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An Investigation into the Use of Fabric Paints for Support Fabrics in Textile Conservation

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Abstract

Support fabrics are used in textile conservation in order to provide support for weakened and damaged textiles. These supports are often coloured in order to infill any loss in the object in order to help with interpretation and improve the aesthetic of the object. This colouring can be done using several different methods, the most common being dyeing, while using fabric paints is an alternative choice. It is important to ensure that the materials used to colour the support fabric are stable, do not produce volatile substances that could affect the object, and will not fade or lose colour too quickly. In this paper three fabric paint manufacturers, Jacquard Neopaque®, Pebeo SetaSilk® and Deka Silk® were tested for the presence of possible volatile substances, their light fastness, and their wash fastness, as well as their ease of application and changes to flexibility of the support fabrics. All three manufacturers performed well in the wash fastness and light ageing tests. The Jacquard Neopaque® and Deka Silk® were acceptable in the Oddy Test testing for volatiles, while the Pebeo SetaSilk® did not perform as well. The flexibility tests suggest that different manufacturers might be considered for different requirements.

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Chapter 1: Introduction

This section outlines the colouring of textiles, a brief introduction to textile conservation, the use of support fabrics in textile conservation, and how these support fabrics are coloured to suit the object they are supporting. It also provides background information on fabric paints and how they are used in textile conservation.

1.1 Introduction

Colouring of textiles is an ancient process. Evidence of colouring can be found in the earliest existing textiles. These early colourants were natural pigments found in the environment and usually mixed with a variety of materials as binders so they could be applied to the object as decoration.[1] Textiles can be coloured using one colour for the whole object or as is often the case, using several colours and shades to create a pattern or design across the surface. There are a number of ways in which these patterns and designs can be applied to textiles including dyeing, printing and painting of the colourant onto the fabric.[2]

The use of colour in textile conservation for support fabrics is very common. It allows the support fabric to provide a visual infill of the object so that it can be seen as close to it originally looked as possible and well as preventing further damage to the object by supporting the damaged areas. The method of infill chosen can be different depending on the requirements of the object in conjunction with the needs of the client or museum that the textile belongs to. These requirements may present a number of different considerations, for example when dealing with a private client the cost of the treatment is often an issue; a large portion of cost is usually derived from the time it takes to complete a treatment. If a colourant can be used that takes a significantly shorter time compared to other choices, while still providing a very similar outcome this may be an important factor when choosing a treatment. Having a range of materials to choose from for colouring support fabrics is useful as different materials, such as dyes or paints, can provide a more suitable infill of loss depending on the original object.[3]

An important consideration in the selection of a colourant for use in conservation is how stable the media is, particularly for long term use with historic objects. Although all

[1] R.L.M. Allen, *Colour Chemistry*, (London: Thomas Nelson and Sons Ltd, 1971), 6.
[2] Ágnes Tímár-Balázsy and Dinah Eastop. *Chemical Principles of Textile Conservation.* (Oxford: Butterworth-Heinemann, 1998), 116.
[3] Mary Kaldany, Maria Berman, and Sigurros Sigurdardottir, 'Evaluating the Stability of Commercially Available Artists' Colouring Materials Used to Create Compensation Infills for Losses in Textiles,' in *Journal of the American Institute for Conservation* 38:3 (1999), 443-458.

materials deteriorate over time materials can produce different deterioration products depending on how they deteriorate. Some of the deterioration products can cause accelerated degradation in other materials when they are in close contact. Changes to the material due to deterioration can cause a visual impact, which can be problematic when an object is on display as it affects the aesthetics of the object. As such it is important to determine if there are any substances released by a support material that could cause and object to deteriorate at a faster rate and affect not only its appearance, but shorten its lifespan. As such, it is also important to use materials that will not change perceptibly for an extended period of time. With regards to colouring materials fading is the most obvious issue relating to visual impact, however drying and cracking of paint can also be an issue as this can put an object under mechanical stress as well if the paint shrinks or changes shape as it dries.[4]

1.2 Colouring of Textiles

As mentioned in section 1.1 there are a number of different ways in which textiles can be coloured. . Dyeing, painting, and printing have been used for most of the history of textile manufacturing. While some methods have been developed to reduce how labour intensive the techniques are and to enable large amounts of fabric to be produced in a small timescale the basics of the techniques has generally remained the same.[5]

1.2.1 Dyeing

Dyeing is one of the most common methods used for colouring textiles. Dyes can be used either to colour fibres before they are used to make fabrics, or they can be used on the fabric once it has been made. In order to create patterns using dyes various methods need to be employed. This can include application of wax such as in the Batik technique, which is a type of resist dyeing process. This technique can also involve things such as rubber bands as used in tie-dyeing. The basic premise of resist dyeing is that part of the fabric is covered with something (such as the wax or rubber bands) and this prevents these areas from taking up the dye during the dyeing process.[6] An alternative way of producing a pattern is to use fibres dyed different colours and to use a technique such as weaving to create a pattern in the fabric. The intricacy of the pattern is limited by the

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[4] C.V. Horie, *Materials for Conservation: Organic Consolidants, Adhesives, and Coatings,'* (Oxford: Butterworth-Heinemann, 2000), v.

[5] Annemarie Seiler-Baldinger, *Textiles: A Classification of Techniques,* (Bathurst: Smithsonian Institution Press, 1994), 6.

[6] Seiler-Baldinger, 1994, 44.

tools used, for example a weaving loom with 8 heddles can create a much more intricate pattern than one with only four.[7]

1.2.2 Printing

Printing onto the surface of a fabric is another popular way of colouring textiles. Printing is particularly popular for applying designs to a textile while not often used to colour the whole textile with just one colour. Printing can be done by hand, such as block printing, or it can be done using a digital system. Very intricate patterns can be made using printing, and several colours can be employed to make the pattern even more intricate. Hand printing can be very time consuming. Digital printing is used commercially as a way to decorate fabrics for many purposes including for clothing and home furnishings.[8]

1.2.3 Painting

Painting is also a common method of colouring textiles, though less popular than dyeing or printing. This technique is most often done by hand and is, like printing, usually used to create a design or pattern on a fabric rather than colour a whole piece of fabric with just one colour. Painting is not usually done on a large commercial scale; dyeing and printing are easier methods for creating large amounts of coloured fabrics. Painting can produce very difficult designs, depending on the skill of the artist.[9]

All three methods have been investigated and used by textile conservators as a way of producing support fabrics and for infilling loss in textile objects. The choice of material for support and infilling of loss depends on requirements of the object as outlined in section 1.6.

1.3 Fabric Paints

Fabric paints are generally an acrylic based paint made of pigments suspended in a polymer based binder. The colourant in a dye dissolves in a polymer while the pigments in paints remain solid.[10] While dyes attach to the fibres in the fabric chemically, the

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[7] Seiler-Baldinger, (1994), 87.
[8] K. Maguire King, 'Inkjet Printing of Technical Textiles,' in *Advances in the Dyeing and Finishing of Technical Textiles*, (Cambridge:Woodhead Publishing Ltd, 2013), 236.
[9] Vicky Loosemore, *Screenprinting Techniques, Dyes, and Pigments and their Suitability for Producing Coloured Supports in Textile Conservation*, Unpublished Dissertation for MA Textile Conservation, (University of Southampton, 2005), 2.
[10] Horie (2000), 179.

pigments in the acrylic paint are attached to the fabric using the binders.[11] There are different binders that are used by different manufacturers, and minimal information on these ingredients can be found.[12] Fabric paints use binders that encourage the paint to disperse in the fabric rather than sit on top as acrylics used in painting on canvas do.

Fabric paints are often heat set using an iron to make them wash-fast, and the manufacturers instructions indicate heat setting as an integral aspect of using the paints. The reason for heat setting is most likely for similar reasons that acrylic adhesives are also often heat set as it drives the adhesive, or the binders in the case of the paints, further into the fibres creating cross-linking to prevent the colour from being removed through washing.[13]

1.4 Pigments

There are a large number of pigments that can be used in fabric paints. The most common pigments for each colour used in this project are in Table 1.[14] These pigments can be either organic or inorganic, often depending on the manufacturer and the colour of the paint. Organic pigments are often synthetically produced in modern paints.[15] Different pigments are used for the same colour depending on the manufacturers choice. A mixture of pigments is also used in some paints to change the tone of the colour.

Table 1: Common Pigments for Use in Fabric Paints

White	• Titanium Dioxide • Zinc Oxide • Zinc Sulphide • White Lead
Black	• Iron Oxides • Carbon • Aniline Black
Red	• Iron Oxides • Cadmium Sulphide • Acetoacetarylamide
Yellow	• Iron Oxides • Cadmium Sulphide • Acetoacetarylamide
Blue	• Prussian Blue (Alkali Metal Ferric Ferrocyanides • Ultramarine • Cobalt Aluminate

[11] Nancy Britton, 'The Use of Textile Pigments in Conservation Applications,' in *AIC Textile Speciality Group Postprints 1997*, 42.
[12] MSDS Sheets provided by manufacturers
[13] Britton, (1997), 42.
[14] R.L.M. Allen, 'Pigments Other than Phthalocyanines' in *Colour Chemistry,* (London: Thomas Nelson and Sons Ltd, 1971), 241-259.
[15] Paul Zelanski and Mary Pat Fisher, *Color,* (New Jersey: Pearson Education Inc., 2006), 92.

