printing methods which was useful because it encouraged us to go out and find out… but not all of us had to do the same methods – I think mine was engraved roller printing – and I just read someone else’s’ so I didn’t personally do the work, so I think as an emerging technology it should be covered, I’m just not sure who would cover it – maybe [...] given that he’s doing the 3D printing and he’s more at the forefront of digital printing – [...] is more…in my opinion, she’s more of a practical printer not a digital printer. So someone who works all the time – [...] could give us a lecture – someone that works with it on a day-to-day basis.

AC: O.K. I think that’s about it, so thanks very much.

[End of interview]

Q.1 What software used for student designs?
AC: I’d like to start off by asking you which software programs do you use to create your designs?

I use Photoshop and Illustrator mainly – these are the only two I use - I don’t use AVA or any other pattern repeat – that’s all I use.

Q.2 More than one computer used to design?
AC: And do you use your own computer at own, or a laptop, as well as the Uni computers?

Yes – I use mainly the one in the University because for some reason, I’ve got software at home, Photoshop as well, but when I try to use it on projects the colour and somehow the files don’t read through – so I tend to spend most of the time using the University ones.

Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?

I just use colours from the colour palette.

Q.4 What colour space used when designing?
AC: OK. Do you know in what colour space you’re working on in your designs – whether it’s RGB or CMYK – or is it whatever the default is?

RGB.

Q.4a Use of colour in software
AC: When you’re working in Photoshop or Illustrator do you have specific colour palettes that you create or do you use the generic one within the software?

Depending on the project if I need some special colour I will create my own palette but usually use the default one. I use the colour spectrum...

Q.5 Any changes made to colour settings?
AC: When you’re working in CAD do you make any changes any to the colour management settings usually, or do you go with whatever the default is?

I just go along with the default because I don’t know anything about this so I can’t play around with it.

Q.8 Is it important for colours to match?
AC: Is it important for you that the colours in the designs you’re creating in CAD match the prints that you get on textiles?

It’s very important. Because in my 2nd year project I did some designs that I felt were really good, and the colours really went together but when I printed them out the colour was completely wrong and my project went downhill from there. I didn’t do any colour management that was the problem – the colour of the design on the screen and the actual print outs were two different colours.

Q.8a Colour differences acceptable?
AC: Is it acceptable for you for there to be any colour difference between your CAD work and your final textile print?

Maybe very minor, minor shade of colour but it is very important for me to get it right and if the screen and the print have to be matched pretty much completely.
Q.9 Personal discretion used to judge colour match?
AC: So when you’re making this judgement about the colour quality of your prints are you - what criteria are you using to judge it against? Are you using your own visual comparison as a designer between the intended output and the actual output, or are you using colour references or colour libraries to match things against?

I tend to use my own judgement instead of colour references.

Q.10 What info on colour have you had on the BSc course?
AC: Whilst you’ve been on the BSc course have you been given any - what information have you been given about colour management in digital textile printing?

None – except for last week one lecture which I missed because I was ill, I was not happy I missed that. We haven’t been given any information on colour management that I can think of.

Q.10a Any info on colour in CAD?
AC: Is there anything touched upon in the CAD lectures that you do about working with colour?

Yes – they very briefly mentioned that you should do a test print but it wasn’t really detailed and you can’t just tell students to do that and expect them to know exactly what to do. So we haven’t been given much help with that.

Q.11 Any other comments?
AC: Do you have any comments about digital textile printing on the programme – your experience of it?

I feel that we might need something that – we might need more printers or something that prints faster – it just feels to me that the time slots are very unavailable since there are a lot of printers. I think that’s the only concern I have with printing. And maybe more lectures on colour management and maybe more help on the software – like CAD and Illustrator – because not many people know how to use them.

[End of interview]
AC: And when you’re looking at colour palettes for trends – are you finding them online – is it WGSN?

Yes - I’ve used that before, but I’ve also found a website – I can’t remember what it’s called, but it’s something to do with forecasting trends, because WGSN is cancelled now – we can’t use it so I’ve got my information from somewhere else – I can’t remember where, sorry!

Q.6 Do you know if colours within gamuts? [question not asked]

Q.7 Opinions on colour accuracy of printed designs?
AC: What do you feel about the accuracy of colour that you get in your textile prints compared to that on the screen?

I think sometimes it can come out a bit dull – it doesn’t look quite the same and sometimes colours don’t match as well – but overall I think it is fine – I don’t mind the difference, I don’t necessarily think it looks bad. I did have one print last year that was supposed to be quite a nice orange and it came out a burnt orange which wasn’t attractive but it’s kind of what happens.

Q.8 Is it important for colours to match?
AC: OK. That leads into my next question which is – is it acceptable for you for there to be any colour difference between your CAD work and your final textile print?

I think because we’ve been taught from year 1 that when you print it out it does look different that you kind of do accept it and think it’s OK. But this year we’ve got the chance to print out our colour chips to make it perfect so hopefully we’ll be able to erase that inefficiency.

Q.9 Personal discretion used to judge colour match?
AC: So you’re using your discretion as a designer when you’re making a comparison and deciding if it’s acceptable to you or not?

Yes.

Q.10 What info on colour on the BSc course?
AC: You mentioned that throughout the course you’ve been given some information about digital printing and colour issues, can you explain a bit more about how that information’s been given to you - lectures or workshops…?

Yes – last year we did a lecture on [PD] that was all about – we had tasks to do where we had to compare photocopies – all of the same image – photocopied on this printer on that printer, on the computer screens, comparing all of the differences, and there were subtle differences in every one. So that was one module and there was another module possibly in the first year sort of touching on the subject but it was basically the second year module.

Q.10a AC: Was there anything in CAD?

No, not so much it was mainly [PD].

Q.11 Any other comments?
AC: OK. And do you have any comments about digital textile printing, anything else you’d like to say about it?

No.

[End of interview]

Q.1 What software used for student designs?
AC: I’d like to start off by asking you which software programs do you use to create your designs?

This year or…?

AC: Generally - over the length of the course.

Photoshop, Lectra, and I’ve just started to use AVA. Not really Illustrator – I don’t really know that much about Illustrator but I have experimented with it before, but not really...

Q.2 More than one computer used to design?
AC: And do you use your own computer at home, or a laptop, as well as the Uni computers?

I’ve got a computer back at home with Photoshop on it and my Dad’s laptop’s also got Photoshop on it, but my laptop at Uni hasn’t got it so I normally use the ones at Uni for it, yes.

AC: But you can be working on designs on different machines?

Yes.
Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?

I scan in a lot of my colour chips that I’ve already done on my mood board, but sometimes they don’t come up the same colours as I want them to on screen so then I’ll try and pick out something that I think is more similar to what I’m looking for on the computer and then print it out and see whether it’s what I’m looking for.

AC: So – the original chips that you scan in – where do you source them from?
Normally from B&Q – they do the colour swatches don’t they – and they’re a good block of colour so I can use them on mood boards, and then just scan them in but sometimes it can come out a little bit darker on screen and a bit duller sometimes – I don’t know whether it’s because they’re scanned, and it depends as well – I remember last year I did a project when I wanted really bright yellows and bright pinks so I had to scan in a really bright pink because I couldn’t pick one out as easy on the computer because obviously it was different colours.

Q.4 What colour space used when designing?
AC: To alter those colours if they’re not quite what you want on the screen – do you into the colour library in Photoshop and pick a brand new colour or do you make adjustments to the brightness...

I probably go into the library – I sometimes change the brightness, but to be honest I normally just go into the library and have a flick through and see if I can get it, but if not then I suppose I would change the brightness if I needed to but normally I just go into the colour library.

AC: And do you use the colour spectrum – the wheel or do use the library that’s got all the colour squares to pick from?
Both.

Q.5 Any changes made to colour settings?
AC: OK. When you’re working in CAD, do you make any changes to any of the colour management settings in Photoshop – or do you just go with whatever the default setting is when you’re working?

Whatever the default is – probably, yes.

Q.6 Do you know if colours within gamuts?
AC: Do you know whether the colours in your CAD work are within the printable gamut of the Mimaki or the monitor gamut of the Apple Mac?

No...

AC: You know like we were talking about last week?

Yes - it confused me that did! I was thinking 'Oh God!'

AC: I’m sorry it confused you!

No it was helpful though, because now I’ve started to think about it more. I had some prints printed out last week and Sonja said the colours are going to come out differently and I needed to change them and that’s what we did – so it has made me think about it a lot more. Because I suppose it doesn’t really cross your mind when you do it on the computer that it’s going to come out differently on fabric, but more recently I’ve been thinking about it especially coming up to the end of the degree.

AC: But that’s why it’s so important for you to do the sampling that you’ve been doing – to print out all your colour palettes first before your final prints – so you can have a chance to adjust the colours.

Yes.

Q.7 Opinions on colour accuracy of printed designs?
AC: So, you’ve had textile prints done before from your CAD work haven’t you, so what are your thoughts about the accuracy of the colour in the textile prints that you’ve had done so far?

I remember last year when I did digital printing – the pink that I needed was a really, really bright pink, and because we didn’t have enough time to mess around with fabric swatches and getting them printed off, some of the prints printed off a lot brighter than others did – so I think really you do need to experiment and print off especially with different fabrics you’re printing on – the colours tend to come out differently.

AC: They do – they’re brighter on the silk aren’t they than the cotton.

Yes.

Q.8 Why is important for colours to match?
AC: Is it important for you that the colours in your textile prints exactly match your CAD work?

I suppose because you've got this colour palette that you want to run through and you want your range to look uniform and like it's all together, so yes it is important. But with some things it can be a little bit more subtle - if there's a subtle change it's not crucial.

AC: So is it acceptable for there to be some colour difference between your CAD work and your textile prints?

Slightly.

Q.9 Personal discretion used to judge colour match?

AC: And are you using your professional discretion as a designer to make that decision, and say 'that's OK'?

If there's a big difference then obviously I have to work on it, but I think what the product – it depends on the product what you're using it for and things like that, but I think that if there's a slight difference then it's not crucial.

Q.10 What info on colour on BSc course?

AC: Throughout the course what have you learned or information been given to you, about digital textile printing and colour management issues – have there been lectures...workshops...?

We had – in the first year we had a lecture on – I don’t know whether we had it for the whole of the semester or not – about colours and things like that, and metamerism and things like that, but in the 2nd year we moved on from that and I suppose in the final year when it becomes more important when you're thinking about colour, you're kind of reminded so because [...] lecture that we had the other day started to bring things back that we taught in the first year with [...] AC: Was that the - what module was that – a specific colour module?

Yes I think so - I’m sure [...] took it and it was for half a semester and I think [...] then took over.

AC: Because there is something on colour up on Blackboard - I can't remember the name of the module. Is there anything – you mentioned [PD] – what about the CAD side of things – is there anything on colour much in that – or is it more getting to grips with the software?

More getting to grips with the software. But I suppose once you get the hang of it – by the second year, by the end of the second year, you're already quite familiar with things like Photoshop and with Lectra that we used last year so that's when you start focussing on colour a little bit more, because obviously it's beginning to get more important in your final year.

Q.11 Any other comments?

AC: Unless you've got any other comments about digital printing that's the end of the interview...?

No – I've discussed most things anyway.

AC: Thanks very much for your time.

[End of interview]

Q.1 What software used for student designs?

AC: I’d like to start off by asking you what software programs you use to create your designs?

Photoshop - I’ve used Illustrator briefly, but I’m not particularly conversant with that so it’s mainly Photoshop.

Q.2 More than one computer used to design?

AC: Do you mainly work on the computers at University or do you work on a laptop at home or another PC at home – do you work across several machines.

I have worked on the ones here but the majority is at home.

Q.3 How are colours in designs chosen?

AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?

I’ve done both – last year I had colour chips from a paint chart which I scanned in so I used those, but this year I’ve used my own art work and I’ve put the colours from my own art work and matched those to the closest Pantone colour that’s in the library.

AC: That answers my next question really – but could you say a little bit more about where you find the colours from – are you sourcing them from a forecasting site and then matching them with colour charts?

When I did it in the second year when I scanned the colour chips in they were from a Dulux colour chart thing, because obviously I was aware that anything I found on the internet was going to be probably
completely different to anything I had on screen, so I physically had those in front of me, as I say, more recently it’s just been from my artwork - I initially had the hard copy colour chips which I used to do the art work with, but obviously they weren’t exactly the same so I then decided that from the artwork I was going to take the colours from that rather than the actual colour chips.

AC: So when you input the colours into the software – scanning them or whatever – how do you adjust the colour - if it’s not right on the screen – what of the options within Photoshop do you use to work on the colours to change them?

I’ve used the hue and saturation I’ve also used – when you first go into the colour section in Photoshop and it brings up a sort of – I can’t really think how to describe it - a sort of fuzzy sort of colour ... it’s got a little circle on it and you can move it around within there – I’ve used that as well, but mostly what I have done is because - again, because I’m aware that my colours that I’ve painted are not actual Pantone colours generally, I’ve always gone into one of the colour libraries and taken one or found the closest to that and taken it from there.

AC: OK – so that’s one of the stock Pantone libraries of swatches within Photoshop?

Yes.

Q.4 What colour space used when designing? Q.5 Any changes made to colour settings?

AC: OK. When you’re working in CAD, do you make any changes to any of the colour management settings in Photoshop – or do you just go with whatever the default setting is when you’re working?

Do you mean like it’s got the RGB setting and CMYK setting – is that what you mean?

AC: Yes – that kind of thing.

I have changed them but I think it was more by accident – I didn’t do it purposely. But I have looked at it – I’m quite lucky in the sense that my brother’s a graphic designer and is really conversant with Photoshop and all that kind of thing, so if I have issues with regard to colours and things like that I tend to ring him and ask him what to do! I can’t sort of tell you exactly what I do because generally he will say ‘just try this – this might work’. I suppose with having that kind of background I was always aware that there were issues with colour anyway, but I don’t mess with it too much to be honest.

Q.6 Do you know if colours within gamuts? [question not asked]

Q.7 Opinions on colour accuracy of printed designs?

AC: How do you feel about the colour accuracy that’s been achieved so far in your textile prints compared to your on screen designs?

That’s actually quite difficult for me to answer because the ones that we had digitally printed last year we, I think because there were obviously time scale problems and they weren’t washed, I think they were steamed but they weren’t washed, so everything I got back was a lot darker than I expected, but then I am also aware that that’s probably because it hasn’t been washed. So I can’t give you an accurate answer because I don’t really know what they’re going to look like. I would think looking at what I’ve got and knowing that they’ll be slightly darker, I would think they’re reasonable I don’t think they’re really, really miles out, and think they’re probably OK when I get round to washing them.

Q.8 Why is important for colours to match?

AC: OK. So is it important for you that the colours in your prints do match your designs on screen accurately?

Yes – I would say so. Well, reasonably, because again I’m aware that the screens are back lit so it’s going to look different anyway, but I think as much as possible.

AC: Why is it important?

Because that’s how I want the design to look – if I wanted it darker I would make it darker. I think it’s because I see the design, that’s how I want it to look. Having said that I am aware that it’s never going to be perfect it’s always going to be slightly different.

AC: Is it acceptable for there to be some difference?

Yes – as long as it’s not too dramatic.

Q.9 Personal discretion used to judge colour match?

AC: Within your own discretion as a designer?

Yes – I think so, like I say, as long as it’s not really, really obvious, completely different, then I think a small difference is acceptable.

Q.10 What info on colour on BSc course?

AC: Throughout the BSc course – what have you learned about digital textile printing/colour management/colour accuracy issues in the lecture programme or workshops..?
I think, a reasonable amount shall we say – I mean I think there could possibly be more emphasis on the digital printing because we didn’t really even talk about it till the second year – it didn’t really come up apart from this is a method you can use to print – we didn’t go into it any further than that really. I think it’s a really useful tool to be able to use it, to know how to use it properly and to understand these issues and to understand all the different substrates and all that stuff and so maybe I think more detail might actually be helpful, with regard to colour latching we did cover that early on. Obviously what you did with us last week was a lot more in-depth which I found really useful, but I think just having a basic knowledge early on would be really useful as well.

AC: Was that delivered through the lecture programme...?

Most of it was done in – we had some lectures early on in the first year – with regard to colour in general and obviously that did cover the issues to do with the different colour spectrums and screens and so on. And in the second year we did do some actual tasks with digitally printed swatches and paper swatches and went into more detail then. But I didn’t really, I don’t think – as much as I enjoyed doing it and its quite interesting to do I don’t know that I gained that much from actually going away and looking at them – it felt a bit disjointed because we had the things and we did that and then we just had to write about different colour matching methods and systems you can use, but we hadn’t had any introduction to that really beforehand.

AC: There’s been various new things coming in throughout the BSc programme but certain years haven’t had all the different elements so there are things coming in now that the third years might get or the second years might get...

That we didn’t...

Q.11 Any other comments?
AC: Do you have any other comments about digital textile printing?

I like it! It’s something I’m really keen to continue with. It’s one of those things that - obviously I really enjoy it, but I’m aware of the fact that it’s difficult to get access to the equipment and to all the sort of – like you talked about the colour management systems and things- it’s very difficult to get access to – and that kind of thing is something I’d like to know more about where you can get access to these things, and obviously even having a look at one of the colour management systems might be useful - I presume there’s one here – so I think having a look at how they work, because I’m assuming that if you were going into that as an industry and it was something that was used you would be expected to know to a point how it worked, I suppose.

AC: The process here would be what we talked about last week - the calibration process between the Apple Mac that drives the printer and the printer itself – to print out the colour library and then input that information back into the computer that drives the printer so you get the same values for each colour. So that would be something that perhaps, looking at that would make it more clear.

Yes – I think it would – it’s always nice to see actual physical examples of things happening. It makes more sense when you can actually see it.

AC: Thanks very much.

[End of interview]

Q.1 What software used for student designs?
AC: I’d like to start off by asking you what software programs you use to create your designs?

What I’ve used so far is just Adobe Photoshop – I didn’t use Lectra, I found it too complicated. A lot of other people on my course as well actually lost work using that so it sort of put me off!

AC: They lost work?

Yes – but I am actually interested in the AVA at the moment so I’m going to hopefully next week going to have a little play around with that and see. But I am working in Photoshop at the moment.

Q.2 More than one computer used to design?
AC: Do you work on your designs on your own computer or laptop at home as well as the computers at University?

Actually yesterday I only had Adobe Photoshop downloaded onto my laptop so now I’ll be working more from home, but I was working in the CAD studio upstairs – I spend a lot of time in there.

Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?
I’ve scanned in colour chips and worked on those and used the colour from that and also scanned in my own work but I haven’t really used many colours that are actually on there – most things are what I’ve scanned in but I haven’t really used the pantone colours or anything like that.

Q.4 What colour space used when designing? [question not asked]

Q.5 Any changes made to colour settings?

AC: Once you’ve scanned your colours in how do you alter them within the software – do you use things like hue and saturation/brightness/contrast or are they acceptable as they are?

Yes – sometimes they are – I haven’t really changed them or if I have changed them…. I use filters or stuff like that, or make them brighter maybe it depends what they look like on screen, but they are different once you print them out. It’s just judging it really.