1.5 The Role of Textile Conservation

Textile conservators work with textiles that are considered of significance either because they are of historic value, cultural value, aesthetic value, or scientific value.[16] Textiles can include a broad range of objects and materials. They can be made from natural products such as silk and wool which are animal based, or cotton and linen which are plant based. They can also be made from synthetic or semi-synthetic materials such as polyester or viscose.[17] All of these materials tend to deteriorate over time, some faster than others. It is the role of the textile conservator to prevent as far as possible this degradation, or to slow the degradation as far as is possible.[18]

A range of materials and techniques are used by textile conservators to assist in preventing further damage to an object in their care. This choice of techniques and materials is determined by the nature of the deterioration of the materials in the object. One of the main ways a textile conservator may try to prevent damage due to deterioration is through the use of support materials when the object is weakened by deterioration.

1.6 Supports in Textile Conservation

Loss of material in textiles affects the stability of the object as well as affecting the appearance. Loss can occur in a number of ways, including degradation of the fibres due to environmental factors such as temperature and relative humidity. Materials that are used to colour the fibres can also cause problems, in particular natural black colourants can often cause breakdown of the fibres often because they contain high levels of iron or tannin and the acids produced accelerate the degradation of the fibres.[19] Loss can also occur due to insect damage as the insects use the fibres as a food source. Wool in particular is a favoured food source for certain types of moth, though other natural

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[16] Roslyn Russell and Kylie Winkworth, Significance 2.0, Collections Council of Australia Ltd, 2009, 10 (Accessed: http://arts.gov.au/sites/default/files/resources-publications/significance-2.0/pdfs/significance-2.0.pdf).

[17] Tímár-Balázsy and Eastop, (1998), 3.

[18] European Confederation of Conservators-Restorers Organisations, *Professional Guidelines,* *http://www.icon.org.uk/index.php?option=com_content&task=view&id=121&Itemid*= (Accessed 15 August 2014).

[19] Gerald Smith and Rangi Te Kanawa, 'Some Traditional Colourants of Maori and Other Cultures,' in *Chemistry in New Zealand,* October 2008, 129. http://nzic.org.nz/CiNZ/articles/Smith_Oct08.pdf (accessed 29 July 2014).

fibres will also attract insects. Damage can also occur through use of the object through its life, it may snag and tear while being worn for example.[20]

When damage affects the stability of the object it is necessary to support the damaged areas to allow for handling and display. Fabrics that can be either stitched to the object or attached using an adhesive can be used to provide this support. The support fabric then supports the damaged area, in order to prevent further damage occurring to the object. This is particularly important if the object is likely to be handled often or displayed in an exhibition as the handling necessary for either of these options puts more stress on the object than the textile remaining in storage.[21]

1.7 Infilling Loss

Infilling of loss in conservation is quite often part of conservation treatment in textiles as well as other objects such as paintings and ceramics. Infilling can be combined with a support material if required to provide the support as well as for aesthetic reasons. As mentioned above with textiles the area of loss may require support to prevent further loss and damage while the infilling is coloured to match as closely as possible to the original object.[22]

The purpose of infilling with a similar colour is to aid in the interpretation of the object, particularly if there are large areas of loss. The coloured infill also reduces the visual impact of the missing section on the rest of the object. In many cases loss can make it difficult to see what the object originally looked like and by visually filling this loss the visitor can get a better understanding of what the object should look like and often from this its original purpose. When there is a pattern involved with the original object the conservator must decide whether to fill the loss with one colour that blends in with the original fabric or whether they should try to replicate the pattern for more accurate infilling. This decision can be based on a number of things such as time constraints, skill

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[20] CCI-ICC 'Textiles' *Canadian Conservation Institute,* http://www.cci-icc.gc.ca/resources-ressources/objectscollectionsobjets/textiles/423-eng.aspx (accessed 29 July 2014).
[21] Mary Brooks, Dinah Eastop, Lynda Hillyer, and Alison Lister, 'Supporting Fragile Textiles: The Evolution of Choice,' in *Lining and Backing: The Support of Paintings, Paper and Textiles,* UKIC Conference Papers November 1995, (Totton: The United Kingdom Institute for Conservation, 1995), 5.
[22] Frances Lennard and Dinah Eastop, 'Image, Object, Context: Image Re-integration in Textile Conservation,' in *The Postprints of the Image Re-integration Conference,* (Newcastle upon Tyne: Northumbria University, 2003), 8.

of the conservator, the materials available, and what purpose the object is required to fulfil.[23]

It is usually more time consuming to create a pattern for infilling when compared to infilling with just one colour as it is necessary to create a template of the pattern from another area before then recreating the pattern using the template. The conservator also needs to be comfortable with their abilities at recreating the pattern. The requirements of the object can also affect the choice of whether to infill with the pattern. If the support is required to prevent damage to the object while in storage a simpler colouring method may be all that is required. If on the other hand the object is going on display or the pattern is considered an integral part of the objects significance it may be considered important enough to take the time to infill using the pattern.[24]

1.8 Painted infills

Painted infills are also commonly used in other areas of conservation. Paintings conservators often use paint to infill loss on a painting using their skills to repaint the image that is missing. This allows viewers of the painting to see as close to the original image as possible.[25] In ceramic conservation objects are often pieced back together with infills painted to fit in with the original colour of the object. Sometimes this is done using a flat colour but designs can also be painted in to visually infill the area of loss more effectively.[26]

The colouring of a support or infill fabric during a textile conservation treatment is most commonly done using dyes that have been tested and approved for use in textile conservation to dye the fabric the required colour. Occasionally however, for a variety of reasons, a conservator may choose to use an alternative to dyeing, and this is often done using paint rather than dye.[27] There are a number of advantages and disadvantages to using paints as an alternative to dyes; which will be discussed in detail in section 1.9.

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[23] Anna Harrison, Pippa Cruickshank, and John Fields, 'Localised Colouring Agents for Textile Support Fabrics: An Investigation into their Colour-fastness,' in *SSCR Journal,* 12:2 (July 2001), 16.
[24] Ksynia Marko and Claire Golbourn, 'Project Planning and Management,' in Textile Conservation: Advances in Practice, (Oxford: Butterworth-Heinemann, 2010), 44.
[25] Mark Aronson, 'The Re-restoration of Antonio del Pollaiuolo's Hercules and Deianira,' in *Yale University Art Gallery Bulletin,* 1999, 53.
[26] Maya Elston, 'Technical and Aesthetic Considerations in the Conservation of Ancient Ceramic and Terracotta Objects in the J. Paul Getty Museum: Five Case Studies,' in *Studies in Conservation,* 35 (1989), 69.
[27] Harrison, Cruickshank, and Fields, (2001), 16.

1.9 Reasons for using painted infills

There are a number of reasons that a conservator may choose to use a paint to colour an infill rather than dyeing fabric. There are also a number of disadvantages that should also be considered when proposing the method for colouring a support fabric. It is the role of the conservator to weigh these choices and present their recommendations to the curator or the objects owner.

1.9.1 Colouring method of original object

One of the main considerations is how the original object is coloured. If the object has been painted then it may be that the support should be painted as well to ensure that the support fabric has a similar appearance to the original. This is also an important consideration if the paint on the original has made the fabric stiffer due to the layers of paint that have been applied. If a support fabric does not have the same weight it may not blend with the original well enough and detract from the appearance of the object as much as leaving the loss without an infill.[28]

1.9.2 Efficiency of Time

Another reason that paints are sometimes chosen over dyes is the perception that preparing and using the paints is quicker than dyeing. Dyeing is certainly a process that takes time and effort, and it often requires more than one dyeing session to be able to get the right colour to use as an infill.[29] Using paints requires time to apply the paints, allow them to dry, as well as, in the case of fabric paints, require heat setting. This can take more than 24 hours including the drying time, however unlike dyeing the process appears to be less time consuming for the conservator as they are able to leave the paint to dry and continue with other work until they are ready to be heat set.[30]

1.9.3 Ease of mixing colours

The mixing of colours is also more immediate with paints as it is possible to test small areas on a piece of fabric and immediately adjust the colour of the paint by adding more of a particular colour. Understanding of colours is certainly important when undertaking this, however this is also necessary with dyeing fabrics and therefore this skill makes minimal difference for either method.

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[28] Teresa Knutson, 'Investigation, Engineering, and Conservation Combined: The Reconstruction of a Seventeenth Century Dress,' in *Textile Speciality Group Postprints* Vol 1 (1991), 41.
[29] Personal Correspondence with Alison Lister at Textile Conservation Ltd, August 2013.
[30] Jacquard Neopaque Instructions for use provided on container.

1.9.4 Infilling Pattern

Paints are certainly an advantage if there is a pattern that requires infilling. It would be very difficult to dye a pattern into the fabric. However it is much easier to reproduce a pattern using fabric paints. This is particularly important if the loss of the pattern is considered important and the decision is made that it needs to be reproduced. This can include infilling loss of pictures such as on banners. Painting can and has also been used to reproduce patterns such as embroidery where replicating embroidery with embroidery is too time consuming or expensive, paints can be used to reproduce the design with less time and expense and this can give the viewer an overall impression of what the object would have looked like.[31]

1.9.5 Disadvantages of Fabric Paints

One disadvantage to using paints rather than dyes is that it is more difficult to prepare a larger support with paint, the larger the support needs to be the more difficult it is to paint it evenly and it is easier to get a solid colour using a dye rather than paint. The other major disadvantage of using fabric paints over dyeing is that it is very difficult to reproduce the same colour at a different time if required. When dyeing for conservation it is usual to create a recipe for the dye calculating the specific amounts of each colour dye to add. This specificity assists in making the colour easy to reproduce at a later date if required. Painting a support is much less structured and the measuring how much of each colour added is very difficult to achieve and thus reproducing the same colour depends on guesswork rather than following a specific recipe.

1.10 Research Value

Based on the above information with regards to colouring textiles and the use of paints for support fabrics in textile conservation it was felt that it was important to look at a number of fabric paints in terms of their use in textile conservation. Fabric paints are worth considering as a useful tool in textile conservation and as such it is important to investigate some of the important aspects of fabric paints as outlined above their stability, ease of use and their ageing properties. Chapter 2 will outline the aims and objectives of this project. Conservators working in private practice or even in many museums do not easily have access to some of the equipment required to test these properties of materials and therefore it is useful to be able to test possible materials where the equipment is available.

[31] Knutson, (1991), 41

Chapter 2. Aims and Objectives.

This section outlines the main aim of the research to be carried out and the objectives intended to answer the aim.

2.1 Aim

The aim of this study was to evaluate a number of colours in different ranges of fabric paints manufactured by various companies for use in textile conservation as an alternative to dyeing support fabrics to infill loss in textile objects.

2.2 Objectives

In order to fulfil this aim a number of tests were undertaken in order to evaluate the suitability of these paints for use in textile conservation:

- The current information available was evaluated through a literature review.
- The suitability of the materials when used in close proximity to textile objects was evaluated using Oddy testing.
- Ease of use of the materials was evaluated when preparing the samples for the flexibility, wash fastness, and light ageing tests.
- The suitability of the materials with regards to the effect on handling of the object was evaluated using a flexibility test.
- The suitability of the materials with regards to further treatment or unexpected exposure to moisture was evaluated using Wash fastness testing.
- The suitability of the materials with regards exposure to light in a museum environment was evaluated using Accelerated light ageing.

Chapter 3. Literature Review

This section will review the literature available for the use of support fabrics and infilling of loss in conservation. As outlined in the previous chapter painted infills are often used for a variety of different objects and for a number of different reasons.

3.1 Overview

There is a wide range of techniques used in the different areas of conservation for infilling loss and providing support for damaged objects. As such there is also a large amount of published information available to cover the range of methods. It is important to consider as many aspects of conservation as possible, particularly as collaboration between conservation disciplines occurs regularly. It is difficult however to be able to access all published material for this dissertation, and therefore it is necessary to attempt to cover broadly aspects of infilling loss in paintings, stone, and ceramics. Matero's article 'Loss, Compensation, and Authenticity: The Contribution of Cesare Brandi to Architectural Conservation in America' provides a good overview of what loss and compensation mean in a conservation context as well as the ethical issues with compensation.[32] Though the article is specifically referring to architectural conservation many of the issues raised in the article can relate to other areas of conservation as well.

The use of infilling in conservation has led to a number of symposia and conferences specifically relating to this technique. The postprints from a number of these conferences provide information on how the techniques are used in conservation. These are helpful in both bringing together the use of infilling from different areas of conservation as well as looking specifically at the range of use within one field of conservation. The Mind the Gap forum in 2009 was specifically interested in infilling of loss in textile conservation and included papers on different techniques for filling loss as well as a paper which discusses whether loss should be filled or not.[33]

The postprints of the "Image Re-integration Conference" held at Northumbria University in 2003 is a useful selection of papers on using infills in a broad range of conservation

[32] Frank G. Matero, 'Loss, Compensation, and Authenticity: The Contribution of Cesare Brandi to Architectural Conservation in America,' in *Future Anterior: Journal of Historic Preservation, History, Theory, and Criticism,* 4:1(2007), 44-57.
[33] Mind the Gap: Structural and Aesthetic Options for the Treatment of Loss in Textiles, Forum of the ICON Textile Group Postprints: London, 2009.

fields.[34] Though they clearly don't cover all aspects the postprints can still give an indication of what is of interest in infilling of objects both technical information on preparing and using infills as well as the ethical issues related to infills such as how they can change the object, and whether they affect the understanding of the object in terms of its history. Ethical issues and the consideration of authenticity such as is outlined in Wiik's paper are issues that all areas of conservation consider when choosing a treatment option such as infilling loss.[35]

Similarly the UKIC conference from 1995 'Lining and Backing: The Support of Paintings, Paper, and Textiles' includes papers from the three different areas giving a broad overview of the practice of providing supports for objects in conservation. These papers cover a range of aspects relating to linings and backings, including the ethical considerations around relining and the possible loss of historical evidence this may cause.[36] Another paper from the conference discusses the ethics of reversibility in relation to paintings, however reversibility is an important consideration in textile conservation as well as other areas of conservation.[37]

There is also evidence that conservators gather knowledge from other areas of conservation not directly related to their own. There are two articles that indicate the idea of painted infills was carried over from painting conservation techniques. A paper given at the ICON Textile Group Symposium by Rijksmuseum Textile Conservator Mieke Albers states that the idea for using paint came from sharing a studio with painting conservators.[38] Jane Wild's paper took a technique used in painting conservation to fill the loss on the object she was treating outlined in her paper.[39] It is worthwhile therefore

[34] A. Jean E. Brown (ed), *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003).
[35] Svein A. Wiik, 'Perception Psychology in Re-integration Processes' *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003), 97-102.
[36] Nicola Walker, 'Artists' Original Supports: Conservation versus Historical Evidence,' in *Lining and Backing; The Support of Paintings, Paper, and Textiles,* Papers of the UKIC Conference 7-8 November 1995, (Totton: United Kingdom Institute for Conservation), 40-47.
[37] Karoline Beltinger, 'Reversible Supports for Paintings as an Alternative to Lining,' in *Lining and Backing; The Support of Paintings, Paper, and Textiles,* Papers of the UKIC Conference 7-8 November 1995, (Totton: United Kingdom Institute for Conservation), 111-118.
[38] Mieke Albers 'Colouring the Past for the Future: Retouching of Old Restorations in a Tapestry,' in *A Woven Alliance: Tapestry, Yesterday, Today, and for Tomorrow*, ICON Textile Group symposium postprints 2012, Edinburgh.
[39] Jane Wild, 'Understanding the Cultural Context of an Indian Painting Tradition to Establish Conservation Methodologies in Loss Compensation.' In *Mind the Gap* ICON Textile Group Forum postprints

looking at treatments from other areas of conservation to assess the possible use in textile conservation.

3.2 Stone

There is no apparent crossover between infilling of loss in textile conservation and stone conservation it is useful to understand that infilling occurs in stone conservation as well. "Loss Compensation Methods for Stone" by Griswold and Uricheck is a good overview of the way in which damaged surfaces of stone are conserved.[40] While the technical aspects of stone infilling are not particularly useful for textile conservation the ethical issues of infilling are often the same for the various areas of conservation including stone and textiles. These ethical issues include the possibility that support will change the current appearance of the object and it is not always possible to know what an object originally looked like. The paper by Griswold and Uricheck also contains a useful reference list that can be referred to for further information on compensating for loss of stonework.[41]

Other useful sources of information on loss compensation of stone include books such as 'Conservation of Building and Decorative Stone' which provide information on the infilling of loss in stone conservation as one aspect of stone conservation.[42]

3.3 Ceramics

As with stone conservation infilling in ceramics is different to infilling in paper, paintings and textile conservation. The similarity between the different areas is mostly restricted to the use of pigments to colour the material used for the infill. The article by Elston "Technical and Aesthetic Considerations in the Conservation of Ancient Ceramic and Terracotta Objects in the J.Paul Getty Museum: Five Case Studies" provides a good overview of the different ways in which loss can be compensated for in ceramics conservation.[43]

3.4 Painting

Infilling of paintings depends on the type of painting. Paintings on canvas will be treated differently to paintings on wood or plaster as the paints react differently to the different

[40] John Griswold and Sari Uricheck, 'Loss Compensation Methods for Stone,' in *Journal of the American Institute for Conservation*, 37:1 (1998), 89-110.
[41] Griswold and Uricheck, (1998), 89-110.
[42] Francis G. Dimes *Conservation of Building and Decorative Stone,* (Oxford: Butterworth-Heinemann, 1998).
[43] Elston, (1990), 69-80.

base media. There are also a number of different methods of infilling of image loss in paintings. It is difficult to cover all the literature on infilling of paintings. As mentioned above there are definite crossovers between painting and textile conservation infills.

While in textile conservation the support fabric often also provides the infilling as well through colouring the support fabric to match the object in paintings conservation it more usual that the support is separate to the treatment of loss. Thus these areas of painting conservation are usually discussed separately in conservation literature.