AC: Do you change any of the colour management settings in Photoshop when you’re working, or do you just use the default settings – do you go in and change anything?

No – I’ve never done that.

Q.7 Opinions on colour accuracy of printed designs?

AC: What are your thoughts about the accuracy of the colour that you’ve achieved in your textile prints so far, compared to your designs on screen?

When we did the [...] project, in the second year, we all intended to work from the same colour palette – our group – and at the end when we all printed out our designs they were all different colours, even though we all tried to work from the same colours. All mine looked good, but they were just different with all the others – I don’t know – we did actually scan them in but I think if there’s light underneath the colour chips or… it can vary.

AC: So you scanned in colour chips and then…?

Yes and then pipette them and then used that colour - saved them in a file and then used them.

AC: Was that across lots of different computers?

Yes – it might have been – we actually used our own computers at home as well. I think […] used a Mac, so it might have been different.

AC: So you all initially had the same paper with the colours on, scanned them in and used them on all different computers and then saved them – the files from all those different computers and then put them back into this computer and printed them out?

Yes.

AC: That’s really interesting...

They all were different – the pinks – mine were actually quite brighter than someone else’s, but because we were meant to do them more as a collection but they were different.

AC: That’s interesting because what I was talking about – were you at last week’s lecture that [...] did on colour management?

No – I wasn’t well.

AC: OK – well it was just that one of the things [...] was talking about was that each individual machine will have its own colour gamut, its own range of colours, so that even though you might have the same initial ting you’re scanning it in across lots of different machines it will look different. Each machine interprets the reference data for colour slightly differently so that’s why when they’re printed out the starting point would be the same – the end point would be different because of that.

Q.8 Why is important for colours to match?

AC: Is it important for you that the colours in your textile prints exactly match your CAD work?

Yes – I suppose it is. What I’ve done so far I’m quite happy with. Yes, I think it is important.

AC: Why is it important?

Because you do something on the computer and you want it to look exactly the same when it’s printed out. You spend all that time on it and print it off and it’s not right – you’d be quite disappointed.

AC: Is it acceptable for you that there’s any colour difference between your CAD work – have you got a tolerance...

I don’t know what you mean...

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AC: Does it have to look exactly like it does on screen or if it looks slightly different is that still OK – have you got a range of difference...

I work in really bright colours, I’m quite a bright person so I’d like them to look brighter if they are bright on the computer screen I’d like them to look bright when they’re printed out.

Q.9 Personal discretion used to judge colour match?
AC: So you’re using your discretion as a designer to make the decision as to whether or not that’s acceptable?

Yes.

Q.10 What info on colour on BSc course?
AC: Ok. Throughout the BSc course what have you learned or what’s been the teaching content about digital textile printing and colour management – have you had lectures or workshops...?

To be fair I don’t think we’ve had that much training on it – we’ve had, or we were meant to have quite a lot on screen printing but, [...] was ill so we didn’t really have a lot of time with that but luckily I’d done that at college before I came here so I knew about screen printing, I’ve never done digital print before. I didn’t actually know that they were steamed afterwards to make it brighter. I think I’ve learned a lot but it would be nice if we’d learned a bit more about it. I’m still in two minds whether to do digital printing as well – I don’t know yet - just screen printing or I was going to combine them both.

AC: So are you talking to your tutor about that?

No – I will be doing – it’s only a decision I’ve made in the last few days.

Q.11 Any other comments?
AC: Do you have anything else you’d like to say about digital textile printing on the programme?

No – I think I’ve said everything I wanted to say.

AC: Thanks very much.

[End of interview]
AC: It’s OK – everyone looks terrified when I ask them that question! But I’m just trying to see how you use the software and colours and everything.

Q.6 Do you know if colours within gamuts?
AC: Do you know whether the colours in your CAD work are within the printable gamut of the Mimaki or the Apple Mac?

I don’t – I normally – especially in second year – I printed out my work and it was more ‘fingers crossed’ that it was the right colour, and for me they virtually did come out the right colours so that was fine. But I don’t actually know if my colours are able to print.

Q.7 Opinions on colour accuracy of printed designs?
AC: You’ve just said that the colours were fine and I was going to ask you what you thought about the accuracy achieved in textile prints compared to your CAD work.

I thought they were slightly darker, my colours when they came out in the print than what they were on screen.

AC: Were your prints just steamed or were they steamed and washed?

I’m not sure.

AC: They were probably just steamed.

We were told not to get them wet.

Q.8 Why is important for colours to match?
AC: Is it important for you that the colours in your textile prints exactly match your CAD work?

I think in my 3rd year, yes, it really needs to be as close as possible, and so I will have to do some tests and stuff to make sure that it can, I don’t think it was as important in my second year because the prints that came out were still good enough and still the right colours.

AC: Can you say a little bit more about why it’s important for you that the colours match?

Just to – in creating a collection, especially in my 2nd year when I did weaving and prints to go with my weave so obviously the colours that I was using in my weave had to be the same as I was using in my prints, which were taken from my artwork, so to make sure everything fits as a collection the colours need to come out right.

Q.9 Personal discretion used to judge colour match?
AC: When you’re assessing your prints afterwards are you using your own professional judgement as a designer to decide whether or not if there is any difference it’s acceptable or not?

Yes – I do usually use my own opinion. Last year I was working in a group so we were able to look at each other’s’ and make sure they fit all together and ask in the group whether they thought they were fine. But this year it is virtually my own judgement.

Q.10 What info on colour on BSc course?
AC: OK. Throughout the BSc course what information have you been given about digital textile printing and colour management – have you had lectures or workshops…?

I think it’s been quite minimal for my year - I think it’s getting better. The only real proper colour management lecture was the one that […] gave the other day. Before that was in my second year, just before we were about to print out we came in and had a look at the printer and had a look at the computer and […] told us how it was going to work, the fact that you put your file in there and it sent it through to the printer, so not really a lot to do with colour. I think really it wasn’t until everything was printed out and people were asking questions about colour that’s when it came out, I think it’s been quite poor really.

AC: At that point did you print out colour palettes and swatches before your final prints then?

No – we didn’t in second year.

AC: So that’s a new development?

Yes, definitely a new development in third year.

AC: Was there anything in the CAD lectures or anything or any workshops that you did – or did it concentrate more on the software?

Yes – it concentrated more on the software and the fact that your colours needed to be the same as your artwork that’s where it came from. I think we were told that some colours won’t be the same, but we weren’t told why or weren’t told how to prevent this, so maybe a bit more information would’ve been better.
AC: Like you say, now that you’re printing out colour palettes before your final prints for your 3rd year for your degree show...

Yes – a lot better now because obviously we can print them out and check that they’re the right colours and if they’re not we can slightly change them and print them out again. It is a lot better now.

Q.11 Any other comments?
AC: Do you have any other comments about digital textile printing on the programme?

For my programme?

AC: Yes.

I think there should be more... I feel like once I’ve left I should be professional in using the printer, if that’s what I wanted to go into – if it was print that I wanted to go into – but the lecture that you gave the other day was really good – really got to understand a bit more – I know that you’ve given it to the second years now and that’s really useful for them that they’re getting it when they’re a bit younger and not so close to the end as we are. I just think there should be more really, especially with printing because in our second year we were supposed to have a series of printing lectures and we weren’t able to have those – they were for screen printing but I’m sure there would’ve been some digital printing as well because [...] was ill, so I think for our year we’ve missed out a lot of printing compared with weave and knit. OK? Was that fine?

AC: OK – thanks very much.

[End of interview]

Q.1 What software used for student designs?
AC: We’re talking about digital printing in the BSc programme, and in particular about colour in printing. I’d like to start off by asking you what software programs you use to create your designs for digital print?

I’m currently using Photoshop but I’ve used Lectra last year, but Photoshop so far.

Q.2 More than one computer used to design?
AC: Do you use Photoshop on the Uni computers or do you use it at home as well – on a laptop?

Mainly on the Uni computers. I’ve just got it on my laptop as well but it’s a very basic version, and over Christmas I went into my dad’s work and used it there.

AC: So you could work on your design across several machines?

Yes. Macs and PCs as well.

Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs on the computer – do you scan in your own artwork or do you pull the colours in from the software programs?

For this I did take a photograph of my colour palette and tried to pipette it, but it came up a lot darker on the screen so I’ve just tried to match it visually. For this one I’m using quite bright colours so it hasn’t been too hard to match it.

Q.4 What colour space used when designing?/Q.5 Any changes made to colour settings?
AC: OK. So when you’re trying to get your colours right on the screen, what tools do you use in Photoshop to change the colours?

I use the pipette quite a bit, and I look at the different colour gradients and pick a swatch.

AC: So are you using the colour wheel?

Yes – I’ll go into the colour wheel – it depends on what colours I want.

AC: Do you use any trend forecasting sites or journals to source your colours?

Well, for this project obviously we are doing our dissertations so I did a lot of market research what’s coming into trends, I looked on – not so much the fashion websites because we don’t have access to them all here – but I went on Vogue and stuff like that and had a look.

AC: Did you bring any of those colours into your designs from there?

Yes - we had a talk from Peclars Paris as well about colours.

AC: Where, sorry?
AC: OK. So you mostly just use the colour wheel or the colour library within Photoshop rather than importing or accessing a specific colour library any of the Pantone libraries or anything like that?

I haven’t been so specific yet because I haven’t got my final prints sorted so when I come to that I probably will do, yes.

Q.6 Do you know if colours within gamuts? [question not asked]

Q.7 Opinions on colour accuracy of printed designs?
AC: What are your thoughts about the accuracy of the colours that you’ve got so far in your digital textile prints compared to your on screen designs?

I haven’t actually printed any of mine out yet, so I’m not sure how they’re going to come out – I need to test that.

AC: Did you do any in the second year?

Yes – we did do some in the second year. I wasn’t too happy about how my fabrics turned out but then we never got our fabrics steamed and washed so I don’t know what the final outcome would’ve been. Greens turned blue when I was printing out last year.

AC: But you didn’t have the opportunity to do your colour chips and colour palettes before your final prints then?

No – we didn’t do that last year. I think we were all in a bit of a rush and we just ended up printing things out that’s why they didn’t get washed and steamed either.

AC: But this year you’ll have the chance...

Yes – I’m going to print out the colour chips.

Q.8 Why is important for colours to match?
AC: Is it important for you that the colours in your textile prints exactly match your CAD work?

It’s important that they match the colour chips on my mood board – it doesn’t matter so much if they match on the screen as long as the final fabric printed out is the right colour.

AC: Why is that important for you?

Just to make sure the collection – I think you need the right colours to make sure it fits together alright. I’ve been screen printing downstairs and if you get the colours off a little bit it doesn’t – they don’t look right together – and I think that’s quite important and obviously I want them to be the same colours as ones that were screen printed as well, if I can.

Q.9 Personal discretion used to judge colour match?
AC: So you’re using your professional discretion as a designer to make that decision and compare the colours across your other work.

[nod]

AC: Is it acceptable for there to be any colour difference between your textiles and you CAD work – is there a tolerance level?

I think I am quite tolerant – I don’t mind if there’s a slight difference as long as you get the idea...

Q.10 What info on colour on BSc course?
AC: So throughout the BSc course what have you been what information have you been given about colour matching issues and digital textile printing in general in lectures or workshops?

We had the talk […] gave us. We did have a lecture on colour I think it was – I don’t know if it was first year or start of the second year – we had a coloration one in first year – I can’t remember who that was... Was that […]? - Yes – it was [...].

AC: So mostly lectures so far?

Yes that was lectures it wasn’t practical – I don’t think we’ve had much practical help on matching colour it’s mostly been up to us playing around with matching colour.

Q.11 Any other comments?
AC: Do you have any comments on digital textile printing on the course?
I think it’s hard to say as a lot of the past year’s been rushed so we haven’t quite finished things off like getting them washed and steamed so we haven’t had the overall look. I think over the next couple of weeks we’re going to learn a lot more, taking time to print a lot of stuff off.

AC: I think that’s everything so thanks very much.

Q.1 What software used for student designs?
AC: We’re talking about digital printing in the BSc programme, and in particular about colour in printing. I’d like to start off by asking you what software programs you use to create your designs for digital print?

Mainly Photoshop, I did use AVA last year and Lectra, we didn’t really get much – we didn’t do much with it really – we had one tutorial I think – but we didn’t really get the chance to work with it, so it’s mainly Photoshop.

Q.2 More than one computer used to design?
AC: Do you work on your designs in Photoshop on a computer at home, or on a laptop at home, as well as the University computers?
Yes – both

AC: So you work on different machines?
Yes – on all different ones.

Q.4 What colour space used when designing?/ Q.5 Any changes made to colour settings?
AC: OK. How do you go about choosing the colours for the CAD work for your designs – do you scan stuff in or do use the colours within the software – how do you do it?

Recently I’ve scanned in my colour chips and them from that I tried matching it with the colours on Photoshop – whichever I think is the closest.

AC: How successful was the colour match from scanning in your chips?
I’m waiting for […], for the samples – so hopefully they’ll be quite close.

AC: Did you find that you had to do much adjustment on screen to get them to look…?
Yes – they looked a lot different, especially when I put them on the computer in this room – just from my computer they looked a lot different, so it will be interesting to see once they’re actually finished how they look.

AC: Yes. And where do you source the colours for your colour chips from? Do you initially find them from a trend forecasting website or are they your own choice – what do you use to scan them in?

This project came from my artwork and my photographs; I did also look at trends as well, so there’s a bit of both going on. I used the scanner in here and I also used the one at home as well but it wasn’t as good.

AC: So it’s more colours from your own artwork rather than, say Dulux colour charts that you’ve pulled the colours off?
Yes – it’s mainly artwork but I also had for my colour chips I used - I think it was Dulux – so those were cut out and scanned in.

AC: So you’ve got your colours scanned in from different sources, and then once they’re in Photoshop what tools are you using then to adjust the colours?

I just usually have a play around with all of the different things to see what I can get. I’ve tried matching it, because it shows the closest Pantone colour, so that’s what I went on, and I’ll see how close that is, then I’ll probably have to do something else to it.

AC: So you use the Pantone colour libraries within Photoshop to – mainly – try and match them?
Yes.

Q.6 Do you know if colours within gamuts? [question not asked]

Q.7 Opinions on colour accuracy of printed designs?
AC: What are your thoughts about the accuracy of the colours that you’ve got so far in your digital textile prints compared to your on screen designs?
I know with my last project they were very different – but hopefully this one will be better – I’m just waiting to get the samples back.

AC: For the last project did you have a chance to do any palettes before...?

We didn't have a chance to do any colour testing beforehand so it was the first time we did it and when the fabrics came out it was a bit like ‘oh – they weren’t my colours’!

AC: But this time you've got a chance...

...to try it...

AC: To try it and make any adjustments – OK.

Q.8 Why is important for colours to match?
AC: Is it acceptable for you that there’s any colour difference between your textiles and you CAD work – do you have a tolerance range?

Yes – I always want it as close as possible, but if they sort of look like the colour I wouldn’t be too choosy with it – but obviously as close as possible.

Q.9 Personal discretion used to judge colour match?
AC: And that’s – your making that judgement with your discretion as a designer against how you want...

Yes – how I want the design to look.

Q.10 What info on colour on BSc course?
AC: Throughout the course what information in the teaching content have you been given about digital textile printing – in lectures/workshops/tutorials/ about colour issues – or anything about printing generally?

We did have quite a bit with [...] last year. It was mainly screen printing and that sort of thing – we had that with [...] as well. We haven’t had that much about digital. [...] did some CAD sessions, but there wasn’t so much about the printing and colour and things – we haven’t had that much.

AC: Was it mostly about with getting to grips with the software in CAD?

Yes.

AC: And in the module that you did with [...] did [...] do projects with you?

Yes – we had little group projects and one of them we had to look into colour issues. So that was the first time I think we were made aware of it.

AC: and you've had more information about doing sampling with your final prints since then?

Just that we have to do them.

AC: Was that with [...]?

With [...].

Q.11 Any other comments?
AC: Do you have any comments or thoughts about digital textile printing on the course?

Just that it’s something that’s quite new for me but I really enjoyed it when I did it last year so this year that’s why I’ve taken it forward. So hopefully this project – I want to get it as good as I can – the colours and things.

AC: Thank you very much.

[End of interview]

Q.1 What software used for student designs?
AC: I’d like to start off by asking you what software programs you use when you're designing your CAD work for digital print?

Mainly Photoshop, I’ve tried using Illustrator and Primavision - I think that’s it. I’ve tried AVA once, but mainly when I carry my work out thoroughly it’s in Photoshop.

Q.2 More than one computer used to design?
AC: Do you work on own computer as well as the University computers? On a laptop at home as well as here – so you work on your designs on lots of different machines?

Yes – just the University and my laptop at home.
Q.3 How are colours in designs chosen?
AC: How do you go about choosing the colours for your designs – do you scan artworks or do you scan in colour chips? How do you select colours that you work with?

I think I decide initially from my photographs that I’ve taken for my theme and they are actually Dulux colours – but then I might have to transfer or rather decide on the computer and see what matches best with the Pantone colours. But in this project that I’m doing for my final year it’s kind of changed – so my colour palette’s constantly changing and it’s coming from different sources like my art work and designs that I’ve done on Photoshop as well so it’s a kind of mixture really.

AC: If you’re scanning in artworks or colour chips from colour charts, are you then matching them up with Pantone colours from within Photoshop?

Yes.

Q.5 Any changes made to colour settings?
AC: OK. And what do you usually – what tools do you use to adjust the colours once they’re on screen – you scan something in and you want to change it – do you find something that visually matches it in the library or do you actually physically alter the colour using any of the tools in Photoshop?

I do look at the colour picker – I use that and visually see what matches best. Also I think sometimes using the adjustments and changing the brightness and the contrast – sometimes I use that as well.

Q.7 Opinions on colour accuracy of printed designs?
AC: What are your thoughts about the accuracy of the colours that you’ve got so far in your digital textile prints compared to your on screen designs?

I think sometimes they have come out duller than what I initially wanted but generally I’m quite happy – I haven’t had a project where I’m really specific with the colour so generally I’m quite happy with it.

Q.8 Why is important for colours to match?
AC: Is it important for you that the colours match exactly?

Yes and no – because as I said my final year project – my colour palette has changed so much that it’s more like a general idea of what colours I need rather than being very specific.

Q.9 Personal discretion used to judge colour match?
AC: So your criteria for judging the colours is your judgement as a designer - you’re using your design skills to decide whether that’s acceptable or not when you get the printed colours back?

Yes.

Q.10 What info on colour on BSc course?
AC: Throughout the BSc course what have you learned from the lecture content or from workshops or tutorials about digital textile printing and related issues of colour management and things like that?

Erm...

AC: Or – Has there been much teaching content on digital textile print or projects...?

I think there should be more tutorials on Photoshop because sometimes I find myself doing the same thing and I’d like to learn a bit more. Because I feel there is more that you can do on Photoshop but I probably don’t know about it. So it would be nice to have a bit more not necessarily one on one but more tutorials that you can find out and it’s quite hard when you’ve got so many people in the CAD room and the tutor can’t go to every single person, so either there should be more... I don’t know.