There are several books on conservation of painting, and books such as Berger and Russell's book or Stoner and Rushfield's include sections on visual compensation of paintings.[4445] These can be useful to gain an understanding of what are typical methods of infilling and retouching of paintings. There are also several papers specifically referring to particular methods of infilling loss in paintings as well as discussing the differences between the methods and suggesting reasons for choosing a particular method. A useful example of this is the paper referred to in Section 1.8 by Aronson which discusses the treatment of a particular work of art.[46] The paper by Derbyshire and Frayling from the Image Re-integration Conference is useful for considering whether reintegration should be undertaken or not as well as giving several techniques used for reintegration of different types of paintings.[47]

3.5 Paper

Paper, like painting, has similarities to textiles, they are often made from similar materials such as cellulosic based textiles and papers which means they often deteriorate in similar ways as well as reacting to treatments similarly. In conservation therefore there are treatments that are used in textile conservation that have come from paper conservation and vice versa. Infilling loss with paper conservation can be for support only without any infilling of pattern loss, however as McAusland suggests in her

[44] Gustav Berger and William Russell, *Conservation of Paintings: Research and Innovation,* (London: Archetype Publications, 2000).
[45] Joyce Hill Stoner and Rebecca Rushfield, *Conservation of Easel Paintings,* (Oxon: Routledge, 2012).
[46] Aronson, (1999), 44-59.
[47] Alan Derbyshire and Nicholas Frayling, 'Re-integration of Portrait Miniatures using Traditional and Virtual Techniques,' in *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003), 15-20.

paper on methods of re-integration, it can also be used to recreate the text on a page or to infill missing areas of an image.[48]

Papers such as Grantham's paper from 2002 review colouring materials that can be used in paper conservation.[49] While papers such as the three papers relating to paper conservation at the Re-Integration Conference at Northumbria University are useful in providing information on the techniques of infilling loss in paper conservation.[50][51][52]

3.6 Textiles

There is a limited amount written about using paints for infilling in textile conservation. Harrison, Cruickshank and Fields stated in an article in 2001 that while some conservators had tested wash fastness and rub fastness there was little information about light ageing of paints and the number of published sources is lacking.[53] The most commonly referred to article is 'Evaluating the Stability of Commercially Available Artists' Colouring Materials Used to Create Compensation Infills for Losses in Textiles' written in 1999 by Mary Kaldany, Maria Berman, and Sigurros Sigurdardottir and this article is referred to by several other authors of related articles.[54] The article outlines a testing project involving a number of different paints used in textile conservation. It assesses their use in textile conservation. This article is particularly useful as it gives a wide range of information, however as it was written in 1999 the information it contained may be out of date as manufacturers of the products tested may have changed the ingredients of the products in this time. The article also only gives very limited information on why paints may be chosen over dyes.

Two dissertations from students on the Textile Conservation Course have previously investigated the use of paints on support fabric in textile conservation. One from 2000 by Kim Thusing focussed on the use of silkscreen printing and digital printing though it

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[48] Jane McAusland, 'Re-Integration of Missing Areas in Old Master Prints and Old Master Drawings: Some Different Approaches,' in *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003), 64.
[49] Sandra Grantham, "Mellow Yellow: Toning Papers with Traditional Far Eastern Colourants," in *The Paper Conservator,* 26:1, 2002, 49-57.
[50] McAusland, (2003), 59-64.
[51] Elizabeth Sobczynski, 'Reconstruction of Losses in Gouche Painting on Paper "Oz Trial" by Feliks Topolski,' in *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003), 65-74.
[52] Marie Christine Enshaian, L. Juillard, and V. Farelly, 'Approaches to the Re-integration of 18th and 19th Century Papers,' in *The Postprints of the Image Reintegration Conference*, (Newcastle upon Tyne: Northumbria University, 2003), 129-134.
[53] Harrison, Cruickshank, and Fields, (2001), 16.
[54] Kaldany, Berman, and Sigurdardottir, (1999), 443-458.

also investigated the ageing properties of several different fabric paints, in particular Deka Silk® Permanent, Deka Silk®Perm Deck, Deka Silk®Silk, Pebeo Pebeo Setasilk®®Colour Transparent, Pebeo Pebeo Setasilk®®Colour Opaque, and Pebeo Pebeo Setasilk®®Silk.[55] The more recent one from 2005 by Vicky Loosemore also looked at screen printing techniques and focussed on the pigments commonly used in screen printing investigating the ageing properties of several products, a selection of acrylic paints and dyes, Helizarin with Bricoprint Binder, Procion P Reactive Dyes, Disperse Dyes, and Liquitex Acrylic Paint.[56] Both dissertations chose only one colour from each range and Loosemore recommends expanding the investigation to several colours from each range to examine any differences in the ageing due to the different pigments.[57]

In 2001 an article was published in the SSCR journal.[58] This article investigated the use of several localised colouring agents including one fabric paint as well as a printing pigment and a dye. This article was looking at using the paint for two specific objects, fragmentary archaeological textiles where the support was required to provide infilling of design. The results may still be used when considering their use for other objects as the testing provides information on the properties of the paints selected. The materials were tested for rub fastness as well as wash fastness and were also tested for light fastness. These are important considerations for the longevity of support fabrics in textile conservation.

Most other literature related to painted infills in textile conservation outline their use in specific treatments. These papers give minimal information on the paints used, usually limited to the manufacturer used and information such as the method for application. While this is useful in gaining understanding of when painted infills are used and what paints are used for this type of support it does not always provide help with understanding how to use the paints and which paints are preferable for use in textile conservation.

[55] Kim Thusing, *Camouflaging Areas of Loss in Patterned Textiles; Evaluating Textile Printing, Painting, and Digital Imaging,* Unpublished Dissertation for MA Textile Conservation, University of Southampton, 2000, 40.
[56] Loosemore, (2005), 2.
[57] Loosemore, (2005), 62.
[58] Harrison, Cruickshank, and Fields, (2001).

Teresa Knutson in her article outlines the conservation and reconstruction of a seventeenth century dress.[59] The conservators used fabric paints to infill areas of loss that were decorated with embroidery. It was decided that a plain coloured support fabric would not fill the areas of loss well enough for this dress, however embroidering the support fabric to match the original would be too time consuming. It was therefore decided to paint an approximation of the embroidery pattern using fabric paints to give the impression of what the original would have looked for. Lumiere fabric paint was selected for use. It is stated in the article that the paint was tested for "compatibility with metals, and for stability in wet and dry cleaning" however further information on the results of this testing are not provided and it is not clear if more than one paint was tested for use.

As mentioned above Northumbria University hosted a conference in 2003 regarding image reintegration. This conference was multidisciplinary, with papers from different fields on conservation. Textile conservation was represented in a discussion on "Imagine, Object, Context: Image Reintegration in Textile Conservation."[60] The conference as a whole shows the importance of image reintegration in the conservation field. The textile paper covers a range of infilling options in textile conservation including the use of painted infills, in particular looking at the loss of image in painted banners.

There was also a textile specific symposium held in Amsterdam in 1994 'The Misled Eye… Reconstruction and Camouflage Techniques in Tapestry Conservation' which looked at tapestry conservation and one paper was presented specifically referring to painting in tapestry conservation, discussing whether it should be used.[61] More recently a textile conservation studio in Amsterdam used fabric paint to paint over an area of a tapestry which had been previously repaired however the dyeing of the infill had faded and had therefore become obviously different to the original tapestry. This was an interesting article as the authors mentioned their inability to use the fabric paint they usually use, Deka Silk® Silk, as it requires heat setting once applied to the fabric,

[59] Knutson, (1991), 26-45.
[60]Lennard and Eastop, (2003), 7-14.
[61] Francesco Pertegato, 'Painting in Tapestry Conservation: Is it Heresy?' in *The Misled Eye: Reconstruction and Camouflage Techniques in Tapestry Conservation*, (Amsterdam: TRON Symposium Postprints, 1994), 97-110.

however they did not wish to apply heat to the tapestry and therefore a different paint was chosen, one that did not require heat setting.[62]

3.7 Conclusion

Infilling is important for a number of reasons, both for support as well as for visual purposes. It is important to understand the materials that are used in infilling in particular their ageing properties such as light fastness and how they react in different environmental conditions. As it is usually commercially available products that are used for infilling it is important to test these materials for their ageing properties to ensure they are suitable for conservation purposes. This also includes retesting of the materials at various stages as it is possible that manufacturers may change the characteristics of these materials without necessarily providing this information to users.

[62] Albers (2012), 95.

Chapter 4. Oddy Test

This section will introduce the Oddy Test with the methodology, results, and a discussion of their meaning in relation to using fabric paints in textile conservation

4.1 Introduction and Methodology.

4.1.1 Introduction to the Oddy Test.

When choosing to use materials in a museum environment, including display case materials, support materials, and materials for use in conservation it is important to consider the impact that these materials may have on the object when they are in close proximity for an extended period of time. Support fabrics and the materials used to colour them are in contact with the object, and will remain in contact with the object even when it is not on display. As such it is important that any materials used for support fabrics will not cause any damage to the object. This damage may occur if the materials used contain something that may cause the object to degrade at an accelerated rate.

The choice of materials used in this project is outlined in Chapter 5: Application of Paints.

Oddy testing is used to determine if the materials are suitable for use in a museum environment, in particular if they release any chemicals considered pollutants that may adversely affect the object causing an acceleration of degradation through being released in the environment around the object. Table 2 outlines the most common pollutants in the museum environment the sources and how they affect the metals used in the Oddy Test. The Oddy Test was originally introduced to the field of conservation by Andrew Oddy at the British Museum in the 1970s and updated by Robinet and Thickett to run the test with all three metal coupons in one tube.[63] The Oddy test has become a common test in conservation to help determine if a material is appropriate for use in the museum environment. It is considered an easy test to do that does not require specialist materials or equipment and can therefore be performed in most conservation studios.[64]

[63] I. Robinet and D. Thickett, 'A New Methodology for Accelerated Corrosion Testing,' in *Studies in Conservation*, 48:4.
[64] D. Thickett and L.R. Lee 'Selection of Materials for the Storage or Display of Museum Objects' *The British Museum Occasional Paper number 111* The British Museum: London, 2004, 13.