AC: Anything specifically about digital textile printing that you remember?

Not that I can think of right now.

AC: No? Did you do some digital printing last year?

Yes – I quite enjoyed that actually. I felt that I did actually progress a little bit more with Photoshop but I think now I’m in the final year and I’m using Photoshop a lot more for my print designs I feel I need to know a little bit more about it.

Q.11 Any other comments?
AC: OK – that’s fine. Do you have any comments or thoughts about digital textile printing on the course?

Not necessarily. I think something you mentioned regards to me about how I match the colours – recently I’ve used – I’ve created my own swatches so that I do stay within my colour palette and don’t side-track so I think it is handy to have that – that’s just an added comment.

AC: When you say you’ve created your own swatches - is that on the computer or have you physically painted colours and then scanned them in?
No – that’s on the computer.

AC: So you’ve created your own little colour library that you select from when you’re designing?

Yes – so I don’t completely side-track and get distracted by other colours - because when you’re colour picking you sometimes colour pick – you don’t pick the right colour – because it’s very detailed it can change tone or shade very easily – it’s very sensitive to that isn’t it. That’s why I thought it was useful or helpful for me to have my own library.

AC: OK. That’s everything, thanks very much.

[End of interview]

Q.1 Software used to create student designs?
AC: I’d like to start by asking you what software programs you use when you’re creating your designs?

When creating the designs – mostly Photoshop. I did a bit last year on Lectra, PrimaVision is it - putting it into repeat and things – but that’s all I’ve used – it’s mostly Photoshop that I use.

Q.2 More than one computer used to design?
AC: And do you work in Photoshop mainly on the computers here, or on your computer at home, or on a laptop or a combination of all of them.

I’ve got Photoshop on my laptop at home, I tend to use it there, and the ones here in the CAD lab in here when it’s free, and store things on the memory stick and take it between the two and work on both.

Q.3 How are colours in design chosen?
AC: When you’re working on the computer, how do you go about choosing the colours for your designs – do you scan artworks or do you use colour palettes that you scan in? How do you select colours that you work with?

I tend to just pick by eye, without scanning things in just pick and try and match it up by eye – the colours on the screen with the colours from my artwork and things that I’m using, or I just use by eye to decide that I want to use I’ve never really scanned in a colour palette or anything!

AC: That’s fine – I’m just trying to find out how people work and use the software and stuff.

Q.4 Any changes made to colour settings?
AC: Do you use the colour picker and the colour libraries within Photoshop to choose your colours – the colour wheel...?

I use the Pantone colours to select, normally them really.

AC: Mostly the Pantone libraries within Photoshop, and just choose the nearest one that you think?

Yes.

AC: And is trying to match to palettes that you’ve got on mood boards?

Yes – sometimes on mood boards and sometimes just from a piece of artwork to try and match it but then sometimes as well just by eye with what looks best together – other than matching it directly to other colours that I’ve got.

AC: When you choose the colours for your palettes, do you use any sources like internet sources, to see any trend forecasting?

For trend forecasting?

AC: So the colours that you’re using for your designs – are they just purely your own choice or are they colours that you’ve pulled from...?

They’re just normally my own choice, for the projects working from the photographs that I’ve taken I tend to take the colours from there through to artwork and then through to designs.

Q.6 Do you know if colours are within printer gamuts [question not asked]

Q.7 Opinions on colour accuracy of printed designs
AC: OK. What do you think about the accuracy of the colours that you’ve achieved so far in your digital textile prints compared to your on screen designs?

Last year when we did the [...] project I was printing then we didn’t get to test anything – we just got one chance to print everything out. I wasn’t really happy with how mine came out. A lot of them tended
to be a lot darker – there was a sort of dark, like a reddy sort of maroon colour that I was using that came out pretty much almost black.

AC: So you were saying you didn’t have a chance to sample colours first?

No – I think because of the timetable in the Print Room we were just given a date when we had to hand everything in to be printed.

Q.8 Why is it important for colours to match? Is it important for you that the colours in your textile prints match your CAD work?

Yes.

AC: Can you say why that’s important?

Because obviously on our course for our assessment you’re marked on how well your artwork translates into your prints – the colours – when you’ve done your print it is the right colour and matches with your artwork and when it’s printed it’s not, it can be a bit frustrating and you might be marked down bit, in the first place it was the right colour it’s just when it’s been printed it’s not.

AC: Are there other reasons other than concern about assessment and things – as a designer’s point of view?

It’s just completely different sometimes. The ones I did last year – there was a couple that had been quite light colours and had been quite fresh as the design had supposed to be – but when it was printed it was all quite dark, and just had a completely different look really.

AC: OK. So is there any leeway for some colour difference between your CAD work and your textile prints, have you got some kind of range of acceptability – if it’s not exactly right, but it’s nearly right?

Yes – if it’s not exact but I think it’s just the main thing’s that, like with mine when it came out black and black wasn’t in my colour palette it wasn’t supposed to be black that’s quite a big problem. Or if it drastically changes the mood of it or appearance, but if it’s just a little bit then that’s acceptable.

Q.9 Personal discretion to judge colour match?

AC: And are you using your discretion as a designer to make that decision?

Yes.

Q.10 What info on colour on BSc course?

AC: During the course - what content of the course so far has been about digital textile printing – in the lectures – can you remember workshops and lectures or tutorials or anything in CAD that’s been about textile printing on the Mimaki – or talking about colour management...

Not really done a lot on colour management. We did a module last year run by […], she did that which was more about the technical side and the different printers and the things you can print onto. There wasn’t really a lot about colour management I don’t think. We did a group task where you had to research different things about why the colours re are different when they’re printed don different things, but we’ve never really done a workshop on colour management and how to do it, or practised doing it or anything.

AC: In the other modules like CAD – is that more about getting to grips with the software?

Yes – more about techniques in Photoshop and that sort of thing.

AC: And during CAD do you talk about anything – about different colour profiles, things like RGB and the differences?

Yes. We spoke about RGB and things, but only a small amount really, not really much about testing colours or how to get them the right colours or anything.

AC: But it’s different now - for your final project you’re getting to print out your palettes beforehand, so was that something you were advised to do because of … when you were advised to do that because of the difficulties with colour management?

Q.11 Any other comments?

AC: OK – that’s fine. Do you have any comments or thoughts about digital textile printing on the course or anything else you’d like to add – about colour in particular?

I don’t think so really – just the main bit that you do is in second year – and you only get the one chance to submit all your designs and have them printed, and I don’t know whether it is possible because of the timetable, but it would’ve been good to have a bit more time to have a go at printing different colours and see how they come out and the differences and things which would be good in second year –
because obviously you go into final year and you’ve only had one experience of it in second year – which isn’t a lot really.

AC: OK – that’s everything so thank you very much.

[End of interview]

Q.1 Software used for student designs?
AC: I’d like to start by asking you what software programs you use when you’re creating your designs?

I’ve always worked with Photoshop because that’s something I’m really confident with because I’ve got that package at home and I’ve had that since I was sixteen so it’s something I knew before I even came on the course. And then last week I taught myself how to use AVA and so that’s now something else that I’m using and they’re the main two software packages that I use – or the only two, really.

Q.2 More than one computer used to design?
AC: You mentioned that you’ve got it at home as well, so do you work on your designs on quite a few different machines – on the machines here up in the CAD lab or –

I don’t work in the CAD lab, I work on my laptop at home and in the digital print room.

AC: So, on the PCs and the Macs in there?

Yes.

Q.3 How are colours chosen?
AC: How do you go about choosing the colours for your designs – do you scan artwork in that you’ve done or do you pull colour palettes in from web sites or from trend forecasting sites? How does it work?

For my project the colours initially came from research that I’d done into trends and forecasts but then really it came from me going to Aberkhan and finding a series of fabrics I really liked and realising that that exemplified the colours that I really wanted. So then I used those fabrics directly, and worked with the fabrics as my artwork and produced paper artwork in those same colours and then all of that has been scanned in and used directly to form a colour palette on the screen.

So when you scan in your source material into Photoshop what do you then do to it in terms of... you know if it’s not quite right on screen?

I’ve used a whole load of filters and things, because most of my digital print designs to go onto fabric have actually come from fabric in the first place and art work, the artwork was scanned and the fabrics were, I’m trying to think, some of the stuff was photographs of the fabrics and they’ve been manipulated but the most of the stuff was trying to get the fabrics as flat as possible and using my scanner at home and then I’ve just taken them into Photoshop taken out a chunk that I wanted to use and sometimes those chunks have only been 3cm but I’ve wanted them 30cm so the main thing that I’ve done really is apply blur to them so that it takes out the pixels but also that’s been important for my work because it’s kind of hazy and very non-descript anyway so it doesn’t matter that the image is blurred. Bu the colours kind of just use them as they are or I just mess about with the adjustments in Photoshop, colour balance and the hue and saturation and brightness and contrast, and they’re the main tools I’ve used to get what I wanted.

AC: So are you using any of the colour reference sources within Photoshop – any of the colour libraries or Pantone colours or anything like that?

No – because nothing of mine is a flat – there’s no one flat tone in any of the stuff that I’ve produced, so it’s just about messing with the colours that are already there. I did produce a colour palette initially because I had a colour palette on my mood board, but there’s virtually not one single design in my work that’s got any area of one flat colour in it, so that’s been discarded.

Q.5 Any changes made to colour settings?
AC: And do you make any changes in Photoshop to any of the colour management settings or do you just use the default ones? To you go in and make any changes to the views, like CMYK or anything like that?

Oh no – I just use it as it is. I do notice a huge difference though between the work that I do on my laptop at home and coming in and doing stuff in the digital print room, especially when I was printing of my visualisation for Bradford the other week, the stuff that I’d done, I was printing in the digital print room, and even the difference between the monitor and the printer was noticeable. And then I realised that I still needed to print it again when I was back at home and tried to do the same and the difference between the print out in here, my monitor at home, my printer at home, every single thing came out completely differently but I think there’s much more parity between the screens and the printers in the digital print room than with my stuff at home. What comes out of my screen on my laptop is always completely different to what comes out of the printer, but it’s usually far more similar in the digital print room, I find.
Q.7 Opinions on colour accuracy of printed designs?
AC: Well that kind of leads me on to ask you what your thoughts are about the accuracy of colour that you’ve achieved so far on your textile prints compared to your CAD work?

The first – because I worked on screen and had designs that on my laptop screen were exactly the colours that I wanted and then I had those printed at UPrint for my interim assessment so I could show them and they all came out a lot more intense than they had looked on screen. But at that point I was actually quite pleased with the way that they looked and it was those designs that I used to make my selections for what I wanted to print onto fabric, and when the fabric prints came they were all much darker and duller than the paper prints but then in actual fact that was actually preferred – the colours that came out from the digital printer although they were different are actually the best I’d achieved. I think that if it had been for a different project it would have been really important that the difference in them, but for me it’s not that important anyway, but it was actually really beneficial.

AC: It was a happy accident?
Yes – pretty much the whole project has been.

AC: So, do you get the chance to print out – you said you discarded you palette so you didn’t print out any palettes or colour chips or anything like that?
I printed them out right at the beginning.

AC: Onto fabric?
Onto fabric and they were darker than on the screen.

AC: Were they washed as well?
Yes – washed and steamed.

Q.8 Why is it important for colours to match?
AC: You’ve kind of answered the question but I’d like to ask you is it important for the colours in your textile print to match your CAD work?

It’s important that the colours that get printed are the colours that you want them to be – because it’s not always the case that what you see on the screen’s the exact colour you want. It’s not important in the sense – it’s not like you – I suppose it’s important if you’ve got art work and you’ve got fabric and you’ve put your whole presentation at the end together, you don’t want the colours to look completely different but as you’re not sort of displaying fabrics on paper and on fabrics in that sense, as long as it’s a collection of fabrics it’s OK for them to have differences but I suppose if somebody were to look at your artwork and your CAD work and then look at your fabric collection and there was a massive amount of difference then it wouldn’t be great.

Q.9 Personal discretion used to judge colour match?
AC: So you’ve got some kind of range that you’re - as a designer – you’re imposing on – a tolerance range if you like – so you’re accepting...

I think you have to because you’re never going to get them exactly the same really, well not in my experience which is not that vast.

AC: Like you say you’re using your discretion as a designer to say ‘I’m happy with that’ or not compared to your original designs.

For me, that’s been the case. It’s probably more relevant the project I did in second year digitally because that was more typical digital print project and I remember working and getting everything exactly ho I wanted it on screen and getting it printed off on the digital printer and the colours were completely wrong and I was definitely not happy with that and I had to back into CAD and alter the colours so that on fabric they would then be what the original colours on the screen would be, and that was hard work and I think then it was really crucial that the colours were right but this project is a bit of an anomaly really because it’s such a tonal range an actual sort of exacting colour isn’t required.

AC: But for the second year project did you not get a chance to do sampling beforehand?
No – we didn’t do samples then, you mean like small thumbnails?

AC: Test prints.
We should have done, but we never did. I think it’s because we were just told to print them out thinking that would be OK because we were told that the machines had been colour calibrated. But then there was quite a big difference in the colours.

AC: Yes – that would only work if the computer you were designing on was calibrated with the printer.
As I'd been working at home, obviously that didn't work.

AC: That's kind of key isn't it because students work across lots of different machines and then bring all their designs to this one output?

The best thing for me is the work that I've done recently in the digital print room – having access to that room – I didn't even know it existed in the second year – but this year using that room has been the best thing to do because things have been made sure that they're all coming off the same, so there's far less difference between what you see on the screen, what you see on the paper printer and what comes off the digital printer. It's just a pity there's not more of it that it's not a bigger resource, because if we all suddenly wanted to go in there it would be – you'd have no chance.

Q.10 What info on colour on course?
So, throughout the course what – in lectures and workshops and tutorials or whatever – what information have you learned about colour management in digital textile printing?

Very little.

AC: Or colour in general?
I remember having lectures in first year with [...] and [...], but that was 3 years ago for me now so I really would find it a struggle to remember anything that we did, but we definitely had lectures on it, and in second year I don't think it was really touched on very much, and then this year it was the session we had with [...] and that's been it – there's not really been – I would like there to be more about it really, because I think if you're going to go into industry into digital printing as a job it's something you need to know about and for us it's just just more a case of give it to [...] and see what happens kind of thing, you don't actually know much of the background behind digital printing or colour management.

AC: Did you do any projects to do with colour or anything?
No – in second year there was I think, a second year module.

AC: I remember [...] ran a project to do – and [...] does some stuff to do with digital print, I just wondered if any of them touched on it at all?
No – not when I was in second year.

AC: Maybe it's coming through now.

Q.11 Any other comments?
Do you have any other comments or thoughts about the digital textile print part of the programme?

One thing – not about the programme – well, I was going to say one comment when you were taking about the colours coming out on the fabric, one thing that's been really interesting is that every different fabric I've printed on the colours have come out differently which is something that I completely didn't expect, that's been really hard to manage.

AC: It is because in the lecture [...] was saying that's one of the things – every single component of the printing has to be calibrated, so if you have a silk or cotton, you'll get a different printer profile for each substrate. So the variables are...

The module – the teaching that we get on it, I just think there should be more of it really because I think it would be really beneficial for us to understand because I suppose we're quite ignorant to it really, exactly that point - we think we can work at home and come in and it will print out the way we've seen it on the screen that we're using at home. If we were more aware of the fact that that isn't the case we'd be more inclined to always use the same machine or try and always use the same system to develop your work maybe. It would be interesting to have more teaching on it.

AC: And to understand maybe more about why sampling is important – that's the key thing I think that's the only way you can keep a control on the situation with so many laptops and PCs being used in different locations, is to always stress how important sampling is – that's one way of doing it.

I think sampling is the best way – well it's the best way to save a lot of waste. For me now it would be so beneficial for me to sample everything first but because of the timescale of the project and the amount of different fabrics that I need to print on, it would take so long to do the samples, it would take as long as it would to just print the actual fabrics, so for me it's easier to just guess and see what comes out of it and use what's worked and discard what hasn't.

AC: And you're working into – on top of your fabrics as well aren't you – which is quite unusual I think
And that’s something again – then having to go into the dye house and make up pigments and the screen printing elements to fit with the colours that have printed digitally that’s another aspect altogether.

AC: OK – well I think that’s everything – thanks very much.

[End of interview]

Transcript of group interview with students

As the students arrived they were asked to read and sign the participation sheet which included the code of ethics; there followed an explanation of the purpose of the meeting – to provide data for the PhD – and of the activities the students would be asked to do. It was made clear that the activities were intended to promote discussion rather than to gather statistical data.

The students began the first activity – rating elements about digital textile printing as either ‘essential’, ‘desirable’ or ‘non-essential’. The list of elements was the same list as used for the staff group interview. When all the students had completed the task, the discussion of the results began.

AC: Let’s have a look at what we’ve got – what I’m looking for really to spark of the discussion is where there’s any disagreement. So this maybe is an interesting one here – there’s quite a range of thoughts about colour technology principles and the different types of colour. So maybe the opinions here that are expressed we might talk about that and why someone’s gone for ‘non-essential’ and someone’s gone for ‘essential’, really opposites. So we could start off with that...

I think I was a ‘non-essential’, I think that was because I didn’t really understand what you were getting at, because I think that that question was answered in the other things, so you could have a grounding of that from learning how a digital printer works and the inks that are used, instead of learning about that, from my perspective.

For me that was about colour technology in general, like general colour mixing, whether you’re talking about mixing paints or mixing for digital or...

AC: It refers to the additive colour element is your monitor and the software, and it becomes subtractive when it’s printed onto cloth because the different...it’s about the difference between RGB and CMYK and how you get those different elements to communicate with each other.

That’s why I went for ‘essential’, because I have had problems with this in this project for that reason because some of my documents are in RGB and obviously they’re printing out differently and it’s creating problems that really I should have been more aware of, I think.

AC: It’s very difficult to separate the elements out, so colour management – that’s a really broad topic – which is why I’ve tried to break it down into smaller parcels because things like that and the calibration process are inextricably linked because each individual monitor has its own colour gamut, and each printer set up has its own colour gamut and how they communicate and how you then produce the same colours from screen to textile is all linked with colour management theory, colour technology, so it’s very difficult to do something like this and have everything very clearly defined in boxes because it does all link together.

AC: How about some people who thought it was ‘desirable’?

I wasn’t quite sure what you were getting at and if it was to do with communicating the RGB that kind of thing, then I think it’s essential and that’s why on that one I have put ‘essential’, so if those two... actually looking at those two [the lists of elements on the wall] they’re actually really different – the one on the right is all saying ‘essential’ virtually, the one on the left you’ve got a really mixed - so I don’t think I really understood what you were trying to get at.

AC: OK – is it more clear now?

Yes – definitely.

Maybe that’s why I put ‘desirable’ because I haven’t come across it, so I was a bit – it would be good if you knew about it, but I haven’t come across any problems with it myself so I didn’t see it as essential.