Table 2: Sources and Effects of Pollutants[65]

Pollutants	Affects	Main source
Sulphur (e.g. hydrogen sulphide, carbonyl sulphide)	Silver and copper	Wool, rubber, adhesives
Organic acids (e.g. formic acid, acetic acid)	Lead, copper	Timber, paints, adhesives, varnishes, sealants, moth and rot proofing
Formaldehyde	Most metals	Timber, adhesives, fabrics, paints
Chlorides	Copper	Plastics, fire retardants
Nitrogen oxides	Copper	Plastics

Determining the results of the Oddy test is based on a rating system consisting of three recommendation levels as outlined in Table 3.

Table 3: Recommendations for Use Based on Oddy Test

Pass	Safe for Permanent Use.	No change to the metal coupons at all.
Temporary	Acceptable for temporary use (<6 months, but not for permanent use.	Slight amount of corrosion on metal coupons, including only a few spots.
Fail	No suitable for use in a museum environment.	Significant amount of corrosion seen.

The rating is determined by the appearance of the metal coupons after the test has been performed when compared to the control coupons. This means that analysing the results is subjective and despite guidelines being laid out it is still possible for different interpretation of some results.

4.1.2 Sample Preparation

The paints were applied to glass microscope slides. Glass was chosen, as it is a substance that is known to be inert and non-reactive and so would not interfere with the results of the Oddy Test. Once applied the paints were left to dry at room temperature for several hours before being placed at an angle in clean glass tubes. A small tube filled with water was also placed at an angle in the tube. Three pieces of metal, silver, lead, and copper, were slotted into a prepared stopper. The stopper was then used to seal the tube as shown in Figure 1 before being placed into an oven.

[65] Thickett and Lee, (2004), 6.

4.1.3 Test Methodology

The prepared samples were placed in an oven at 60 degrees Celsius. The increased temperature accelerated the reaction between the test material and the metal. The small test tube of water increased the humidity in the tube and this also acts to accelerate any reaction caused by the test material. The samples were left in the oven for 28 days to gauge the reaction. The level of water in the small test tube was checked and replenished when necessary while the stoppers were also checked regularly to ensure they were still secure.

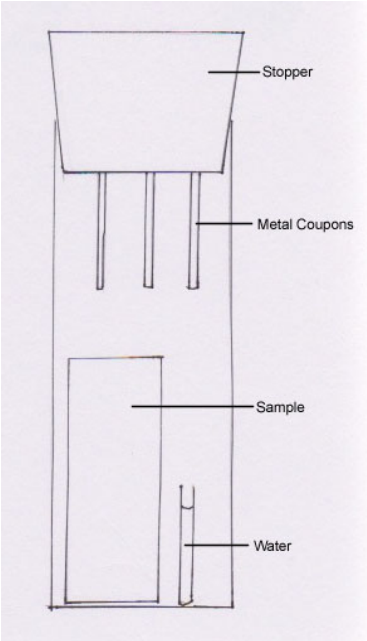

Figure 1: Set-up of Oddy Test

At the end of the testing period the metals were assessed visually, including microscopically, for any evidence of corrosion. The different metals are affected by different volatiles in the surrounding environment; it is therefore possible to ascertain whether these volatiles are present by examining the tokens at the end of the test.

4.2 Results and Discussion

After 28 days of testing the metal coupons from the Oddy tests were examined and the results shown in Table 4 were analysed based on the appearance of the coupons.

Table 4: Oddy Test Results

Paint	Coupon Appearance compared to Control	Suitability
Deka Silk®		
Red	No Change to any Coupons	Pass
Yellow	No Change to any Coupons	Pass
Blue	No Change to any Coupons	Pass
Black	No Change to any Coupons	Pass
White	No Change to any Coupons	Pass
Pebeo Setasilk®		
Red	Lead, small amount of crystal-like corrosion. No change to silver and copper.	Temporary
Yellow	Lead, significant crystal-like corrosion. No change to silver and copper	Fail
Blue	Lead, small amount of crystal-like corrosion. No change to silver and copper.	Temporary
Black	Lead, small amount of crystal-like corrosion. No change to silver and copper.	Temporary
White	No Change to any Coupons	Pass
Jacquard Neopaque®		
Red	No Change to any Coupons	Pass
Yellow	No Change to any Coupons	Pass
Blue	No Change to any Coupons	Pass
Black	No Change to any Coupons	Pass
White	No Change to any Coupons	Pass

Figure 2: Oddy Test Coupons - Control

Figure 3: Oddy Test Coupons - Pebeo Setasilk® Yellow, showing Lead Corrosion

Figure 4: Oddy Test Coupons - Pebeo Setasilk® Red showing some Lead Corrosion

As can be seen from the summary of results in Table 4 the Pebeo Setasilk® Yellow was found to be unsuitable for use, while the Red, blue, and black were found to be suitable only for temporary use (less than six months).

The Oddy Test showed that the majority of the results were acceptable for use in textile conservation. Both the Deka Silk® and the Jacquard Neopaque® ranges results show that these paints can be considered acceptable for long term use in conservation.

The Pebeo Setasilk® range of paints however had a small reaction with the lead coupons present in four of the five test samples, the Pebeo Setasilk® Lightening Media being the exception. This indicated the presence of a volatile pollutant that was interacting with the lead in these samples and use of the Pebeo Setasilk® range should be evaluated carefully before they are used on support fabrics in textile conservation. The yellow paint sample in particular had a clear reaction with the lead when compared to the control, as shown in Figures 2 and 3 and therefore it cannot be judged suitable for use in conservation. Although the Material Safety Data Sheets (Appendix 2) for each range of paints was examined the Pebeo Setasilk® had the least information about the composition of the paint when compared to the others. Without further testing or information it is difficult to identify material present in the paint may be causing the reaction with the lead.

The red, blue, and black paints did not have as strong a reaction with the lead as the yellow, however they did show some reaction as seen in Figure 4 which shows the coupons from the Pebeo Setasilk® Red Oddy Test. Therefore they were evaluated as suitable for temporary use. The usual purpose of these paints in textile conservation however, as previously outlined, is for use on support fabrics to infill loss. The support would rarely be used as a temporary conservation treatment as the support is usually required for long term protection from further damage.[66] For this reason it appears that it would be very unlikely to use the fabric paint for anything less than a long term purpose and as such it would be recommended that a paint other than the Pebeo Setasilk® range were used in textile conservation.

It is worth noting that the paints in this test were painted directly onto glass microscope slides and left for several hours to dry before being sealed in the tubes for testing. It may be considered worthwhile to repeat the test with the same method, but it may also be worth creating samples that are left for longer to see if allowing the paints to cure for longer eliminates more of the detrimental volatiles present to acceptable levels. When creating the samples for the other testing, the wash fastness and the light ageing, the paints were painted onto the fabric, allowed to dry for 24 hours before being heat set using an iron. An Oddy Test following this procedure should also be considered in order to evaluate if this procedure may provide different results.

[66] Knutson, (1991), 41.

In this project, it was felt most appropriate to test the paints without the addition of the fabric samples to prevent alternative sources of possible pollutants. The types of fabrics used have been tested previously and considered appropriate for use in textile conservation, however it was decided that there was still the possibility of interference and the decision was made to use the inert glass slides in this project.

Chapter 5: Application of Paints

This section describes the choice of test materials, how the paints were applied to the test fabrics with the reasons for this choice and observations on their ease of application.

5.1 Introduction

In order to ascertain whether the different paints are suitable for use by textile conservators it is necessary to test the paints in a number of different ways to see how the paints may affect the textiles they are in contact with. This involves testing to see if the paint releases chemicals that may cause accelerated deterioration of an object as well as testing the stability of the paints, in particular the stability of the colour over time. It also involved testing to evaluate any change the painted support may make to the handle and flexibility of the object.

5.2 Choice of materials

The choice of paints to test was based on the literature with the number of manufacturers being restricted to ensure that the time allowed for the project could be used most effectively.[67][68][69] It was felt that more than three different types of fabric paints would be difficult to test in the time allowed. This timing was also restricted by the size of the testing equipment. The three fabric paint manufacturers chosen were selected from a number of articles in which the paints were used or referred to, the authors of these articles come from different countries which provides some information on what is being used by conservators in different countries. Two of the paints were previously tested by Kaldany, Berman, and Sigurdardottir, the Deka Silk® and the Jacquard Neopaque®. The third paint range, the Pebeo Setasilk® was not tested however another range by the same manufacturer was tested, Pebeo SetaColour®.[70] While textile conservators also use artist's acrylics to colour support fabrics it was decided for the purpose of this dissertation to focus on paints that are designated as fabric paints.