AC: This is exactly why I thought it would be good to get you in as a group, because you’re now at the stage where you’ve had a full experience, most of you, of digital textile printing and you’ve come across little or big problems that you’ve had to deal with and finding out why that’s happened is part of understanding and being able to then get a better result.

AC: OK. This is another mixed one – looking at the different substrates that you can digitally print on, and how it is very different when you print off – as you know – on all different kinds of paper on the same printer, a glossy paper or a matte paper or a plain paper you get different colours. You get different colours on that printer or that printer on the same paper, and then you take the same print
that's on paper and put it on textile and you get another different result. So we've got a similar
difference of opinion for this one... I was the 'non-essential' because I thought it was a general understanding that you do get differences,
so it's not something that needs to be taught – it's just something that you 'know', if you know what I
mean? So that's why I thought it was 'non-essential' to be taught it because it's just something that you
understand as a textile designer.

I think it's something that you don't just understand until you've had experience of it happening to you
because I had no idea that printing out onto cotton drill, silk, cotton madras, cotton poplin, and all the
different fabrics that I've tried my prints on where going to all come out completely different, and had I
been told that beforehand and been told, well generally silks come out darker, or cottons come out
brighter or whatever then I would've adjusted the design that I knew was going on to specific substrates
to make it so that they were all more comparable because I got some really different results coming
from the different substrates.

I think you almost need to try your different designs on different substrates though, because if it does
come out darker on one of them that actually might be an effect that you quite like, or something like
that. For me, I've been printing on organza and cotton and they're completely different because
organza's a lot thinner and you get a very different effect but I liked both of them and I didn't really
realise how much difference you were going to get, but I did like both of them. I think it's not something
you can be taught, it's more something that you experiment with and you experiment with different
substrates.

It's a part of the learning process – it's quite organic. You don't know it until you've tried it. I think
sometimes you get a better effect for the experimentation. Yes, it would be nice to be told that 'X, Y and
Z', but it's sometimes nice to find it out yourself because you get the opportunity to see the results and
as designers generally we tend to learn by 'doing', I find.

AC: Do you think then that perhaps there's room for time for experimentation?

Yes – definitely, more.

No – I think that really links in with the idea of sampling and how important the sampling is, I don't
know about anybody else but I wouldn't have had time to sample for me it has been nice to have the
experimentation to find things out as I've gone along but it's meant that I've not been able to do things
because I've then not had the time to do it correctly having found that what I'd originally done was
wrong.

AC: Ideally, in a perfect world...

- You'd sample on all the different substrates?...
- I think in terms of the course I think we should – this is just my personal opinion – but I think we
  should have had more chance to experiment with that probably earlier on, as in second year and first
  year, to try these different things and look at the different fabrics, see how they come out, see what
  happens, see what difference you get on silk, see what you get on cotton, so by the time you get to the
  final year you've got a better understanding, so yes you'll still sample things but you wouldn't be
  sampling on the wrong things and wasting time, so I think probably should be done more and earlier.

If you did the student project again given what you know now, you would have time for experimentation
and more sampling because you'd have learned all that already. If you'd learned it earlier then you could
put it into practice now.

Exactly – that's the thing, that's the difficulty.

AC: And also the difficulty is that the course is already jam packed because you do all the other things –
spinning and knitting and weaving.

But I think we do the lab classes with [...] in the First Year and I think that probably the amount of
screen printing that people do in the final year versus digital printing, you can learn what we learn about
screen printing in a relatively short period of time, whereas there's a lot more to do with digital printing
that we could've learned earlier in that time, and other people could get involved in teaching earlier on.

In terms of it being a developing technology and it's going to keep going and keep going – personally I
actually at this stage I feel at a disadvantage, because I don't think we've covered enough about it
actually. I know probably more than people doing a BA course but in general terms there's so much to
learn and we've been I think really all we did was in the second year – we did a bit with [...] didn't we –
she did a little bit with us, but apart from doing our Edinburgh Weavers project that's really it, we
haven't really gone into any kind of detail and I think given the fact that there's expectations that the
technology's going to keep developing and it's going to become more and more and more popular, there
should be much more concentration on it than there is.

I think so too – because it is an emerging technology that is being used more and more and were we to
go out in industry and work in that industry now you'd feel really ridiculous with the amount of
knowledge that you’ve got about digital printing because I think some of us have been quite involved with it but for a lot of people it’s been ‘there’s my print, oh yes, thanks’ and it cuts out – rather than you don’t have any understanding of what goes on from you handing over something on your USB and getting your fabric out at the end. If somebody said to you ‘explain digital printing’ you’d be like, ‘well I give my design to a nice man and then he gives me this back.’ You need to know all the in-between – I think it’s really important to know that.

When you did that lecture on colour calibration that was really interesting I thought – that’s probably one of the first times we’ve really gone into it in some depth and I thought that was really useful and really helpful. I mean that’s our final year and we should be getting that in the first year.

AC: I was just going to say, the question reflected back is what are employers’ expectations of what students have knowledge of digital print when they graduate – I don’t know what they are, or how high they are...

I think, going into a design job, you would just give it to a nice man in a factory and say ‘these are the colours that I want’ and it’s his responsibility to match the colours that you want. If you go into a technical job in a factory then yes you would be expected to do that, but I don’t think that doing this course you would be going into a technical application. Although it’s a BSc, there’s not enough of the technology to warrant you going into a technical career, which is a real shame.

I think employers would expect you to come out of a BSc with enough knowledge that you could pick up when there was a problem and you would understand why there was a problem otherwise they might as well just employ anybody. If it’s something they’re going to say, well you take it away and you take care of it, what’s the point of studying it at all? The whole point of this is that you would go out with an advanced knowledge or an enhanced knowledge above someone else. In this instance I mean I know you would learn a lot on the job, obviously you would, because it’s different in different places, but I think having that base knowledge and to be able to pick up on faults and know why there’s a problem, I think that they would expect you to do that, definitely.

But do you think it all comes through experimentation and practice and stuff like that? It sounds stupid, but we’ve been using printers to print off paper for years and years and never really understood why sometimes it’s a little bit darker, sometimes it’s a little bit lighter, a bit different from what it is on the monitor...

...You just accept it, don’t you?

Yes, you kind of accept it unless it has to be perfect and then you give it to someone who knows exactly what they’re doing.

Yes! It’s just through experimentation and doing it yourself so I’m not sure that even if someone told me about different substrates and how the colours were going to be affected I’d still want to go and trial it myself.

AC: OK. We’ll do one more quick one, then we’ll move on to part two. One more that’s a bit of a mix up – which is, I guess, the principles of the calibration process – the majority rate it as ‘essential’, but then we’ve got a ‘non-essential’ and a ‘desirable’ vote for this too, so it’s similar to what we’ve just been talking about. So who would like to kick off?

I’ll go. I think I was ‘desirable’ – I can’t remember – it was two minutes ago! But I’m sure I was ‘desirable’ in that, yes it would be really useful to be able to be able to know how to do it, but generally speaking in industry you would have a technician who would do it for you. So if you understood that’s wrong, you would then call someone up and say can you come and sort out the calibration. So although an understanding of it is good, you don’t need an in depth understanding.

AC: I think that’s what I was getting at with ‘the principles...’ so you understand that there is a process, and why you have that process and why it’s necessary to calibrate your equipment because of what we were talking about earlier with the colour discrepancies and things like that.

I think I was the ‘non-essential’, because I think it was what I was asking you about, in terms of what is it necessary for, because if you were saying that the principles of calibration from screen to textiles are needed for this course I would say no, because somebody does it for us, but if you were to go out into industry then I think that yes, it would be good for you to have that for yourself.

AC: Do you think it might help with the understanding that if you’re up in the CAD lab or at home on your laptop doing your designs and then you bring it in, to understand why – if you put that straight into the printer – why that’s not going to give you the colours that you want because it’s not been calibrated.

I think it’s essential, because if you’re doing some work and you go to print it out and you’ve got a deadline or something like that and you do it on the last day and it comes out the wrong colour, then you need to be aware of that before so that you can change your colours – you showed me a programme where you can see a 3D version of if your colour’s going to be able to print or not, and I didn’t know that before, and I think that’s quite essential to some prints that I’ve done to have a look, because if some of the colours weren’t able to print I’d have changed them.
AC: That was the gamut profile on the Mac that’s linked to the printer – it shows you the colour gamut for the monitor and the printer and what is actually physically printable in that set up – you see it as a solid sphere that’s either inside or outside the gamut.

It is important; particularly from our point of view, when the majority of us are translating art work into prints, and then you take it in and you find that actually what comes out is not actually something you can even achieve, you couldn’t even possibly achieve that colour, so if you did have the knowledge of that you can make the adjustments, which again it saves time – it saves wasting time printing things out that are constantly going to be wrong and you’re never going to get them right. I think it’s quite important.

AC: Anyone else got any thoughts or shall we move on to part two?

I think, just in general, we’re trying to relate it to our course, and I don’t know whether that’s what you’re wanting to achieve? Because I think if we were talking as people out in the world of work we may give you completely different answers, so it’s very swayed towards our opinions as students in the course.

AC: That’s fine – otherwise it just becomes - the variables are too difficult to talk about – so it’s good that’s it’s your opinions as students, that’s fine.

[Students took a break to get a drink and then Activity 2 began, after explanation from AC]

AC: Only one vote for eLearning out of the whole lot...

Don’t like it – hate it!

Blackboard – hate it, hate it!

It isn’t good – because I think we’re quite an inquisitive group and we like to ask a lot of questions and you can’t ask a question to the computer.

AC: Do you think it’s no use even for backing stuff up that’s already been done, or for putting videos up or animations or things like that?

Yes – it’s a good supportive tool, but as a primary method of teaching it’s not.

AC: So as a support it might be useful?

Yes.

The problem with that is if you don’t have to do it a lot of people won’t look at it.

AC: unless it’s got an assignment on it or something, or a questionnaire or quiz...

But even then I think...

Lecturers say - look at the thing online before you come to the lecture...

You just think, well I’m here for you to teach me, not to sit at home and look at it on a computer. I can find anything on a computer if I want to but I’ve paid for you to teach me, that’s my opinion, sorry.

I think I took that wrong – I took eLearning to mean learning that you do on the computer, but not necessarily through Blackboard, I meant it to mean like conducting your own research on the internet and things as eLearning, so discredit my ‘eLearning’.

There’s one ‘eLearning’ there, and there’s one ‘eLearning’ there...

...and there’s one over there as well...on the ‘pre-printing and post-printing treatment’.

AC: OK – so let’s have a quick review of where’s there’s a little bit of difference of opinion... can we just have a chat about who thinks a group task would be the best way to deliver this element [the evolution of digital textile print] and how that could be achieved?

I was a ‘Lecture’

And I was a ‘Lecture’...

I was ‘Tutorial’...

I must have been the ‘Group Task’ then! I think it’s easier to go away as a group and find out about it and put it together and you know if you were to give a presentation on it or something, because it must be a really big field, and if each person gets it separated and has an element of it to look at then you have to bring it all together then you’re going to learn from what everybody else has found out and then
AC: So breaking up a larger subject into smaller bits?

We kind of did that with [...] in second year. But it was more like learning about printing as a whole, not just digital.

AC: Which you need to do to see it in context, in the whole scheme of things, because it is relatively new it’s only been around in the form it’s in now since about 1995, and in terms of textile printing that’s a tiny baby.

I think that’s the kind of thing that would be really dry if it was delivered in a lecture. It would be so long winded and everybody...

That’s why I went for ‘Tutorial’ because when we did have those lecture last year with ... some of them went on for two hours and it was all interesting and it was all valid but over that period of time to keep people concentrated and to keep people just taking it in was impossible because it’s so technical I think smaller tutorials that are short where people are paying attention and they’re listening to half an hour and maybe then you go off and do a group task, but going for a full-on talk, an hour to a two hour lecture is too much.

I think from a time perspective of all those different things, you could fit the information that you need in a two hour lecture, whereas the lab classes would take ten hours to teach everyone and I think the relevance of that compared to some of the other things, I think – you know – splitting the time down - I’d rather have a lecture on that for 2 hours and spend 10 hours in lab classes sampling and practical if that’s how they were going to break it down.

AC: and that’s reflected in how people have rated that isn’t it? Nobody thinks it’s essential, a couple of people think its non-essential. It’s kind of reflected in what you’ve just been saying as well. So let’s have a look – the importance of sampling – everybody agrees that’s key for digital textile print and loads of people have gone for a lab class – how do you think that could be achieved in a lab class?

Well, [...] does a lab class with our group or someone else and they choose a colour at the beginning of the lab class, don’t they, and then it’s up to them to mix a dye to match that colour and it’s an experimental process of trying different colours to get back to that colour, so maybe something, I don’t know if he does it for us...

I don’t think he does...

- but it would be a good way of helping you see what you want to achieve and then experiment in a way to get to that end result.

I don’t know what you mean by ‘sampling’ to be honest.

AC: Like you did before you do your final print because you know you do your colour chips and you do a test print and then...

I think I put ‘Group Task’ just because when we’re talking about all of this, the really big thing that’s always in my head is waste, and how much stuff gets printed and the expense of it all and doesn’t get used and that’s one of the reasons why sampling is so important isn’t it – to do something that scale or a full metre of something - and I think I said group task because – say everybody was given the same image and each one of you had to investigate it on different substrates or a different aspect of colour then you would share the results rather than everybody doing everything and you just getting fifty samples on cotton and fifty samples on silk...

I think if we had a greater understanding of all these things in the first place though there wouldn’t be as much waste anyway, because people wouldn’t be going into that issue of printing it on all those different things and only realising that one of them works, so wastage would be reduced just by teaching people about this. Because the only proper sampling that people do is printing off the colour chips isn’t it – that’s recommended to us – the rest of it is just if you want to, go and do it.

I’ve done it but I think because it’s not something that you’re taught to do you could just go in there with enormous prints and print them all out and think Oh my god they’re all wrong, I’m going to have to do them all again, and it is a waste because there’s no guidelines in terms of you need to take this time to sample them, and they need to be this size, do you know what I mean – it’s just something that we’re not really taught about at all.

AC: So at the moment, how is the sampling part of, how is that given to you that advice?

It isn’t.

AC: It’s not currently?

No.
Because I find that a real issue for me, because before Easter I gave [...] prints and got them back when I came in after the Easter holidays and almost all of them were the wrong colour because of what they’d been printed out onto, but there’s no time for sampling, not only for me personally but within the time slots that we’re all given, if I’d have used one of my time slots to sample I would have lost one of my time slots for actual fabric, so there really wasn’t the opportunity to sample really. So maybe that should be done much, much earlier, with more flexibility.

I think maybe a timetabled sample, like to do your colour chips, and maybe do your colour chips on the fabrics that you intend to print on probably and have a slot for that, ... to save [...] time, if he has all the colour chips all in one and printed them all for everybody at once on all the different fabrics that are available so that [...] is not doing loads of tiny little bits and everyone’s getting them at the same time so everyone’s at the same position to start within that the colours are right they know what the colours are going to look like on all these different fabric bases. Whether it would work or not in practice is another story.

AC: Do you think it would be helpful or not if there were- if the colour map that was possible – printable by the printer was actually printed out, so you could see the range of colours?

-Yes.

AC: When they do the calibration they print out the number of colours that that set of colours is capable of printing, and you could maybe have a sample of it on all the different fabrics.

Yes.

Yes...

AC: You’d have to keep re-doing it because it would fade in time...

Or, I think maybe at the beginning at that point, you give everyone the printer settings so everyone’s aware that it’s CMYK and its calibrated to this...I don’t know if you can?

AC: Not really – what you have to do to calibrate it – you have to calibrate the monitor by using the spectrophotometer to read the screen then you print out the colour swatches from that process on the machine and then you steam it and then you scan them in again and marry the two up, and that is specific to that substrate - to get an exact calibration you’d have to do the same process, for a cotton, for a silk, for a wool... and even then there’s no guarantee – I’ve just printed out a couple of quotes for my PhD and one of them is saying, basically, if you’re printing out on the same printer, with the same inks/dyes, same substrate, same software, you’ll get different results on different days because of environmental conditions. So it’s not an easy thing to achieve, which obviously you’ve all had different experiences of, but that’s why it’s not easy to achieve.

AC: Maybe just wrap it up...the main votes here for talking about how colour communication is taught have gone for a lecture, then there’s one vote for individual project – how do you see that individual project panning out?

I haven’t given it that much thought really it’s just... because I think it’s quite a practical thing to understand the differences and be aware of the differences and I think it’s something you probably grasp a lot better if you’re actually physically producing things rather than just being told about it. We have all been told about it but until you physically see what happens and what the differences are you just sort of forget about it – I forget about it all the time, but I still know about it but I don’t, when I’m working I’ll look at files and think, well actually it’s in the wrong colour format to be printed anyway, and I know a lot of printers would just change it over anyway but I just think it’s something you should maybe physically hands-on have a go at producing things and seeing differences.

AC: It sounds like basically you need each element needs to be backed up – maybe by a variation of delivery – so you get some basic information and that’s reinforced by doing maybe a practical exercise that then brings to life what you’ve been doing in the lecture or something?

The problem is depending on how essential it is as well – if it’s not very essential you’ll have to have one lecture maybe, but if it is really essential like sampling and knowing about colour and how it comes out differently I think you really need to back that up.

We did have one with [...] last year didn’t we, where she gave us a paper print and then she gave us fabrics and they were all different and we had – it’s similar kind of thing to what you’re talking about – the problem was timescale I think, that none of us really had the time to give it our full attention, because we had so many of them – you’d literally get them every week – that you’d just dash it off really quickly, don’t even bother to read it, hand it in, get your marks and that’s it. So you’re not learning anything like that. So I think if you’re going to do something where it is an important you need to have more time to actually do the work rather than get it and have to hand it in three days and you haven’t got the time to take any notice of what you’re doing.

I think like the topics that you’ve covered up there you could probably split them down into three groups – you could probably have a lecture to cover each of the groups – the history of digital printing, how it
works, how it’s used in industry today and the benefits and limitations - that could be a lecture, and then you could split it down into the different fabrics you can use substrates and do some sampling within that and then do a section on colour management and probably do it across, I don’t know, one semester, and do three lectures and an individual project where you’ve got to find a colour in a couple of lab classes, instead of something like we do with [...] where you - I don’t know – you probably could put all this in one module.

AC: Do you think – where would that come in the course – which year?

Second year.

I think we should start it in the first year.

Definitely – I think it should start in the first year and carry on to the second year.

AC: there are lab classes I the first year aren’t there?

Yes- but we only did screen printing.

They’re not particularly relevant though are they?

No – it’s very dated really isn’t it?

Yes it is.

AC: In the labs that you do at the minute is there anything like this – the reactives...?

We learn about the different dyes in first year, and you do a colour file in second year.

We did dyeing of fabric in screen printing, traditional things, but it’s not digital.

Acid dyes, reactive dyes, that kind of thing, vat dyes, which I suppose is important to know, but why can’t they be taught together?

But think about printing in first year and second year how much of that time is spent talking about screen printing and traditional things that maybe it’s time to move forward into digital stuff because you then come into final year...

Also, some of this stuff I think in first and second year, unless you’re intending to carry on with print when you specialise you wouldn’t need to necessarily know it.

And you could be a bit blinded by science couldn’t you? I think probably a lot of it could be backed up by eLearning, but you could say it’s available – yes this is all about in final year if you decide to do print in final year there’s all this information to back up what you learned in second year – go on Blackboard and find it. Because there isn’t – apart from going to speak to you or [...] – there’s nowhere that you can go and get that information that’s condensed, it’s not like going to the library and trawling through a hundred books, you just don’t have the time, and if it was filtered down in to the best of the best...

That’s just so difficult though because it is so open and varied and like you said if you do it on different days you’re going to have different colours and different effects, it’s so varied that you’re not going to learn this stuff unless you’re doing it yourself. For them to condense books and books of information how are they going to pull out the most relevant stuff? Except for saying things like that there are differences between monitors and printers, I suppose that’s the thing they...

I suppose it’s the principles isn’t it, and the benefits and limitations and innovations in digital technology and how it’s being used by designers and companies - that kind of thing you could get on line but the practical stuff you’d do in a lab class.

But don’t you think that should be done earlier? I think the more scientific aspects of it like we said if you’re going to specialise in digital print that could be potentially be left until much later on, but certainly early on in the first year we might use it. We learn so much about screen printing but what we learn obviously all about is hand screen printing which is not something that you do in industry anyway – it’s rotary printing which we have – I’ve never even seen a rotary screen printer – I don’t know what they look like, I only know what they’ve told me and shown me on slides. If you’re going to concentrate on something it would be, personally I think it would be more viable to concentrate on things which are actually being used rather than...

But waiting to learn the science until you know that you want to do printing would be final year and it’s too late then...

Oh no, I meant towards the end of the second year, but introduce it as a subject earlier...

I think it’s little things that you should be learning every year...

Yes – continually...
I think the thing is there are key things that you could go into, I think there are key things that need to be signposted, like it’s very important to sample, get sampling done early, fabrics produce different results, make sure you experiment with this, just fairly brief and concise guidelines that could be provided, because I didn’t have a clue about that until this year and even just being told that - it would be different - then you investigate it for yourself and you find out the result, but knowing that you are going to get some differences is helpful.

You do give it to […], and when it doesn’t come out like you expect you don’t know why, you can’t then go and rectify it because you don’t know why, you just know that it’s wrong and then you go and experiment a little bit more, to maybe get another wrong one...

It takes ten times longer if you don’t really know what you’re doing, when you get it back to try and put it right, you then think you’ve put it right give it back and it’s wrong again and it’s so long winded. There’ve been occasions when I’ve been and asked questions and they can’t give me an answer...so I’m asking what I consider to be... I don’t the answer I don’t know why this has tuned out like this, but I half hope that someone can give me some guidance as to why it’s happened. To be told ‘I don’t know’ is not really very helpful.

AC: There are a couple of things from what you’ve said that I’d just like quickly to ask you before we wind up. One of them is: talking about traditional screen printing, do you think though that it still does have a place alongside digital printing because you can marry the two together? So some element of that is important as well, to retain?

Yes.

AC: The other thing is do you think potentially that a work book would work? I know you get something for weave – do you get a weave...?

We get a weave file in second year, we had a file and it was...

Enquiry based learning...

I know the problem is, if you’ve got something like that, is a similar mind set to having something on Blackboard, not to actually be mad keen to read it from cover to cover and commit it to memory...

The enquiry based learning that we did for weaving and knitting were useful.

I’ve still got all my notes and the weaving thing last year – I went back to it...

AC: I don’t know, maybe some essentials, some basics that you’ve got to refer to like a reference manual?

I think so, because you can’t hold all of this in your head unless you’ve been doing it for years and years and years and years, and that to me is another issue, if you’ve got that you’ve got some means of when you do leave here, if you do come across a problem and OK you might not be able to answer it but you’ve got something to refer to.

AC: and you could maybe include your own samples in there and your own notes, it could almost be like a reflective diary so that you add your own experience to the basics that you’ve got there and it becomes very personal.

It’s a good idea – but given the current timetable of things that we’ve got to do I can’t see where it would fit in.

Could that not be running from first to second year?

Why can’t they just add it on – not necessarily add it on but get rid of some of the stuff we do with […] and put screen printing with digital printing, put it all together. Because at the moment it seems like a very separate thing, actually. I hadn’t even thought about printing my fabrics with the screen print, I just wouldn’t – I just went straight to the digital printer, but, because it does seem like a very separate thing. But if you had an EBL that was, brought both of them together, that might...

Because you tend to have four EBLs don’t you? So you could have two screen printing ones and then two digital printing ones, so it is combined.

One could be on substrates and one could be on different colours.

Yes.

But do you think given the volume of work that we had to do in the second year in general that you could add more to it, and would it not be better if it was spread – it’s just my opinion, but I think it’s something you should start to learn in the first year and continue over the next two years rather than ramming it all into one year when you’ve got a million and one things going on.

But I think that’s a fundamental issue with the course – the fact that the course hasn’t decided whether it’s a management course or a science course so if it decided it was a science course this would be really,
really beneficial and some of the management modules and the costing and economics, which are pretty irrelevant could be scrapped and then this kind of thing which is relevant and we’ve used, could be brought in.

I would like to have seen it as a module for us that were specialising in digital print this year. We’re doing two modules, one of which personally I think is completely useless, and doesn’t benefit me in any way at all, but if I’d had the option to do colour management as a module I would have taken that alongside digital print, that makes sense to me.

AC: Thanks, this has been really useful for me and everyone’s contributed to the discussion, which is great.

[End of interview]

**Transcript of interviews with BSc graduates**

**A:** I’d like to start with talking about how you work with colour in your own design process, what software you use and how you go about choosing colour, then how that shifts into the actual printing process?

**D:** So, I always begin my design process by sketching and doing everything on paper first, which gives me an idea of the palette that I will then want to use. Then I translate it onto a CAD design. And, given that I tend to use a lot of different colours in my designs, and one of the benefits of digital print is that I have no limitation with that, so I can put 60 colours into one design if I want, but when I’ve - once I’ve done a sketch and an initial design idea - I then scan that into an Adobe programme – I work with Photoshop and Illustrator - and using them I can refine all of the colours that I started out with, so I can use the Pantone galleries within both of those programmes and select exactly which colours I want from hundreds of different ones. So I probably really define my colours once they’re into a CAD programme, having just started with a rough idea.

**J:** Do you use flat colours in your designs?

**D:** Yes – always flat colours.

**J:** It’s not like digital printing you can have...

**A:** Tonal variations...

**D:** I’ve always used flat colours so far because I think I’ve come to it from a screen printing perspective and I kind of break the design down into screens – because I had some work experience at a screen printers whilst I was here, and I think it’s the way I learned print design in a way, and all of my prints look as if they could have been screen printed.

**J:** And in fact they could be screen printed if you had 60 screens, which is probably a bit impractical but, yes – I understand what you’re saying.

**D:** Because there is a massive influx of more photographic digital print at the moment.

**J:** Yes, that’s what I was trying to get at – you keep it as a design rather than a sort of photographic image, where, like one colour – there are 60 versions of that colour.

**D:** Yes - so you can break it down into different colours. Sorry – what was the question again?

**A:** Well, we were talking about how you work with your printers to ensure that the colours in your designs are the colours that come out in the print – do they use the same Pantone references or do you use samples?

**D:** I do samples - I’ve never needed to give any Pantone references to digital printers. I’ll talk about it later, but I’ve recently had some wool scarves printed and I had to give Pantone references for them and I received swatches to approve all of the colours on those, but with the digital printers I save my files as RGB and I think they put that into AVA software and then they print from there – they don’t request any references whatsoever – it’s as it is on screen, and obviously I get samples because that doesn’t always translate to my monitor, so... I have found - not to go off the point – but I’ve found that I can get a sample back of a design in say five different types of silk and the variation is really notable.

**J:** Because of the substrate.

**D:** Yes.

**A:** That is really very much on the subject because that’s all part of the process, that everything looks slightly different depending on what you’re looking at it on, which monitor it’s on, which printer it’s printed out on, or which substrate it’s printed on, so it’s all part of the overall area of colour matching in digital printing. It’s interesting though.

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D: And from time to time as well - so I could sample with one printer and the colours would...the thing I'm always trying to get is the vibrancy that I can see on screen and with me using really contrasting colour ways and really bright colours, I find that the print loses its impact if it's not as bright as I want them to be. I've noticed I've used a printer for one run, and they've come back absolutely perfectly and then the next time they've looked a lot duller, and whether or not that's because the machine's been calibrated differently or - you mentioned to me last time that if they've had a different type of fabric in there they might not have changed the settings.

A: And have they given an explanation – have you asked them about why they think that might have happened?

D: Yes – I have and all they've really offered – it's not been something that's been a huge problem it's only been on very small samples - but they have said they will steam it for longer and that has brought the colours out a bit more. But I can tell when it's exactly as it should be and when it's not. Having said that, I'm talking about two particular printers and I've noticed that they print differently on to different types of fabrics, so one seems to work better with twill and one with crepe de chine, so I don't know the answer to that.

J: It's interesting even with screen printers, because when you actually screen print you have to reduce your colours and make your screens or rollers - people do it in different ways and I know that you'd go to a company when I worked in industry - this printer is really good for this type of print and this printer should be good... and trying to explain to students that a print, when you gave it to somebody to separate they would have two different designs almost, because of the way they separate them - very subtle, but it would be different. And you have to know the printer to know how you are going to get your print separated. It's the same really with digital print – that's interesting that it's the same sort of thing; although it's digital and you would think you could have more control over digital printing in a way, but you're saying that actually one printer's good on this and one printer's good on that fabric.

D: And maybe that's the case, maybe the printers are better suited to - I don't know - the density of the fabrics or...

J: I suppose it's as we say – there are different substrates and you set your machine up slightly differently don't you, so one's set beautifully for twill, but when they put something else through it if they don't completely recalibrate it and change it you're not going to be wanting to change your machine too much are you?

A: Not unless you'd already calibrated it for every possible substrate and then you could just switch.

D: Right, OK - so would there tend to be a general silk setting?

A: I think so, I'm speaking from my own experience but I know here there's just the one ink setting used for whatever substrate there is, but you would think if it was a professional print bureau that they would have a finer range of settings available. Because it is an involved process - there's a lot of work involved in getting each substrate calibrated in your printer.

A: So, how do you think your experience of digital print on the BSc programme prepared you for your setting up your digital print business and your digital design?

D: Enormously – when I graduated I worked for a handbag company for a while and worked on a lot of prints there. They were surprised that somebody who'd come straight from uni had digital print experience and could use CAD software, and they're not really two different things. I think being able to use the software that allows you to do digital print is so important now and having an understanding of Photoshop and how to – I think just being comfortable with CAD and not seeing technology as a completely alien part of design helped massively - because digital print is so widely used, that if all I'd have known was artwork and being able to do things by hand and not knowing even how to make things ready for a printer and I know it was probably at a lot less sophisticated level than the printers I use will do, but at least you understand how to prepare something. So I think that knowing the flexibility that digital print gives was really helpful and also knowing, from the point of view of setting up on my own, it's viable for me to do it with digital print whereas it probably wouldn't be – well it would be but it would be very limiting cost wise with screen printing. Because I can print such small volumes and sample so easily that it's possible to do a substantial range of products with very small volumes and I think just that understanding of how digital print woks and how quick it is as well. I can send files off to a printer on a Monday and have the fabric back on a Friday, so for starting out and trying to establish something on your own, it makes it a lot more accessible and I probably already knew that when I graduated.

A: In terms of colour and your knowledge of colour in digital textile printing, once you'd left the programme and started up your own business did you have already the background knowledge you needed or have you built that up since you left the programme?

D: In terms of colour?

A: Yes – and how you work with it in your designs.

D: I think your design style is naturally going to develop a lot from when you graduate, just having a couple of years working in industry, and the most important thing is probably looking at things from a far
more commercial perspective. So in that way, I do love to use lots of colours in my designs, but I’ve learned that whilst it might look pretty and it might look nice as a wall hanging or a painting, it’s not necessarily wearable. The company that I worked at, the handbag company, they would start off by – they used to buy in prints from studios and they’d buy in prints with, say, 10 plus colours and all sorts of really striking colour ranges that I thought were amazing, but once they’d worked on them and refined them down they’d be a lot more commercial and I suppose the palette would be a lot more wearable for people. My use of colour has changed since I graduated and I still feel I’m learning a lot about that, and learning from what sells and what people respond to and what they like. A lot of the really bright colour ways that I use people seem to love but shy away from wearing or wouldn’t really feel comfortable wearing them, so I think that’s more of a commercial thing as well as a technical thing.

A: The system that you’ve developed for your own method of working using the Pantone colours – is that something you’ve done through trial and error or have you tried different ways of working with colour in the software and decided that’s the best way of working for you?

D: Yes – I have tried different ways. When I worked in industry they always used the same Pantone swatch cards so I learned about it there and also got to see how easy it was to tell whether or not the printers had been accurate with their colour matching. But then when I started on my own I felt that I didn’t need to have that constraint so I did use just the regular Photoshop colour palette where you don’t have to define which shades you’re using. But I find now it helps me work to have a palette with Pantone references because it gives you a starting point. It’s very easy if you’ve got all the colours in the world, I think, to deviate, and it can end up looking like an overload of different shades, whereas the Pantones help from an accuracy point of view but also it kind of reins you in when you’re doing a design and working with a palette.

J: You’ve given yourself constraints, haven’t you?

D: Yes – and even though I do digital print, this is sort of going against what I said – I tend to only - a lot of my designs are 2 colour designs or max maybe 5, and I feel like I’m learning more and more that having that limitation is actually good.

J: It’s quite interesting, I’ve been doing some reading by a chap called Dino Dini, he’s actually a musician and a computer games designer and he’s talking about design as being – you have constraints – and you have negotiable constraints and non-negotiable constraints – and if you’re working for somebody a non-negotiable constraint about design might be the time and the budget that you’ve got – the amount of money you’ve got to spend, but actually, your negotiable constraints as a designer, you keep putting limitations on them so you actually make a decision that ‘I’m going to use this colour palette’ so you’ve constrained yourself, and actually designing, or his view of designing, is about constraining things and it’s kind of true isn’t it – you decide on a repeat size so you’ve constrained it, you decide on colour so you’ve constrained what you can do. And actually it’s only by constraining things that you can design because if you can do anything, you don’t know what to do.

A: It allows you to make decisions as well by doing that, to move it forward.

J: Yes - design is a decision making process, you’re constantly making decisions about what you can and can’t do.

D: And also what you want your house style to be, which even very early on – I mean ideally I would like to get known for a certain type of print and at the same time, sometimes I feel like I should be branching out and trying all sorts, it’s sort of finding what works and sticking with it in the beginning. If you manage to make a mark with something then you can maybe dilute it or do lots of different things but I think you need to realise you don’t need to do everything in terms of style. If something isn’t working then change it, but if something seems strong – I’m trying to at the moment – because I’m only a year into this so whilst I’d like it to happen a lot quicker it takes a long time and I think if already I start changing, well, moving in a different direction, my style isn’t known to anyone yet so it needs to be – you need to have a limitation in that way otherwise I think you’re lack of all trades and a master of none.

J: Yes – you start to do everything but you need a bit of a niche don’t you? It’s a bit like doing the project in the final year – you have to have a niche and a ‘story’ that covers all the designs, and yes, you’ll have a very brightly coloured one, and maybe a more subtle one, and maybe a two-colour one, but they should all tie together shouldn’t they, really?

A: How do you go about choosing the colours for your designs, for your inspiration? Do you use trend forecasting sites or are they from your own observations?

D: They’re seasonal, at the moment I’m just getting up to speed with seasons. I obviously have a really small collection and it’s a really niche product so I’m able to plan ahead and do very small quantities with that to try and get in line with the time of year, so I tend to do much brighter colours for spring/summer, more daring colours I suppose, and richer, darker colours for autumn/winter. Having said that, I feel like I’m forced to do that really - to not be stagnant and just keep with the same thing. But I’d like to think with something like a scarf it could be worn all year round. I don’t think you really have a choice to work in your own time frame. If you want any chance of getting into shops or getting into press with your work, unfortunately you do have to work to their timescale a little bit. So if I’m at the moment wanting
D: Well I'm slightly the same, to be honest, I have to admit - I don't know if I should say this - I love joyful, everything's illuminated and there are bright colours everywhere.

A: And it is the light as well, isn't it? If you're in a beautiful bright sunlit environment everything looks joyful, everything's illuminated and there are bright colours everywhere.

J: If you look at the geography we live in, in Manchester, its grey buildings and red brick buildings and that's why people in cities wear colours like this and people in the country wear greens quite often and browns and people that live in tropical countries wear tropical colours.

D: People don't want to stick out too much.

J: Definitely and I think you've got a good niche for brightly coloured...you know with this, I want a brightly coloured scarf.

D: And I think as well, my mum has always said that people in this country don't wear bright colours so much, and I always thought - that's just choice, why not? But it is true; I don't know whether it's a culture thing or maybe a weather thing...

J: It's camouflage thing as well...

D: Definitely – I really enjoyed my final year and I loved doing my project and I can see now it would not work in any way whatsoever with what I'm doing, but I think the things that you really hone on your degree course should be your commercial understanding but your creative ideas as well, and if you've got that sort of foundation you've got good drawing skills for design then you're going to be made to work in a commercial way as soon as you go into the workplace or as soon as you try to get into industry in whichever way. So if you've got the creative foundation there I think hopefully you'll be able to work better in a more commercial environment.

J: I think the commercial bit – it's got negative connotations as a word, commercial designer, but really what you want to be is a designer that produces things that people will want. And as you were saying it's a case of people wanting – I'm a designer and I've got on a white t-shirt and a black jumper, I've not got on a really vibrant design, although I really like vibrant designs – it's what people actually use.

D: Well I'm slightly the same, to be honest, I have to admit - I don't know if I should say this – I love bright colours and I love designers like Pucci or any designers that use really striking colour ways, but I don't necessarily know that you should stick to trend forecasts if you're working with print so much – I can see why commercial high street retailers definitely need to be in line with colour forecasting but I don't think it's maybe as relevant with an accessory – with something like a scarf.
J: It’s like architecture, architecture used to be very specific to regions and it’s not now so much. If you look even at the colours of buildings they tend to be we do have turquoise buildings and stuff, but with the greyness in the atmosphere they very quickly change colour because it’s dirty. A hundred years ago it would have just been red brick.

A: Or coal dust encrusted buildings!

A: So we were talking about your hindsight of the student experience and what you think is key and we can link that back in with some of things from the questionnaire that I sent out to you – have a chat about that maybe in a little more detail, let’s have a look... there were some here that you rated as very important and some that are not so important and we could maybe talk about your thoughts about your choices for this?