The fabric paints were tested on both cotton and silk fabrics. These fabrics are commonly used in conservation for support fabrics and are the most likely to be chosen

[67] Wild, (2009), 11.
[68] Karen Ayers and Chloe Hesketh, 'Mix and Match: Compensating for Loss in a Large Tudor Tapestry,' in *Mind the Gap* ICON Textile Group Forum postprints 2009, 68.
[69] Albers, (2012), 95.
[70] Kaldany, Berman, and Sigurdardottir,, (1999), 445.

to use with fabric paints for support fabrics. Cotton is a cellulose based fibre while silk is a proteinaceous fibre. These fibres may react differently when used with different materials. This variation in composition of the fibres will therefore assist in identifying if there is a difference in the stability of the paints on these different types of fibres, which is important when considering using the paints on either type of fabric.[71] Although synthetic fibres are also sometimes used for support fabrics in textile conservation it was decided not to test synthetics as it was felt more important to test on the natural fibres in the time allowed for the project as these are currently more commonly used in textile conservation as support fabrics.[72]

A range of colours from each manufacturer were also chosen to be tested as it is possible that different colours may have different light sensitivities due to their composition as suggested in the dissertation by Loosemore.[73] All the paints were sourced from the same supplier, George Weil (See Appendix 1).[74] According to the information provided on the samples received the three chosen ranges were manufactured in different countries reducing the chance that they may have been manufactured in the same factory and be marketed differently. The three products are outlined in Table 5.

Table 5: Manufacturers, Details of Range, and Country of Origin.

Manufacturer	Range	Number of Colours	Country of Manufacture
Pebeo	Pebeo Setasilk®	29	France
Jacquard	Jacquard Neopaque®	13	USA
Deka Silk®	Silk	46	Germany

Five colours were chosen as the most likely colours for a textile conservation studio to use as shown in Figure 5. These were red, yellow, and blue as the colours that can be mixed to make most other colours. Black and white coloured paints were also chosen as these can be used alongside the other three colours to lighten or darken the shade as required. The ranges differ widely in the number of colours available to purchase, with some ranges having several different shades of one colour. When choosing the paints for testing the most similar shades for each were chosen, and the closest to the primary shades of the colours was also chosen. Table 6 shows the colours that were chosen from each manufacturers range including the manufacturers code and the name given to the

[71] Tímár-Balázsy and Eastop, (1998), 4.
[72] Brooks, *et al,* (1995), 10.
[73] Loosemore, (2005), 62.
[74] George Weil http://www.georgeweil.com/Default.aspx (accessed 30 July 2014).

colour. It should be noted that the Pebeo Setasilk® range however did not include a white paint and it was chosen instead to test the Pebeo SetaColour® Lightening Medium as this would be used in the same way as the white paint in the other ranges. This was the lightening media recommended for use with the Pebeo Setasilk® range.

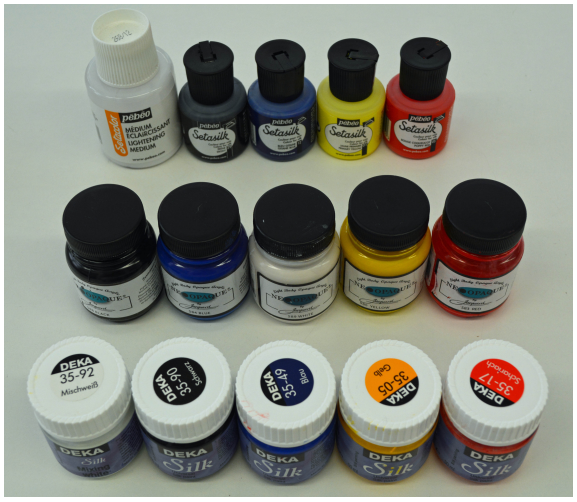

Figure 5: Paints Chosen for Testing

Table 6: Colours Chosen from Each Manufacturer.

	Pebeo Setasilk®	Jacquard Neopaque®	Deka Silk®
Red	05 Poppy Red	1583 Red	35-17 Scarlet
Yellow	01 Primary Yellow	1580 Yellow	35-05 Golden Yellow
Blue	12 Gitane Blue	1584 Blue	35-49 Blue
Black	29 Ebony	1588 Black	35-90 Black
White	Pebeo SetaColor® Lightening Medium	1589 White	Mixing White

5.3 Application of Paints

The ease of application of the paints to the chosen fabrics was assessed as the samples were painted. It was noted whether the paint requires any dilution to prevent a change in handle. The appearance of the paint on the fabric was also observed. It is difficult to test this empirically as the ease of use is subjective, though the change in flexibility can be tested as outlined in Section 4.5.

The different manufacturers provide different instructions for application and setting of the paint as laid out in Table 7. All three require fixing using an iron once the paint is dried. The temperature required for fixing as well as the time required to fix the paint is vague for each manufacturer.

Table: 7: Manufacturers Instructions for Use of Paints.

	Deka Silk®	Pebeo Setasilk®	Jacquard Neopaque®
Drying time	Not stated	Not stated	24 hours
Fixing time (iron)	3 minutes*	5 minutes	1 minute**
Fixing temperature	"cotton setting"	Not stated	"Temperature suited to fabric"

*Wrong side
**30 seconds each side

In order to reduce variability in the application of the paint on the samples it was decided to paint the samples from all three manufacturers and then leave them to dry at room temperature for 24 hours before being heat set, as this was the longest time suggested by the varying manufacturers (Table 7).

The samples were then ironed using a heated spatula rather than a regular iron. This method was chosen as the temperature of the spatula could be regulated more effectively than a general iron can be. As it was unclear what temperature should be used for heat setting it was decided that 90 degrees Celsius would be chosen. It was felt that a lower heat would not be effective enough however a higher heat may cause damage to the silk fibres which are more affected by high temperatures than cotton. Ironing the cotton at a higher temperature to silk was considered, however it was felt that this would introduce a further variable into the testing and the decision was made to use the same heat across all samples.

The recommended fixing time as shown in Table 7 was different for each sample varying from 2-5 minutes. Ironing on both sides or only one side also varied between the different manufacturers instructions. Again in order to reduce the amount of variables within the preparation of samples it was chosen to fix all samples using the same method. It was decided that the samples should be heat fixed on both sides for 2.5 minutes each side, for a total of five minutes. A sheet of silicon release paper was used between the sample and the iron to prevent any transfer of the paint onto the iron surface.

The Deka Silk® also includes instructions for setting the paint in an oven or microwave. As the other paints do not include these as options for setting the paint they were not considered as an option for setting the paint. It was also considered unlikely that textile conservators would use this method to heat set the paint.

The paints were painted onto both cotton and silk fabrics for testing. While a number of different weight fabrics are used in conservation it was decided to test on medium weight fabrics as these provide a good middle point for the different weight fabrics. A medium weight silk habatai was chosen as the silk fabric. The cotton fabric chosen was a medium weight cotton lawn (See Appendix 1). Both these fabrics are plain weave fabrics. The cotton was scoured before the paint was applied as cotton is usually scoured before being dyed.[75]

Thus the following method was used to paint out the samples:

1. The samples were cut from the fabric. Selvedges were not included in any samples used.
2. Paint was applied to surface of sample with a paint brush.
3. Samples were left to air dry at room temperature for 24 hours.
4. Samples were ironed on both sides at 90 degrees Celsius for 2.5 minutes on each side (total 5 minutes).

5.4 Paint Application Observations

The paints are all marketed in bottles. The Pebeo Setasilk® bottle has a pouring spout in the lid to allow for easy decanting. On initial observation of the paints the Jacquard Neopaque® was noticeably thicker than the other two products. The Deka Silk® and Pebeo Setasilk® were of similar consistency to each other.

The paints were initially tested in small areas on a piece of cotton. Application of all three ranges was quite easy using a paintbrush though decanting the paint from the bottle into a beaker was somewhat difficult, particularly for the Jacquard Neopaque® and Deka Silk® both of which tended to spill during pouring. It would be possible to use both the Jacquard Neopaque® and Deka Silk® directly from the bottle, as the top of the bottle is wide enough to allow a medium sized brush. The Pebeo Setasilk® bottle had a narrow top and therefore it would not be possible to use the paint directly from the bottle. Decanting of small amounts of paint was done to prevent any possible contamination of the paint in the bottle from the brush. If the paints require blending to create a new colour then it would also be necessary to decant small amounts to mix with other colours.

[75] Centre for Textile Conservation and Technical Art History, *Dyeing Techniques Manual*, University of Glasgow, 2013, p16.

The edges of the painted area of the Deka Silk® and Pebeo Setasilk® are feathery from where the wet paint has been drawn along the fibres during application. This is more noticeable on the silk than the cotton. The Jacquard Neopaque® has much sharper edges. The brush was slightly dampened before use and then rinsed between applications. The first attempt at rinsing the brush led to the paint being diluted the next application. Blotting the paintbrush on absorbent paper reduced this problem and this was continued throughout. It was not found necessary to dilute either the Deka Silk® or the Pebeo Setasilk® with water before application. The Jacquard Neopaque® was first applied undiluted and it was found to be quite thick and made the fabric noticeably stiffer after application. Several drops of water were then mixed into the paint and applied to a new section of fabric it was observed that the paint application was easier, there were less noticeable brush strokes and the colour appeared more even. A ratio of 1:5 (paint:water) was chosen for the Jacquard Neopaque® as this ratio gave the fabric painted with the Jacquard Neopaque® a similar feel to the other two paint ranges. This dilution did however reduce the colour intensity of the dye.

It was found that some of the paints, in particular the darker colours of all three manufacturers, developed a slightly mottled appearance as they dried, which was not as obvious while the paint was wet. This was most obvious with the Jacquard Neopaque® samples. It was found that application of the paint needed to be fast to prevent the paint drying too quickly while application is still being done. Using a larger brush did appear to reduce this problem as it applied the paints over a larger area and required less reloading of paint onto the brush, which made the process quicker. The dry environment in the laboratory (<50% RH) may have affected the drying of the paint and have been the cause of this problem during the application process. As the samples being made were small this may indicate that this would be a problem when larger painted areas are required. Further application of paint may reduce this appearance, however this may change the handle of the fabric more than the one layer being applied in this experiment. This slight unevenness of application was only noticeable when looking at the samples closely.