D: OK. So – ‘substrates’ is really important, as we were talking about before, it’s really important for students – or undergraduates - to get an understanding of how the substrate they use will affect the ultimate appearance of their print, and again that would be, I suppose, through lots of trial and error. Like you say here, paper as well – it’s not just about using loads and loads of fabric and just doing samples, but just seeing how the substrate reacts with the print - for example, I’ve just done some wool scarves and the print doesn’t have the same crisp appearance that it would on silk, but it has its own qualities that are nice, and if an undergraduate has a specific idea of the type of fabrics that want to produce or the type of look that they want their designs to have I think they would be hugely influenced by seeing how their designs came out on different fabrics, so I think that’s hugely important. ‘Colorants’ – yes – do you mean the type of dyes?

A: Yes – to have an understanding of things like reactivcs and pigments and the differences between them, and the differences in colour output that you can achieve with both of them.

D: I think that’s important from a personal development point of view – you don’t really need to know about that when you use [commercial] digital printers, but it definitely informs the way you think about your design and when things go wrong you might have a better understanding of it if you understand the actual production process rather than just blindly handing over artwork and expecting it to come back exactly the same. So I think that’s something that a lot of people would choose to ignore, but actually it would put you in a better position when you deal with commercial printers. ‘Pre-printing and post-printing treatment of fabrics’, I’ve said that was important – every printer that I’ve used has insisted on using their own stock fabrics because they’re already coated for digital print, so that takes that worry away, knowing whether or not your fabrics are correctly prepared. But again, I think from a personal interest point of view you shouldn’t be ignorant as to how the fabric has been made ready for printing and what will happen to it after – especially with post-printing treatment – like I said before, when I found that some of my fabrics looked a lot duller than they should be the printers explained that they could steam them for a little bit longer. I understood what they meant by that, that they could probably bring more of the colour out. I think all of these things you might not necessarily need to deal with when you work with industrial printers, but to not have an understanding of it is to take away a massive chunk of the process and to leave you in the dark. If everything went smoothly all the time it might not be so important – but it doesn’t. I think it’s important to be aware of the whole process. I put ‘the mechanics of how a printer works’ as not being too important, purely because I’ve never really, other than actually seeing the fabric come off the printer, I’ve not really had to deal with that myself. ‘The importance of sampling’ – obviously very important, the fact it’s so easy to do means you shouldn’t ever avoid it. I think ‘innovations in digital print technology’, I remember the last time we met you telling me something about new technology where fabrics can be printed with heat sensors...

A: ...yes - all kinds of things can be printed onto fabric now...

D: And I remember we had the ‘smart textiles’ module in the final year which probably ties in to that quite a lot. If you’re lucky enough to get the chance to us these things I think digital print is still so new – I’d say twenty years ago people wouldn’t have been able to do what I’m doing because it wouldn’t have been as easy to produce small volumes to begin with and to trial lots of different things when starting out. So I definitely think innovations - if you know about the newest developments in digital print then you’re at an advantage to people who are still working with traditional methods, or aren’t even aware of possibilities of what they can do. ‘Communicating colour’ – that’s really important, because I always still send my files to printers in the wrong format and honestly don’t always understand why I’m doing it or what it means for them at the other end and how much work it will add, which from a practical point of view, costs me more money because I usually have to pay preparation time for all of my discs which can add up. If you can do that work yourself - which isn’t hard, it just means setting up the file in exactly the right format to begin with, colour modes, whether it’s Mac or IBM format, all of these things are a two minute job at the beginning of your work, but ultimately save you money and save the printers time, so that’s really important. And you explained to me last time, the difference between RGB and CMYK so I’d say definitely they should know about that. I’m learning from Aileen as well you see! Two-way...

J: That’s great – that’s absolutely fantastic – learning always is a two-way process. It should always be a two-way process – people who just try and teach and don’t learn themselves are not very good teachers. There you go, you can put that up on the wall after I’ve retired! It’s true though, you should always be learning.
D: What else...

A: The main ones at the bottom were all about colour and the calibration process and why things don't look the same on the screen always that you get on the textile.

D: I think to know all of the different variables, because there are a lot more than you might initially think – it's not just about the substrate or the file format that you send it in, it's lots of different things, it's whether they are machine settings...

J: Things like how long they are steamed for as you've said...it's all these things...

D: Yes – even if it's something that an undergraduate would pass on to somebody to help them with, I think they should be mindful of all the things that can affect the difference from the initial image because you can end up feeling really disappointed, or, more importantly, just not understand why it's turned out the way it has. So if you're informed about all of the variables that can help you.

A: Where do you think that information would be best delivered in terms of – at what point in the programme would that be most useful, do you think, for a student to have?

D: I'd almost say right at the beginning – it is slightly different, but I've noticed - one reason why I tend to use a lot of strong colours as well, is because I print onto something that you're going to see the reverse of, whereas if I was going to use my fabric for a dress it wouldn't matter so much what the back looked like, but I wouldn't say that dictates the colour choice at all. But I know what works best and the stronger the colours I use the better the penetration though the fabric, so, in a way I suppose I'm making that decision at a design stage, but then also when you actually come to printing – I suppose when you come to making your file ready for printing - I suppose that's when it comes into play, so you're making sure the settings are right and everything from making sure you've got a flattened image to everything that you do in CAD, I think that's the point that you need to be looking at the variables and then when you go to print, making sure the printer's ready. I can't remember – we'd have our design tutorials, but then there's not really an interim stage is there, before it's printed?

J: That was the big problem really, and I think you would be one of the group that actually just handed over your designs and got prints back. Which is a really bad way to teach print design, I personally think, because you give it over to somebody - it's a bit like if you give it to a bureau in a way – you give it to somebody to print and then you get it back, but if you've got no understanding of why it's going to go a bit wrong or what's going to happen, then you've not actually learned anything from it. You get back what you wanted, sometimes, but you've not actually learned about the process, you've not actually sampled, it's sort of magically happened, you give it over and you magically get fabric which you may or may not like.

D: And I'd say that the...

J: We've changed a lot since then... the whole teaching of it is improving...

D: I'd say that one of the unique things about the BSc programme is there are people from my year who've gone into all sorts of different jobs, and there are lots of people who won't want to be designers and who won't want to go into something design led or creative and if they're working in technology then it's going to be even more important for them to understand all of these processes. I think given that the course does give you a really broad skill set - if digital print is going to be a part of that, and if people are going to go into jobs where they're using it a lot more, they'd be at such an advantage by having a really good understanding of the whole process. I know people who've done a straight BA design courses, which are obviously geared towards something different, it's not about comparing them, but I think they've got such a resilience to using everything from CAD programmes to having anything to do with printers or production - if you have that instilled in you during your degree you come out with a sort of confidence that you can handle digital print.

J: You can talk to these people can't you – you can talk to printers...and even if they're telling you things that you didn't fully understand you've got some idea of what they're on about, even if the language they're using is a bit familiar.

D: You don't feel like it's totally out of your hands and you've got to accept whatever you get back.

A: For some of these you've not ticked all of them, but did you...do you think all of them are required or do you think some aren't necessary?

D: I think in an ideal world it would be great if you had time to teach them all, I think I ticked the required ones as the ones that I thought as being the most relevant that you would definitely benefit from using, so I know it's not all about preparing for industry and a lot of it is learning as well, but in terms, say, which one that I've not ticked – maybe 'pre-printing and post-printing of fabrics' so that – if you can know about that – brilliant – but if time won't allow for that in reality, if you were working as a designer – in my experience really – if something doesn't come back the way you want, then you'll raise it with the printers, who will then try and ...because the printers use their own fabric, there's not much influence you can have on the pre-treatment of it, other than taking it for granted that it will be correctly
prepared. That’s also really a good sort of insurance for designers, because you know if it goes wrong it’s not because your fabric that you supplied them wasn’t correct – so it works both ways – they know what they’ve got in, and I suppose they know that it won’t damage their printer or anything. When you get it back if it’s not as expected that’s down to them again, really. I’d say in an ideal world it would be great if all of these things could be taught but I think some are definitely more important and helpful.

A: So really you’re saying these [elements ticked on the list] are essentials and the others are perhaps more desirables, if it was possible – rather than essential.

D: Yes – I would say so.

A: Let’s have a look at the other comments you made – I think you might have spoken about some of these points already in the interview - talking about resolution, things like the technical side of setting up your prints as being really important to have a handle on?

D: So I’ve said that I don’t think it’s hugely important to have a massive production understanding, but I think if you have a general understanding then I think it just informs all of your decisions when you’re sending over your designs and also it allows you to – it takes away a lot of limitations if you understand all of the benefits of digital print, so I suppose in a way it is a technical issue that there’s no colour limitation or that you can print one metre of fabric with ten different designs if you can fit them on, so I’d say if undergraduates understand that there’s no limitations in that way - which you wouldn’t be familiar with, with screen printing - and how quick and easy it is to get all of that information onto a file, then that’s a good thing.

A: When you mentioned ‘sizing’ at the bottom – do you mean sort of image resolution issues?

D: Yes – I do. When you work in Photoshop, for example, there are lots of different views you can look in, and you’d think it was really cut and dried but I’ve sent things to the printer before that I thought I was sending in print size, but they’ve come back slightly smaller and it might be because of the dpi I’ve used. I have to admit, I’m not completely – I know that I do it right now, and I know what I need to do - but to me, if you’re viewing the print size that should be exactly how it comes out, so I think that’s really important – the sizing which is something that whether you’re using Photoshop or another programme, to be completely clear about what view they see on the screen - is that going to be to size or slightly smaller – so I suppose that’s a technical thing. And, like you say – colour – from sampling - knowing that the design that they finally send over - if it’s not going to be exactly as it is on the screen, that they’re happy with how it will come out. Also, with the finishing processes, maybe if they have a good understanding of what different processes do make the colours brighter - maybe they don’t want that. Some people might choose not to steam fabrics for as long, for that reason. I guess the best thing that I found from the course, with it being a mix of design and more practical production related processes, you just didn’t feel in the dark and I think a lot of people categorise themselves as being ‘scientific’ or ‘creative’, and it’s not the case – you do need to be aware of both. I’m not saying that I remember everything about different substrates or different types of dyes but it certainly isn’t alien to me and I wouldn’t feel in any way shy of approaching it.

J: Yes - if people talk to you about acid dyes, you might not be able to say exactly what an acid dye is, but you know that an acid dye is different to a reactive dye, and you know that different dyes are used for different substrates and that’s more than a lot of people do.

D: And you don’t think it’s out of your remit either. I can’t impress enough having worked with designers or having known people who did different degrees, definitely see that as being something they shouldn’t be involved with and that’s a totally separate issue, which is great if you’re an in-house designer for a massive company where you don’t need to get involved and you can just pass it on – but that’s not everybody and especially if you ever want to try and go it alone you need to be able to take on all the problems that come to you and there’s nobody else to pass that on to, is there?

J: Yes - you need to have a good understanding - even in a big company you need to understand that the colours that you’re giving are colours that are able to be printed – they’re not outside the printer gamut for example, and things like that... an understanding of what happens so you know if it’s gone wrong and you think ‘oh – that’s nothing like I wanted it to be’ - you’ve got a bit of an understanding why – you can say maybe ‘this’ was wrong or ‘that’ was wrong, or the monitor was wrong or ‘this’ looked wrong – or they obviously can’t print that range of colours because the printer just can’t do it – you can’t print gold, for example – things like that, that’s an extreme example but there’s other colours that you just can’t do, they’re just not able to do them on certain printers.

D: And also - which I should have mentioned - the actual colour of the base cloth. I’ve spoken to Glasgow School of Art who print on wool, and I’m waiting to get a print, I’ve only had swatches of the white cloth, but it has a distinct sort of yellowy tinge and they’ve said that will come through, which would affect the colours.

J: So although it’s ecru, basically, un-dyed cloth, whatever it is – silk or wool or whatever, it will have a different appearance because, as you say, wool has got that rather creamy look about it.

D: Which you might want or you might not.

J: That’s interesting.
A: Well I think if everyone’s happy – that’s great – thank you, that was really good.

[End of interview]

VOICE FILE NAME: 30th_June_2014

Key:
I = Interviewer
R = Respondent

I: I’d like to start just by asking you how you work with colour when you’re creating your designs. Things like what software do you use? How do you go about choosing colours for your designs?

R: It depends. If we’re designing for a specific trend we have a colour palette. So for every season we have about six different trends and each trend we have a colour palette of about twenty colours. So if I were designing a screen printed design or something where you can choose the colours easier, I’ll pick from the colour palette and Pantone reference them. Whereas if it’s a digital printed design I often work from photographs.

I: Right.

R: So I’ll take photographs of things then I’ll crop them on Illustrator or Photoshop, and then I often, it’s normally a [s.l. inter news print - 0:01:07] digitally printed so I’ll have a garment that I’ll then paste the design on a pattern piece on CAD, but the coloration for that it, kind of, just depends on photographs but I’ll then go on to replace colour, and change the saturation of the colour to try and change it that way. It’s obviously more difficult with a photograph than if you’re drawing from a palette. Otherwise I might paint a design or draw a design and scan it in and then I can flatten it off and it straightens out, or it might be just a digital print and I’ve kind of kept the colours up so they [unclear speech – 0:01:56]

I: So quite a variety of ways of choosing the colours.

R: Yes, definitely.

I: How do you think your experience of digital print and working with colour in digital print on the BSc textile design programme prepared you for your role in industry?

R: I did digital print for my final project. We would send the thing off to [the technician] and then he would point them out for you for the final collection. It wasn’t a process in the development of it, so if it came out it wasn’t the right colour there wasn’t really an option to then go back and try do it again, that was, kind of, it. That would probably have been more helpful if you could see the developing of it. Sometimes we’ll get things digitally printed, and on the screen it might look completely different to when it comes out, and depending on which digital printer you use as well. We’ll use different companies and some companies their chart’s slightly different from other ones. We didn’t really have a huge amount of experience on it, it was just, kind of, giving him the disk. The prints that we were doing were, kind of... they could have, probably, been screen printed at that point. They were chosen to be digitally printed for speed, I think. Does that make sense?

I: Yeah, that’s fine, thank you. So in terms of colour and your knowledge of colour in digital printing, once you’d left and once you’d graduated did you feel that you had the background knowledge that you needed, or have you built that up since you left?

R: I think it’s a bit of a mix. I think had some grounding but I don’t think that it’s until you actually, practically did it that you actually learn exactly what colour restraints and what you could do and what you couldn’t do until after university, because I think once you’ve put it into practice you, kind of, just learn through trial and error, to be honest.

I: Okay.

R: But I did understand what the machine looked like and I understood how the machine worked which was really good because a lot of people don’t.

I: Yes. Ok that’s great. How do you go about choosing the colours for your designs, for your inspiration? You mentioned painting and things before; do you use trend forecasting sites, or is it just...?

R: We do. We use WGSN’s style site, and we’ll have a look at the catwalks. So every season we’ll do a pack for print of what new trends are and maybe at the back we’ll have colourways that are coming out and trending. We do a lot of vintage shopping, we might find garments that we really love the coloration of and transfer that to a different print. We do look at artists and any exhibitions that are coming out, so
for example Matisse Exhibition’s just come out which is just great for colour, so we look at that, which is great. So a real variety, really, and also we’ll look at what sells well, which is the biggest part, really. So maybe last season everybody loved a red dress, and you had to make sure that there’s enough red in the collection that people want that red in print. Yeah, that’s it, really.

I: Okay, that’s great, thanks. So we were talking a bit about hindsight, you looking back at your student experience, and some of the things that you chose as being very important when you were looking at the questionnaire and some of the topics that were potential teaching content. So maybe we could have a look at some of the ones that you chose as very important and have a chat about why you think that was the case. You’ve picked some of the basic things, like the colorants and the substrates, and also the pre-printing and post-printing treatments. So these are quite basic fundamental things that you think it’s very important that students have knowledge of.

R: Yeah, definitely, I think so. ’Cause also you’re talking to suppliers all the time, so if you don’t know what they’re talking about, you’d sound a bit silly, and you are representing a big company, so you have to know the basics. I don’t think you need to know really in depth exactly what happens, because you’re not actually practically doing that, but then if there is a problem I think it’s really helpful to actually know why there’s that problem and then you can empathise with the supplier that’s producing the print for you.

I: So you think that because there are so many variables involved in digital print as a process, each of which can impact on the final colour output, you think just having a knowledge of, at each stage, what can happen that will change the colours is important?

R: Yeah, and even really simple things like the fabric bases, or sometimes a supplier will print on creamy white and another ones will print on a slight cream colour and it will change the colour of the fabric, and then if you, kind of, half way through the collection change suppliers you will notice a big difference in between two prints. Often we have jersey suppliers and woven suppliers for projection, and they will come back quite different. So, yeah, it’s about knowing exactly... and also shrinkage, and things like that, is really important as well.

I: My machine’s buzzing; I’ll stop it and start it again.

(The following notes were taken by hand after the voice recorder malfunctioned)

R: Practice would help students to understand the processes more – at times the teaching content goes into too much detail before students have understood the simple things – they’re almost scared to say anything – subject should be put into perspective to give a basic understanding first – for example, understanding that printing onto different types of paper gives different results. There should be more time to experiment – as digital printing is developing so fast – new things are coming through all the time such as embellishing on to the surface of digitally printed textiles – quick pace. Students need to be given time to try new things.

I: When do you think teaching content about digital textile printing should be delivered in the programme?

R: Students should be introduced to the basics of digital print from first year – rather than in second year. CAD is so important as in industry you spend so much of your time working on the computer. Having a good knowledge of the software, of colour profiles, working with layers etc. is really important.

I: Any other comments?

R: The BSc programme sets students up really well for industry, though personally I would have liked more practical, more design work. The focus is on exams in first and second year, on the theory; students need to put the knowledge into practice. Simple things like not knowing what a fabric is, but knowing the science behind it – the fabric structure – perhaps there is too much theory and not enough practice. Students should be involved with more events such as Graduate Fashion Week, Premiere Vision and New Designers to make industry contacts.

[End of interview]
I: Okay, so we'll start by just a few questions about how you work with colour if that's okay. So, how do you work with colour in your own design process? What software do you use and how do you go about choosing colours for your designs?

R: When I started work for the company I used to work for before the stretch fabric industry, I've always worked on polyester bases, always been the style, on sublimation, and when I first went in to industry I was all very new to whole colour matching and just, sort of, got around everything by printing off an RGB and a CMYK colour chart...

I: Yeah.

R: ...because I was printing mainly for the dance industry, and they were looking for the, sort of, brightest hues you could get out of each colour. When I first started work I was back to basics; I was on a PC; I just had Photoshop, the RIP software and a printer, so I would just print out an RGB/CMYK colour chart, have my favourites on there; just collect them and use them in Photoshop. So there'd be no surprises really when it came out. And the beauty of it was when I was running two digital printers I could print as many little sample swatches as I wanted to. So that's sort of how I got around everything there.

I: Yes.

R: Even now, having my own business, I still print at the same company; I still print onto the... [recording blanks out – 0:01:25 to 0:01:28] memorise the colour library now. So, when I work off past work I'd still use the RGB/CMYK colour charts. I do a bit of freelance work now, where if I don't really know where the design's going to be printed - because people like to keep that, sort of, to themselves, anyway, they don't want to share that information – so I'd rely a lot on the technician at that printer company adjusting colours. Which is what I used to do [in my previous job] as well; if the colour wasn't right I'd speak to them, so I'd know how to get to that colour.

I: Right, okay. So when you graduated from the BSc programme you were already aware of all the variables involved in the process and how each stage of the process affects the colour output?

R: Yeah. I mean, I had a vague understanding, and I think once you're thrown into it in industry that's when you've really got to start problem solving yourself and get on top of it quickly. I think, for my final collection [on the BSc programme], as long as I was happy-ish with the colours they didn't necessarily have to come out exactly how they were meant to. I can remember vaguely going back and probably tweaking my colour palette slightly to match the ones that had actually come out of the digital printer; I didn't get myself too stressed about it. Whereas I think once you're in the industry, you have to be slightly more accurate. It can be a little bit more difficult.

I: Yeah, okay.

R: Being in the industry is where, like I said, first I started off on a PC but things quickly changed; got Macs, got AVA, and things became a lot easier. My skill level – I got more confident on Photoshop, so I do go back to my old techniques.

I: Now that you're in industry and with your own business, is Photoshop... are you finding that still the software programme of choice for digital textile printing; for creating designs?

R: Yeah, I think it is a personal preference. I'm on Photoshop all day, every day, so I just find it so easy now, whereas I've had training courses on Illustrator but then, sort of, forgotten it again because I've just always stuck with Photoshop. Even AVA makes some of it so easy, but I love the freedom of Photoshop and I do always end up going back.

I: It's interesting that Photoshop is used so much in textile design as it's not intended primarily as a textile design programme, whereas AVA is, but it's still mostly Photoshop that's used by students on the degree courses.
R: Not so many people have come across AVA. I mean, [unclear speech - 0:04:14] the headquarters of some places, anyway. If I’d not been put on that training for work, I don’t think I’d be any the wiser.

I: Yeah, okay. So, in terms of your experience of digital print on the BSc programme, how do you feel it prepared you for going into industry? Did you feel that it gave you a good general background in the subject?

R: Yes and no. I mean, I think, not so much as a hands-on approach. I’m not sure if it’s changed now, but when I was studying we only had one CAD session a week, and then we didn’t have any at all in our final year. You have access to the computers but I think we could have definitely done with a few more CAD sessions, ’cause as soon as... you’re so much emphasis and hand-drawn and painted designs, but I think as soon as you go into industry you don’t have time to hand-draw; you don’t have time to paint, and you’re working a lot of the time from stock photos and you’re expected to produce three or four designs daily. So, I think there needs to be a bigger emphasis on CAD lessons, definitely.

I: Yeah. What did I want to say? So, in terms of your knowledge of colour and in particular your knowledge of colour and digital textile printing, you mentioned you have some basic knowledge but it’s mostly been trial and error, do you think, since you left; building your knowledge about that through working?

R: Yeah, I think it’d be different for me if I used several different printers, because I’ve always used the same printer and I’ve worked there for nearly three years and they’re still printing there now; the colours just seem to come to me straight away now, I’ve been using the same colours for so long. ’Cause even though I have my own business now, it has, sort of, been slightly inspired by my old work; I’ve always had a very bright colour palette, so I’ll always go back to my favourite references.

I: Yeah, okay. I had a look at Tinned Bananas and it is amazing, the colours, they are so bright. So, yeah, I’m going to pick some nice screenshots to illustrate the PhD, from the website. So, with your experience, now, of working in digital design and print, and looking back to someone who’s on an undergraduate course, what would you say are the most important things that should be taught to an undergraduate textile design student about digital printing for them to have a good grounding in it?

R: [In my previous job] I had the role of design technician as well, ’cause I was also running the printers, so I think they do need a basic knowledge of how the machine works. I suppose it’s always so hard when you’re at university ’cause there’s so many students, it’s hard to, I suppose, sit down and show people the RIP software, but I suppose being able to layout a design on the RIP software would be very useful as well, to know about the different colorants and the different requirements for the substrates and applications. I mean, I think just a basic knowledge of everything, then I think once you get in and you’re doing it, ’cause you do take it in so much quicker, but it’s just getting the students to go out and be familiar.

I: Yeah. One comment that was made by an interviewee was that sometimes things can be over-complicated, and that it’s good to get right back to the very simple facts about fabrics and the printing process. And because something’s obvious, sometimes it’s overlooked because it’s obvious. I mean, things like how even on paper, on different paper substrates, digital printing looks different. So, would you agree that sometimes you need to really get back to real fundamentals?

R: Yeah, definitely. ’Cause I think even in industry this is something, now, I have to go back and explain to customers; you need to be able to tell customers on a basic level because they don’t have any understanding. So, it’s like, yeah, definitely get back to basics. I think that’s the thing with the BSc, we have so many lectures as well, there can be so much information it is easy to forget the little things.

I: Yeah, that was another comment that was made, that there was a lot of very technical, in-depth information about fabric structures and things like that, but it, kind of, was almost too complicated, in a way. So, that you all knew about the very complicated chemistries and structures of the fabrics but perhaps just going back to being able to identify different substrates and things, and know that that’s a silk or a cotton or whatever; it has to be that simple.

R: A bit more of a hands-on approach as well, yeah.

I: Yeah. So... more practical sessions rather than getting the information in a lecture situation?

R: I mean, I think working with fabric swatches – printing out small fabric swatches, and testing different variables, and looking at the different fabric bases – yeah, that’s definitely part of...
I: Okay, and in terms of where the information is given to students on the degree programme, I think from talking to people that most of the digital printing content was delivered in the second year of the course. So, would you think that right from the very beginning some basic information should be given to students?

R: You know what, I think that now as time’s changing; I think, I’ve never done any work – screen, or block, or any of those sorts of printing – since I’ve graduated, so yes, it’ll be different for other people but I just got straight into digital. So, I think, yeah, I think how things are changing now... And, I mean, I wouldn’t be able to do what I’m doing now if it wasn’t for digital printing, and it was a very new thing when I started [in my previous job]. They’d just got the digital printer and it made a huge difference for there; we started replacing all the designs that they had on papers digitally so people could just order the one metre or two metres – which is what people wanted, ‘cause they do do retail as well as wholesale. Even though most people in wholesale were only ordering 10, 20, in the rare case where you’d get a full metre of 70 that’d be more like a, sort of, annual thing for customers. And even now at Tinned Bananas I only print to 10, 20 metres of each different design, which is great ‘cause it just allows me to keep things fresh and not having to have it in stock. I think that stock side of things is important, how it’s benefiting people today, I do think digital print is more fashion forward.

I: So, having now graduated and been working in the industry, are you seeing digital textile printing coming through much more? And you’ve talked about your experience [in your previous job]...

R: You know what’s interesting, I’d say even in the last few weeks I’ve had a lot of people contact me from our course saying, “Oh, I’m starting up my own business now.” We’re selling at a couple of festivals this summer, and we’re working with a [another] company; they take on a lot of small brands like us, and one of the other girls from the BSc programme, she used to set up her own label and do a bit of printed textiles, and she’s selling there as well.

I: Yeah. So, digital printing is really important in terms of an entrepreneurial opportunity? Because it’s becoming much more accessible and you don’t need start-up costs, it’s something that gives these opportunities to graduates to set up their own business quite easily, yeah? Yeah, that’s great. Is there anything else? If you were to transport yourself back in time to your first year as a student, what advice would you give them about working with digital print now with all your experience?

R: It’s really hard - I wish was a bit more passionate when I was there! [laughs] I think it is, I mean, I can remember different teachers saying to us when we got there, “Enjoy it now, because you are a student and you’re designing for yourself, and you’ve got so much freedom and everything,” and just to experiment, to explore. You know, I look back now and I did a lot of hand painting and drawing, which I loved, but then taking it through to the computer I never really did much with it, but I think from being on Photoshop every day, all day, it freed me; like it suddenly just clicked. I think how times are changing now I reckon students that are going into the course will be a lot more familiar with Photoshop than, say, I was when I first started.

I: Yeah, okay. So, you mentioned experimenting; do you think that should be built into the programme so that students have got time to try new things out with digital print? You, know, like embellishing on top of it, and things like that.

R: Most students definitely need to be encouraged to be a bit more innovative and yeah, just to explore, ‘cause that’s what they’re going to have to do as soon as they start getting out into industry. They need to be brave and take chances and be able to move quickly.

I: Yeah, ‘cause it is still relatively new, and it’s a chance to be creative; perhaps the only chance you’re gonna get ‘cause once you’re in industry it’s a bit different, isn’t it, ‘cause you have to achieve deadlines and things like that?

R: And I suppose that’s the beauty of digital printing. I mean, you could have shorter projects for students, where you don’t have to work on it for a full term, or something like that. I think by doing quicker projects where the students are encouraged to work with photographs and stock photos; it’s just something that you do.

I: Yeah, okay. Is there anything else you want to add, or is that...?

R: No, I think that’s everything.

I: So, I think we’ll close the interview now. So, thank you very much for your insight, which is going to be very, very useful for my research. And what I’ll do is I’ll just stop the recorder... [End of interview]
Appendix D: Lectures

‘Printing for designers’
Printed Duffel Jersey Dress
‘Paul’ by Paul Smith
Source: http://www.alexandermcqueen.com
Accessed 2009/04

“Bubbles” T Shirt by Paul Smith
Source: http://www.alexandermcqueen.com
Accessed 2009/04

‘Boots’ T Shirt by Paul Smith
Source: http://www.alexandermcqueen.com
Accessed 2009/04

Negative Flower T Shirt Dress
Jonathan Saunders
Source: http://www.alexandermcqueen.com
Accessed 2009/04

Giles Deacon: Spring/Summer 2011
Source: http://www.alexandermcqueen.com
Accessed 2009/04

Alexander McQueen
Patchwork print jacket
Engineered digital print
Source: http://www.alexandermcqueen.com
Accessed 2009/04
Ant Kimono
Engineered digital print on silk crepe de chine.
Part of the 'kimono generator' concept, pioneered at the Centre for Advanced Textiles (www.centreforadvancedtextiles.com)
Source: http://antkimono.blogspot.com
Accessed 03/09/11

Anton & Alison
Digital print dresses
Source: http://www.facebook.com/pages/Anton-Alison/722777545301
Accessed 03/09/11

Basso & Brooke
Spring/Summer 2010
Source: http://www.bassoandbrooke.com
Accessed 03/09/11

INSIDEOUT at Project Showroom No. 5
Crystal Printed Vest Top
100% silk
Source: http://www.insideoutfashion.com
Accessed 03/09/11

INSIDEOUT at Project Showroom No. 5
Layered Cardigan
Cotton jersey
Digital printed back & front
Source: http://www.insideoutfashion.com
Accessed 03/09/11
Application of Digital Textile Printing Technology

By: J. B. Hynek, J. R. Campbell, K. M. Bryden

"Digital textile printing enables the designer to incorporate unusual components into a design by printing fabric that matches the pattern of the component."

Examples of textiles created using 'shibori' resist dyeing technique

'Shida shibori' by Melanie Bowles

Digital Textile Design (Portfolio Skills: Fashion & Textiles)
Melanie Bowles, Ceri Isaac
Hand-crafted discharge print  Digital recreation of discharge print


Fison-Zair by Katy Aston

Devore Designs
“Devore Designs explore the idea of transparency and opacity. Designs were digitally printed on lightweight fabric before I devored out areas of the design and layered hand printed flock, foil and puff binder on top.”

Source: http://www.katyaston.com/secondart.htm
Accessed: July 11

Fison-Zair by Katy Aston

Digitally Printed Fabric
“The fabric collection is digitally printed onto furnishing velvet. Once the design was fixed to the fabric I finished the designs by embossing into the pile of the fabric adding an additional textural effect.”

Accessed: July 11
‘Colour calibration issues in digital textile printing’

The variables in digitally printing imagery to cloth using ink jet technology are so great that, if the same print design were digitally printed on a variety of different printers using the same type of ink sets and fabric, the color results would vary widely. Factors such as environmental conditions, ink properties and print head construction can cause results to vary from day to day using exactly the same printer and inks.

Colour calibration issues in digital textile design & production

- How are colours created in digital textile design (CAD)? Additive colour mixing
- How are colours created in digital textile printing? Subtractive colour mixing
- A monitor can display many more colours than can be reproduced by a printer
- Each individual monitor or printer will have its own achievable range of colours — or gamut
- A colour viewed/printed on one device may appear different when viewed/printed on another device.
Additive colour mixing (i.e. computer screen – light emitter)

- RGB colour space – red, green & blue primaries combine to create the perception of millions of colours
- RGB colour space is device dependent – each monitor will be slightly different
- Each pixel is made up of 3 tiny points of light called phosphors: the R phosphor, the G phosphor & the B phosphor
- Varying the brightness of the 3 phosphors adjusts the colour of each pixel

How is the colour information for a digital design stored on computer?

- Example: an RGB digital image 100 x 200 pixels = total 20,000 pixels
- Each pixel has 3 components – one for each primary (red, green, blue)
- Each RGB component has a value from 0 – 255
- The image is stored in computer memory as 60,000 numbers, each with a value from 0 – 255
- The meaning given to these values depends on the profile incorporated into the image
- Values + profile = numbers plus reference necessary to give each number its intended colour

Subtractive colour (i.e. printed textile – light absorber)

- CMYK colour space: Cyan, Magenta, Yellow primaries plus Black (K represents black as ‘B’ already in use to represent blue)
- CMYK colour space is device dependent – each printer has its own gamut
- Terminology comes from the graphic industry – wide format inkjet printers were adapted for textile printing
- Colours expanded to achieve wider gamut required for textiles: e.g. CMYK + Orange + Blue + Grey
- Textile surface absorbs some colour wavelengths & reflects others – the reflected wavelengths create the sensation of colour in human vision

Subtractive colour mixing

Device profiles

- Average human eye can see a range of colours, this range is known as ‘absolute colour space’
- Absolute colour space is represented as a 3D map
- A colour’s co-ordinates in absolute colour space remain constant – not device dependent
- The profile of a device shows its gamut in relation to absolute colour space i.e. what proportion of colours it is capable of reproducing
- Systems that represent absolute colour space include CIE L*a*b* space
CIE

- Commission Internationale de L’Eclairage (The International Commission on Illumination)
- Covers all aspects of light & lighting, including colour vision & image reproduction
- Produces standards & models used worldwide
- Developed L*a*b* colour space which depicts colours in a mathematical 3D map format
- L*a*b* colour is not device dependent so can bridge gap between RGB & CMYK

Source: [http://www.huevalues.com](http://www.huevalues.com) (accessed 5/2/10)

CIE L’a*b* Colour space

- L* = the lightness of a colour
- a* = colour’s position on the red-green axis
- b* = colour’s position on the blue-yellow axis


Colour gamuts for Apple Mac monitor & Mimaki TX1600S in B46

Colour in printer gamut

Colour out of printer gamut
Calibration

- "To correlate the readings of an instrument with those of a standard" (OED online)
- For digital textile printing this means calibrating the monitor, digital textile printer, colourants and substrates to same standard

Colour profiles

- A colour profile is a description of the numerical relationship between two colour spaces (e.g. RGB & CMYK)
- A colour profile may describe several types of colour spaces. For example, an output profile, which should include all the factors that affect the print.
- In inkjet printing, for example, a complete output profile incorporates the colourants, printable media, the printer and all its settings.
- An input profile may also describe input conditions for RGB, CMYK, or any other colour space. Typical input profiles include scanner profiles or monitor profiles.

Source: http://www.exactlab.co.uk [accessed 8/2/10]

Printer profiles

- Calibration of Mimaki digital textile printer:
  - print out AVA colour library (255 colours) on to a textile substrate coated for digital print e.g. cotton
  - steam printed fabric
  - after scanning with spectrophotometer to give reading in CIE L*a*b* values
  - results provide printer profile & ink setting (unique to the particular substrate used)
  - those determine what colours are achievable with particular substrate / digital textile printer / colourants / software used in calibration i.e. the gamut


Screen calibration

Printer calibration


Pantone Inc.

Stork ‘U See’

“[Stork ‘U See’ accreditation] is awarded to those companies with the systems in place to maintain total colour control, from creation of the design concept to printing of the finished product.”

“The quality standard requires compliance in four specific areas - software ensuring design files can be safely and efficiently exchanged between printing houses and locations, hardware used at each production stop, consumables and working procedures.”

Source: [Link]

Making judgements about colour quality

“Perceptibility: Can I see a difference in colour?
Acceptability: Is this difference in colour acceptable?”


Factors affecting judgements

- colour vision of person viewing samples
- light sources - natural or artificial light
  - type of artificial light e.g. tungsten, fluorescent
- viewing distance from samples
- background samples viewed on
- surrounding room conditions
- metamerism - when 2 colours appear identical when viewed under one light source but don’t match in different viewing conditions

Appendix E: Journal article

Colour accuracy in digitally-printed textiles: what you see is not (always) what you get

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One problem faced when digitally printing textiles is ensuring that the colours of the final printed output are a satisfactory match to those of the design on a computer monitor or the original artwork. In other words, that there is a close enough match for the designer to feel that their intended outcomes have not been compromised. Anecdotal evidence from colleges and universities with digital print facilities suggests that they regularly encounter problems in this area of colour matching. This paper discusses the initial stages of an investigation into colour accuracy in digitally-printed textiles in the higher education environment.

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Introduction

The impetus for this project emerged from the authors’ experience when creating and printing designs digitally onto textiles (Figure 1) and from observations made while working with BSc Textile Design students. The difficulties encountered when colour matching between screen and digital textile print are, more often than not, an issue. The aim of this research project is to look at what is currently being done with regard to colour matching between media in higher education (HE) and to develop a resource that can be used to raise students’ awareness of all aspects of colour in the digital textile print process, and therefore better equip them to work productively with digital textile printing.
There is a raft of information readily available (from industry journals, company websites and specialist trade fairs) relating to commercial digital textile printing. Innovations and developments, such as the latest printers and the newest colorants and colour management systems, are widely documented. However, although textile digital printing is becoming widely available in HE establishments there is a scarcity of information about how digital textile printing is being used in undergraduate textile degree programmes and how staff and students deal with colour accuracy issues. This research aims to investigate digital textile printing and related colour accuracy issues within the HE environment, essentially looking at how colour in digital textile printing is understood and managed in order to optimise teaching of this important developing technology.

This current paper explores and compares approaches to achieving colour accuracy in digital textile printing in industry and HE environments, determining the importance of colour accuracy in both environments.

It is not unusual to find a digital textile printer in HE institutions offering textile degree programmes. To have access to a digital textile printer is undoubtedly an asset for students. Having a working knowledge of a range of textile printing processes and their associated applications, restrictions and potential, will be beneficial in their future careers. Students on textile degree programmes may gain experience of various software programmes (for example, Adobe Photoshop, Lectra Kaledo Print, AVA CAD/CAM) for creating their textile designs, giving them transferable skills they can take forward into the workplace.