Chapter 6: Flexibility Testing

This section will introduce flexibility testing, outlining the methodology, present the results, and discuss their significance in terms of use in textile conservation.

6.1 Introduction and Methodology

6.1.1 Introduction to Flexibility Testing

As already mentioned in Section 1.9.1 the effect on the flexibility of the support materials is an important aspect when considering the use of fabric paints as an alternative colouring method for the support fabrics. If the paint significantly changes the flexibility of the support fabric, most likely by increasing the stiffness or decreasing the flexibility of the fabric this is likely to change the handle of the fabric of the original object where the support fabric is applied. If the original object has a very soft handle stiffening of the fabric where the support is applied will prevent the natural movement of fabric. This will change the look of the fabric but also increase the possibility that the stiffness may create stress on the edges of the support, particularly if it is a patch, and thus it may cause increased risk of damage to the fibres.[76]

Alternatively if the object is already a stiff fabric, then a support with similar handle may be the most appropriate choice when deciding on a support fabric. This may be the case with painted textile objects, which are stiffened due to the decorative paint applied.

While the flexibility of the painted samples can be assessed to some degree by feel, being able to objectively evaluate the change in flexibility reduces the subjective nature of evaluating based on an individual's interpretation. The flexibility of the material after application of the paint in this instance was assessed using a flexometer to measure the bending length of the fabric. This will show any differences between the unpainted fabric and the fabric that has been painted using the different paint ranges. The bending length is determined using a ratio of the length of the material that will bend under its own weight (in mass per unit area) as outlined by the British Standards. [77]

It was chosen to only test some of the paints for the flexibility test to reduce the number of samples. The samples were also only tested along the warp length. After handling of the fabric samples prepared for other tests there was no perceptible difference in the

[76] Knutson, (1991), 41.
[77] British Standard, *Method for Determination of Bending Length and Flexural Rigidity of Fabrics* BS3356:1990, The British Standards Institution 2013, 1.

handling of the prepared samples of each range of paints. The red paints from each range were chosen randomly for testing the flexibility.

The Pebeo SetaColour® lightening media was also chosen to be tested as this appears to have a different effect on the fabric than the paints in the Pebeo Setasilk® range. A 1:1 mixture of the Pebeo Setasilk® red paint and lightening media was also tested as how mixing the lightening media with the paints in the Pebeo Setasilk® range was also considered useful to know. The Jacquard Neopaque® paint was tested without dilution as well as diluted in the same method used in other testing during this study. It was considered that seeing how significant the change in flexibility between the undiluted and diluted Jacquard Neopaque® paint would make. This could be used to evaluate whether the Jacquard Neopaque® could be considered in a situation where a stiffer support fabric might be required.

6.1.2 Sample Preparation

Pieces of cotton and silk fabric were cut into strips 20cm long and 2.5cm wide with the warps parallel to the long edge as shown in Figure 6. The specimens were cut so that for each sample type the samples did not contain the same warp threads. These strips were then painted with the paints selected for testing, left for 24 hours before being heat set using the same method as the samples for wash fastness and light ageing. The samples were weighed to determine their mass per unit area in centimetres.

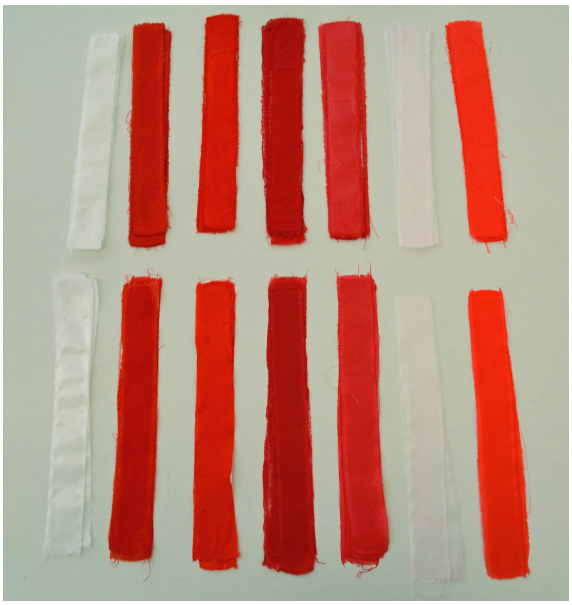

Figure 6: Samples Prepared for Flexibility Testing

The samples were handled as little as possible before the testing to prevent changes in handle before testing. The fabric used however had been previously handled, particularly the cotton, which was scoured before use. As scouring was required before application of the paints this was considered necessary. This would also be how support fabrics used in conservation would be treated and therefore this was considered acceptable in this case. It is the change between the unpainted control samples and the painted samples that is the main consideration in this test, rather than the values and therefore if all samples are treated identically then the results would still be valid.

6.1.3 Test Methodology.

A fixed-angle flexometer was made by cutting a piece of Plastazote® at an angle of 41.5 degrees as outlined in the British Standard *Method for Determination the Bending Length and Flexural Rigidity of Fabrics* shown in Figure 7.[78] This was overlaid with Melinex® to allow the fabric to slide across the surface (see Appendix 1 for suppliers of Plastazote® and Melinex®).

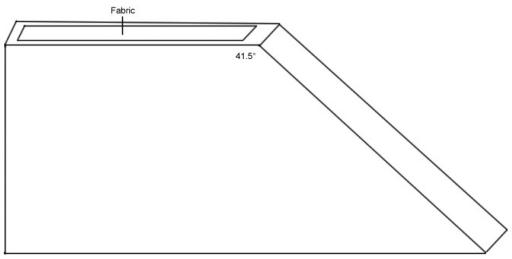

Figure 7: Fixed Angle Flexometer

The fabric was laid on the flat top of the fixed angle flexometer with one end aligned with the edge of the angled area. A ruler with rubber inserts was laid on top and this was used to push the fabric sample past the angled point as indicated in Figure 8. It was noted when the end of the fabric touched the angled surface of the flexometer and the length of fabric beyond the angled point was measured. This was repeated in triplicate for each sample.

[78] British Standard, BS3356:1990, 2013, 1.

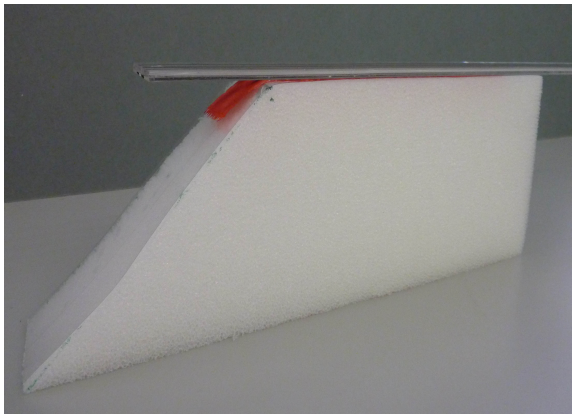

Figure 8: Fabric being tested using the Fixed Angle Flexometer.

To determine the flexural rigidity of the samples the ratio of the bending length of the sample, as measured using the flexometer, and the mass per unit area of the sample is calculated using the following formula:

$$G = 0.10\ MC^3$$

Where:
G is the flexural rigidity
M is the mass per unit area
And
C is the mean bending length

The mass per unit area was calculated using the following formula:

$$M_{ua} = \frac{M_c}{L_c \times W_c}$$

Where:
M_{ua} is the Mass per Unit Area
M_c is the mass of the sample in grams
L_c is the Length of the sample in metres
And
W_c is the Width of the sample in metres

This is outlined in the British Standard *Method for Determination Bending Length and Flexural Rigidity of Fabrics.*[79]

The samples were tested in a laboratory with a temperature of and a relative humidity of 25 degrees Celsius and 47% relative humidity.

6.2 Results and Discussion

Table 8: Mean Flexural Rigidity for each sample type.

	Cotton	Change from Control (Cotton) %	Silk	Change from Control (Silk) %
Control	307.69	0	209.99	0
Deka Silk® Red Undiluted	598.60	94.58	613.75	192.28
Pebeo Pebeo Setasilk®® Red Undiluted	832.57	170.59	648.20	208.68
Pebeo Pebeo Setasilk®® Lightening Media	731.25	137.66	711.24	238.70
Pebeo Pebeo Setasilk®® Red and Lightening Media	512.28	66.49	577.90	175.20
Jacquard Neopaque® Undiluted	**5944.64**	**1832.02**	**1143.00**	**444.31**
Jacquard Neopaque® Diluted	2109.35	585.54	783.37	273.05

It can be seen from the results in Table 8 that all the painted samples have a higher flexural rigidity than the control samples by between 66.49% (Pebeo Setasilk® Red and Lightening Media on cotton) and 1832% (Jacquard Neopaque® Undiluted on cotton). This appears to be a significant difference in the change in flexural rigidity.

The undiluted Jacquard Neopaque® samples had the highest flexural rigidity for both cotton and silk. The Jacquard Neopaque® undiluted were the second highest flexural rigidity results for both cotton and silk. The Pebeo Setasilk® Red and Lightening Media mixture has the lowest flexural rigidity, or the least change from the control samples.