These transferable skills should also include a fundamental understanding of the intricacies of colour management. In terms of colour matching, digital textile printing comes with its own restrictions and requirements. A colour viewed on screen cannot be accurately reproduced if it is not within the achievable colour range (or gamut) of the particular digital textile printer and colorants being used (Figure 2); a colour that is viewed on screen may also not be an accurate representation as it may not be within the monitor's gamut, and will appear differently depending on the actual monitor used for viewing. To complicate matters further, each individual monitor or printer will have its own achievable gamut; so a colour viewed or printed on one device may appear different when viewed or printed on another device (Figure 3). From experience, students are often disappointed when colours in a design they have created on computer do not match the same design when it is digitally printed onto fabric. With no prior knowledge of the technicalities of colour matching, it is not unreasonable to have an expectation that there will be an exact match from screen to textile (Figure 4). To have an understanding of colour matching and colour management issues for digital textile printing would undoubtedly be an asset in the colour-sensitive world of textiles. Ujiie suggests that, ‘...an effective textile education should encourage problem solving in digital inkjet fabric printing and cutting edge design concepts’ [1].
Figure 2: Selected colours from digital textile design by Aileen Collis; when viewed in AVA CAD/CAM software, the individual colour chips display warning triangles when a colour is not within the gamut of the printer and/or monitor (screen shots courtesy of AVA CAD/CAM; copyright AVA CAD/CAM Group Ltd).

Figure 3: Digital design (left) which has been digitally printed onto a variety of paper substrates via two separate ink-jet printers (right).
Defining the function of digital textile printing in a HE environment is an important stage in understanding the related colour accuracy issues. Having access to this design tool gives students the opportunity to experience digital printing technology alongside more traditional methods (for example, screen printing). It gives an extra dimension to their creative practice allowing them to bring their computer-aided design (CAD) work to life and into real-world applications, such as furnishing or apparel fabrics; otherwise this work would only exist on screen or on paper. The digital textile printer can be utilised on a number of levels, with different aspects of the machine and its function giving students different experiences: it is a design tool; it is a machine for the coloration of textiles; it offers a more environmentally friendly alternative to traditional methods; it provides an insight into colour matching and finishing issues; it is an adaptable and flexible medium for exploring technical textile applications. In all of these cases a basic knowledge of how the machine works, the different colorants that are used, the requirements for the substrates and the applications, plus fundamental aspects of colour management will give students grounding for a whole range of future roles including those of designer, technologist, buyer and merchandiser.

Compared to more traditional textile printing processes, such as block printing, digital textile printing is still in its infancy. Students are in a position to explore and develop this as a medium. A core function of digital design is to create representations of things that do not (yet) physically exist. Having a machine that allows the realisation of these designs blurs boundaries: the digital textile printer is a device for printing onto cloth, but it is also a relatively new medium with its full potential as yet undiscovered. As Ujiie comments, ‘Throughout history, textile designs have been tailored to the production methods in use, and each technological innovation has led to a change in the visual vocabulary’ [2].

Digital textile printing enables rapid response to changes in fashion, is more environmentally friendly than other methods such as screen printing (using less water and creating less waste) and lends itself to innovative technical textile applications. In a changing market where the production of printed textiles is moving away from long print runs, digital textile printing is coming to the fore. As Holme comments, ‘Within Europe, the average production run is now only 500 metres or less’ [3]. Knowledge of the issues relating to colour accuracy and how these can be dealt with will enhance students’ employability.
Experimental and methodology

The methodology used in this study includes:

- an overview of the history of textile printing, in order to place digital textile printing in context;
- the history of digital textile printing and colour matching issues, in order to understand its development from a carpet and paper printing process;
- the current status of digital textile printing in industry, to gain awareness of what innovations have been made and how these relate specifically to colour accuracy issues and provide comparisons with findings from HE; and
- how digital textile printing is being used in HE.

An overview of basic colour theory and how colour is communicated is also included, in order to understand what colour actually is and how this relates to colour matching in digital textile printing.

Primary research commenced with a review of textile degree programmes. A preliminary course search was carried out via the Universities and Colleges Admissions Service (UCAS) website to determine which HE institutions provided undergraduate textile design degree programmes. Each of the identified institutions’ individual websites was then searched to establish whether digital textile printing was included in their programmes, and to find staff contact information.

From this research, a contact list for appropriate institutions was drawn up. A short questionnaire was designed after consulting relevant guidelines [4]. Specific information was sought as to what equipment was being used, what issues relating to colour accuracy were being encountered and how these were dealt with. The type of questions used were a combination of ‘closed format’ (when the respondent is required to chose an answer from a given list) and ‘open format’ (when the respondent replies to a question in their own words). A ‘differential scale’ was used when asking about attitudes to colour accuracy, with respondents asked to rate how important this issue was. Each one of the respondents stated that colour accuracy was ‘very important’ to them (the highest value on the differential scale) and they all had issues with achieving accurate colour reproduction. Responses to the questionnaire were followed up by visits to four HE institutions to discuss their digital print facilities in more detail.

Visits to the HE institutions revealed differences in the ranges of equipment used for digital textile printing and how it is delivered to students:

- printers used range in age and model;
- different types of colorants are used (both reactive and pigment);
- colorants are supplied via bulk feed systems, manufacturers sealed cartridges or refillable cartridges;
- a variety of colours are used, for example, magenta may be used in addition to, or instead of, red;
- there are a variety of software packages used to run the printers, for example, AVA or Smartprint;
- digitally-printed fabrics are finished in different ways, for example, fabrics may be steamed but not washed, or steamed and washed; and
• some fabrics are washed in a domestic washing machine while others are washed using industrial equipment.

The methods for delivering digital textile printing and colour matching issues to students also varied:
• some students are given a demonstration of the textile printer alongside lectures and projects specifically designed to emphasise colour management issues;
• others are instructed to print small samples of designs and to keep detailed notes on colour adjustments made at the design stage; and
• varying the length of time fabrics were steamed is another method used to try and control colour.

**Contextual review synopsis: history of printed textiles**

The practice of decorating the surface of textiles (generally referred to as ‘textile printing’) has been carried out for thousands of years [5]. In the history of textile printing, digital (or ink-jet) printing is an emerging technology. A timeline detailing some of the key dates from the history of printed textiles up to the advent of wide format digital textile printing is shown in Figure 5 [5–10].
Advances in technology do not necessarily signal the cessation of earlier techniques, for example, as Storey [5] points out, block printing continues to the present day, ‘as a means of producing exclusive fabrics for a specialised market’. Many factors influence the choice of printing method: the end application; the desired effect; the substrate; cultural and economical criteria.

**Contextual review synopsis: digital textile printing**

Digital textile printing is a comparatively new development in the history of printed textiles. As Moser states, ‘The first true inkjet printer for fabric was exhibited by Stork in 1991’ [7]. Although inkjet technologies existed prior to this point in the graphic and carpet printing industries, adapting the process for direct printing onto a range of textiles required a great deal of modification. However, traditional methods are still used to pre-treat and finish digitally-printed fabrics.
Adapting existing ink-jet printing technology

Ink-jet printing has been defined as, ‘[a] non-impact dot-matrix printing technology in which droplets of ink are jetted from a small aperture directly onto a specified position on a media to create an image’ [11].

Existing ink-jet printing technologies from the graphic industry and carpet manufacturing industry were adapted to extend their applications to textiles: the Milliken designed Millitron ink-jet printer for carpet, launched in 1975, was the first of its kind; wide-format ink-jet printers were in use in the graphic industry for signage and banners [11]. The processes used for carpets and banners then had to be modified to make them suitable for direct printing onto a variety of textile substrates; print heads were adapted from carpet printing, where control and continuity of ink droplets was not a requirement. However, in order to reproduce finer, detailed designs directly onto textiles, control and continuity of discharged ink is essential [12].

To date, digital printing for the textile industry has proved to be most useful for sampling designs prior to full production, as the process removes the need for producing numerous screens for each sample, which is costly. However, digital textile printing is an area of growth and innovation and is becoming a more viable option for industrial production as machines become faster. At the Federation of European Screen Printers Association’s (FESPA) Digital Textile Conference in 2008, Patti Williams (from the American consultancy IT Strategies) predicted that the share of the market for digitally-printed textiles for fashion and home would grow, ‘from $890 million in 2005, to $1.6 billion in 2010’ [13]. It is, therefore, becoming more pertinent for students on textile degree programmes to develop a working knowledge of digital textile print.

The most up-to-date industrial digital textile printers are capable of longer print runs as their performance improves; for example, the Osiris digital textile printer (from Xennia Technology Limited) has the potential to produce 30m/min [14]; and the Heracle (from the Korean company d-gen) is advertised as having a daily production rate of 900 m² [15]. Digital textile printing has the potential to push what is currently possible in textile design rapidly forwards. It has a place in industry alongside established and traditional printing methods, not in competition with them. As Tyler points out, ‘...digital printing should not be seen as competing with rotary screen printing or other mass production techniques...the main market opportunities for digital printing are likely to be in areas of innovative designs and customised products’ [16].

Technical textiles is an area of exciting developments in digital textile printing. Karen Pooley (FESPA’s Group Marketing Manager), reporting from the Digital Textile Conference in 2008, noted that current research includes, ‘...chromic materials (which change colour under specific conditions); materials that delivered controlled release of substances such as pharmaceuticals; and antibacterial and anti-static finishes’ [13].

In addition, research is also being carried out into the possibility of using ink-jet technology to produce printed electronic circuitry within garments, with a view to creating ‘wearable electronics’ [3].
In order to understand the difficulties implicit in achieving accurate colour in digital textile printing, it is necessary to gain a basic understanding of what colour actually is, and how it is perceived in human vision.

Colour is a sensation produced by the viewing of light wavelengths in various environments. Billmeyer and Saltzman describe colour as a result of ‘interaction of a light source, an object, and the eye and brain, or a visual system’ [17 p1-30]. Colour can be ‘additive’ or ‘subtractive’ depending on whether it is created by mixing light wavelengths (additive), or by mixing physical colorants together (subtractive). For the purpose of this research, both additive and subtractive colour are being considered – additive colour when viewing a design on a computer screen, and subtractive colour when viewing the same design printed onto fabric.

**Additive colour and RGB colour space**

Colour generated by the mixing of several sources of illumination, where the light sources combine together to produce white light, is said to be additive. RGB (red, green, blue) colour space (one of several specific ordering systems for colour) is so called because it is a combination of red plus green plus blue wavelengths that combine to create white light. RGB colour space is typically used for monitors and scanners, i.e. devices that produce colour electronically. There are several RGB colour space variants as different standards apply for different applications: for example, sRGB, ISO RGB, Adobe RGB 98. As Süsstrunk, Buckley and Sven explain, ‘There is no one size fits all approach, no one RGB colour space that is ideal for the archiving, communicating, compressing, and viewing of colour images. The correct colour space, be it RGB or not, depends on the application’ [18].

Having some knowledge of the different colour spaces used when designing and printing digitally onto textiles and, most importantly, knowing that each individual device (i.e. laptop, monitor, digital textile printer, etc.) will have its own distinct colour gamut (range of achievable colours that can be viewed and/or printed) will go a long way in demystifying some of the issues students have concerning colour in digital textile printing.

**Subtractive colour and CMYK colour space**

Another colour space, CMY (cyan, magenta, yellow), is created when red, green and blue colorants are blended together in different permutations. Different types of surfaces absorb different wavelengths of light. The unabsorbed light is reflected from the surface into the eye to create the sensation of a particular colour. Colour generated in this way is said to be subtractive colour, as certain colours are absorbed by a surface, leaving a remainder that reflects as a specific shade via the eye. While additive colour produces white light, the starting point for subtractive colour is understood to be the white of paper. CMYK (cyan, magenta, yellow, black) is the colour space historically associated with graphic design and ink-jet printing on to paper, which in turn is the model which has been adapted for use in digital textile printing.

Whereas in additive colour mixing, white is achieved by combining red, green and blue wavelengths, the opposite is not true for subtractive colour mixing; the addition of a separate black component represented by the letter ‘K’ was necessary to achieve a satisfactory depth of black; for digital textile printing, the basic CMYK format did not yield a sufficiently wide range of colours. This was addressed by including additional colours such as
blue and grey [19]. As with RGB, there are several variations of CMYK, for example, CcMmYyKk, where there is an additional, lighter version of each colour [20].

Difficulties arise when trying to recreate colours produced by additive mixing (i.e. with light wavelengths) by subtractive mixing with physical colorants (e.g. reactive dye onto cotton). Because of the inherent differences between additive and subtractive colour mixing it is not easy to recreate the range and depth of colours from a design on computer screen to a digitally-printed textile [12]. This creates a problem that is constantly being addressed by industry, in the quest to achieve the closest colour matching possible. In their online resource, Wasatch Computer Technology (an American company with 25 years’ experience in colour management) describes the printing process, ‘The real challenge of printing ... colour images accurately is that we are attempting to approximate the colours of the real world using devices or technologies that are not capable of reproducing anywhere near all the colours in the visible spectrum’ [21].

Textile students often build the colour palettes for their designs using different sources: colour libraries in software packages; decorators’ colour charts; scanned in original artwork. There is then an expectation that their colour palettes will look exactly the same when their designs are digitally printed onto fabric. This is not an unreasonable expectation to have without some basic knowledge of the many variables affecting colour in digital textile printing.

Colour perception

The human eye’s limitations restrict the range of what is visible in the light spectrum to an approximate range with a wavelength of maximum absorption (λ) between 380 and 750 nm [17]. Within this range, the eye can discern the colours of the rainbow from violet through to red. Typically, this translates as the average person being able to ‘distinguish about 2.3 million colours’ [19]. Computer monitors are capable of reproducing millions of colours, ‘far more than the eye can see’ as Treadaway points out [22]. The perception of colour is different for each individual, as the information received visually has to be interpreted by the brain and human beings are non-standard. As Taylor comments, ‘The eye is only a conductor. It does not analyse or determine the character of what we observe, but only passes the message on to the brain. In other words it is the brain which determines the colours seen, and no two human brains discern or comprehend in like manner’ [23].

When evaluating whether or not an acceptable colour match has been achieved on a digitally-printed textile, the colour vision and colour perception of the person making the evaluation, the viewing environment (lighting, background colours etc.) and the method of assessment, all have an impact. An evaluation of the colour reproduction is made by examining the printed textile output against the required standard. In this scenario, the light source has a direct effect on the appearance of the print; whether the print is assessed by a human or a mechanical process will also affect the interpretation. If there is a difference between input and output, it is then necessary to describe the difference in a meaningful way, and then make a decision as to whether the difference is acceptable or unacceptable [17 p107-130,24].
Colour management in digital textile printing

Colour management in digital printing attempts to minimise all the variables involved when printing colour images by using specific colour modes or spaces. In terms of printing digitally onto textiles, colour management could be said to ‘facilitate the achievement of acceptable colour fidelity’ [25] in that an evaluation is made between the on screen colours and colours on the digitally-printed textile. Using the same colour space throughout the process of printing a colour image, from monitor screen to printed media, is intended to ensure colour accuracy. According to Boris Oicherman, previously a colour management specialist at the University of Leeds, when the concept of digital colour management was first introduced in the 1980s it was intended to, ‘[maintain] the correct colour across the printing production chain. The correct colour, being a philosophical, rather than technical term, could not be delivered, simply because no one knew what it was. Thus, it was gradually replaced by consistent colour - which was at least technically definable, though not really achievable. This was due to colour gamut limitations inherent to different imaging devices. The scanner can capture colours which are not reproducible by the printer, who in turn can generate colours that are not reproducible by the monitor - meaning that the colour can be maintained consistent only within some fairly narrow limits’ [26].

Colour management between different colour spaces

The CIE (International Commission on Illumination) was founded in 1931 [27] and has a broad remit covering all aspects of light and lighting, including colour vision and image reproduction. Technical and scientific data are shared and discussed across the member countries. The standards and models produced as a result of this dialogue are commonly used across the world. The Commission is divided into seven sections, with the first of these devoted to research into the study of colour vision and reproduction. A key example of the work carried out by the CIE is their development of the $L^*a^*b^*$ colour space, a depiction of colours in a mathematical map format.

Because it is not device dependent, CIE $L^*a^*b^*$ space can be used to provide a bridge between RGB and CMYK colour spaces. In CIE $L^*a^*b^*$ space, colours are referred to in terms of their position on axes within a three-dimensional model: where $L$ is the value between black and white, i.e. the lightness of a colour; $a$ is a colour’s position on the red to green axis; and $b$ is a colour’s position on the blue to yellow axis. These values are constant and remain unchanged regardless of what application is used, i.e. computer, scanner or printer. But despite the values remaining constant, there will still be variations in appearance dependent upon the type of media being viewed – screen, paper, textile etc.

Colour profiles

The International Colour Consortium (ICC) comprises companies from around the world who have a vested interest in the business of colour reproduction. The founding companies included Adobe Systems Inc., Agfa-Gevaert NV, Apple Inc., Eastman Kodak Company and Microsoft Corporation [28]. A colour profile may be an ‘input’ or an ‘output’ profile; output encompasses all the variables involved in producing a colour print, e.g. what media is being used and what the capabilities are of the printer being used; and input refers to the specifications of the computer, scanner and specific colour space being used. An ICC colour profile takes the numerical information for a particular colour in a particular colour space (e.g. RGB), then expresses the same colour in another colour space (e.g. CMYK). Both sets of information are then combined to produce a third set of figures in $L^*a^*b^*$ colour, which facilitates the correct transfer of information from input to output.
The difficulties of standardising colour and creating a universal language with which to describe it are well documented. At every point in the process of describing and reproducing colour there are vast number of variables at work waiting to undermine the outcome. Colour management is the phrase used for systems and parameters that attempt to corral colour; yet colour persists in being unmanageable to a great extent. In Taylor’s opinion, ‘It may well be that the rationalistic view of matter will be found to be quite untenable, and that as regards colour no object will be considered to have an intrinsic colour in the sense of human vision, but only a specific electromagnetic wave vibration which every human being may resolve differently’ [23].

The final variable in the equation is the human interpretation of colour; by definition an element that will continue to remain impossible to standardise.

Conclusions and future work

There is scope to examine each of the elements involved in the delivery of digital textile printing in a more detailed in-depth study: the technical elements used to create a digitally-printed fabric; the human element with regard to evaluating a digitally-printed fabric; and how these elements interact to manage colour throughout the process. The next step of this study will focus on digital textile printing on a BSc textile design programme, with staff and students to be interviewed to elicit their thoughts and experiences of the digital textile print component of the degree programme. Input from industry will be obtained via questionnaires and interviews. This will provide a valuable insight into what industry professionals consider to be essential knowledge regarding colour in digital textile printing and will help to build a picture of what expectations there are for textile graduates. Once the results have been analysed it is hoped that a model for the delivery of digital textile print on textile degree programmes will emerge: a definition of best practice. Further work could include the development of a student resource in the form of a handbook or e-learning facility, to raise awareness and better equip students for their professional careers.

References


27. International Commission on Illumination (CIE) [http://www.cie.co.at – last accessed 17th September 2012]