[79] Textiles and Clothing Standards Policy Committee, *BS 3356:1990 Method for Determination of Bending Length and Flexural Rigidity of Fabrics,'* BSI, 1990, p3.

In the majority of the results the Cotton samples have a higher flexural rigidity than the silk samples, however with the exception of the Jacquard Neopaque® undiluted and diluted the percentage change for the cotton samples is less than that for the silk. This is consistent with the control cotton sample having a higher flexural rigidity and this relates to the chemical structure of each fabric. Silk has weak secondary forces that allow the sheets, which make up the silk fibres to move along each other.[80] The Deka Silk® and the Pebeo Setasilk® Red/Lightening Media results both show a higher flexural rigidity for the silk samples than for the cotton samples, though the percentage change is lower for the cotton than the silk.

All paints tested were found to increase the flexural rigidity of the fabric being used for testing when compared to the unpainted fabric using the fixed angle flexometer. The different ranges affect the fabric differently as can be seen in the results above. The Jacquard Neopaque® was found to change both the cotton and the silk more than any of the other paints making it much more rigid. The combination of the Pebeo Setasilk® red with the lightening media in contrast was found to change the flexural rigidity the least for both the cotton and the silk samples when compared to the flexural rigidity of the control samples.

Diluting the Jacquard Neopaque® did reduce the change in flexural rigidity compared to undiluted samples. Therefore if any change in the flexibility of the support fabric is considered inappropriate, diluting any of the paints would be worth considering to reduce the change in flexural rigidity as much as possible. This decision would depend on the intended use of the painted fabric and as suggested in Section 1.9 this would depend on the handle of the object and the requirements of the support fabric in each individual case.

This change is also worth considering when evaluating the choice of fabric for the application of paint for support fabrics. It is important to know that the application of paint will affect the flexibility and handle of the fabric. This knowledge would not necessarily preclude the use of fabric paint on a support fabric, but may lead to discussion on the type of fabric to use if considering using paint. This may include using a fabric with a softer handle than required for the support so that when combined with

[80] Tímár-Balázsy and Eastop, (1998), 45.

the paint, which will add stiffness to the fabric, it would then provide the correct handle for the object.

It is also worth noting that the percentage change as outlined in Table 7 indicates that the change in the silk, with the exception of the two Jacquard Neopaque® sample types, when compared to the control is higher than the percentage change of the cotton. The Jacquard Neopaque® however shows that the cotton samples for both the diluted and undiluted show a much higher percentage change, approximately double, when compared to the change in the silk.

The test using the fixed angle flexometer is useful to provide a value for the change in flexibility of the fabric, however it is difficult to be able to compare a numerical value to the perception of change when the fabric is handled. The increase in flexural rigidity between the undiluted Jacquard Neopaque® and the unpainted samples may be very obvious when handling the fabric after it has been painted, while the change between the unpainted control and the Pebeo Setasilk® Red diluted with lightening media may not be perceptible when being handled. This is a limitation on the flexibility testing and where a more subjective test can be more useful than an objective test such as this one.

Subjectively all the samples were handled during the process of testing and it was possible to notice differences in some of the fabrics. On handling the undiluted Jacquard Neopaque® samples were obviously more rigid than the other samples. This fits with the previous experience of the paint being noticeable thicker mentioned in Section 5.3. This led to the samples for the wash fastness and light ageing tests being painted with a diluted version of the Jacquard Neopaque® paints.

The Pebeo SetaColour® Lightening Media on the other hand had a somewhat surprising result. During application this material felt thicker than the paint and it is therefore surprising to find that the mixture of the paint with the lightening media reduced the flexural rigidity compared to the undiluted paint. It was also unexpected that the results of this mixture increased the flexural rigidity of the silk samples to higher than the cotton samples. This was also true for the Deka Silk® paint however the control and the rest of the samples all show the cotton as having a higher flexural rigidity. When comparing the percentage increases the cotton for both the Pebeo Setasilk® and the Deka Silk® have a much lower percentage change than the other sample types, while the silk change is similar to the changes for the other sample types. This may be related

to how the paint was applied, or that because the cotton weighs more originally and therefore the percentage change is not as affected.

When comparing the samples through handling as stated the undiluted Jacquard Neopaque® was obviously less flexible than the control as well as the other samples. The diluted Jacquard Neopaque® was less rigid than the undiluted as the flexural testing results indicate, and this was also apparent when handling the samples. The Pebeo Setasilk® and Deka Silk® undiluted samples however were not as obviously different in handling when compared to the control as the numerical results might appear to indicate. This may indicate that a relatively large change in flexural rigidity needs to occur before the change becomes perceptible during handling and therefore handling of painted samples will provide as much information as the flexural rigidity test may. If a relatively rigid support was required then it would be reasonable to choose the Jacquard Neopaque® paints. On the other hand if minimal change is required then it is probably less important which paint is chosen than perhaps ensuring ease of colour matching.

The flexometer test samples, show the range of red tones between the three manufacturers tested, as well as how the tone can be changed by diluting the paint either with water or with the lightening media. This may be an important consideration when choosing to use paints for colouring support fabrics. As it is likely that a conservation studio would only have one range of paints the tones available as well as the number of colours available in one range may help when deciding on the paint range to choose when other factors do not affect the choice. As outlined in Table 1 the Deka Silk® range has the largest variety followed by the Pebeo Setasilk®.

Chapter 7: Evaluating Colour Change

This section will outline how colour change can be tested and evaluated in relation to the testing undertaken for this project.

It is important to be able to assess the change in colour between before testing and after testing for the wash fastness and light ageing testing undertaken. The change in colour between before and after ageing or wash fastness was evaluated by looking at the change in the colour values given by a chromameter.

A Minolta Chroma Meter CR-210 (Figure 9) was used to read the colour following the instructions for use outlined in the Chroma Meter Instruction Manual.[81] The colour was read using the L*a*b* colour space, also known as CIELAB. Figure 10 shows a diagrammatic rendition of the L*a*b* colour space where L* refers to Lightness (white to black), a* to the red-green direction, and b* to the yellow-blue direction.

Figure 9: Colourimeter

[81] Minolta, Chroma Meter CR-300/CR-310/CR-321/CR-331/CR-331C Instruction Manual, (Milton Keynes: Minolta Camera Co. Ltd, 1987).

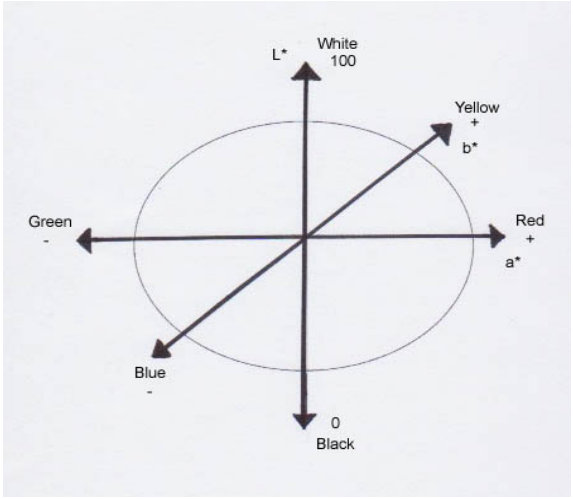

Figure 10: Diagram showing the CIELAB colour system.

The overall change in colour can be determined using the equation:

$$\Delta AE*_{ab} = \sqrt{(\Delta L*)^2 + (\Delta a*)^2 + (\Delta b*)^2}$$

This equation provides the overall size of the change however it does not state the way in which the colour has changed, such as lighter/darker or more green/more red. The most important aspect of this study is to see if there is a significant overall change, however it is also useful to know if the change is the colour becoming lighter or darker. Any significant change in the hue is also important as the more likely the colour is to change in any way the less it will be match the object colour and will become more visually intrusive when looking at the object.

A small amount of colour change may not be significant if it is not perceptible to the human eye. Several studies have indicated that a colour change of less than 2 $\Delta AE*_{ab}$ in the CIELAB range is not easily identified by human participants.[82] The colourimeter is more sensitive to change than the human eye and therefore any change perceived by the colourimeter may not be visual to visitors in a museum. The lighting in a museum is also significant with regards to colour change. In lower level lighting it may not be possible to see a change in colour in a higher level. As lower level lighting will also reduce the likelihood of change occurring it has been recommended to museums by conservation

[82] Clare Richardson and David Saunders, 'Acceptable Light Damage: A Preliminary Investigation,' in *Studies in Conservation,* 52:3 (2007), 184.

scientists to reduce the light levels in museums to a range of suggested standards depending on the materials present in the display.

The samples were examined for visual change under workshop lighting consisting of fluorescent bulbs and diffuse daylight through windows with blinds. This is in conjunction with the colourimeter as it is useful to identify if there is any perceptible change by human evaluation between the colour before and after the testing.

Chapter 8: Wash Fastness Testing

This section will outline wash fastness testing, the methodology, the results of testing, and a discussion of the significance of these results with regards to using fabric paints for textile conservation.

8.1 Introduction and Methodology

8.1.1 Introduction to Wash Fastness Testing

Wet cleaning will be undertaken to determine the colourfastness of the paints. This is important as if the paints are not colourfast they risk washing out of the support fabric if the object was washed in the future with the support fabric still attached. If the paints are not colourfast they may also transfer from the support fabric to the object where they are in contact. The wash fastness is also important when considering the possibility of a disaster such as flooding. An object may not be washed once a support is applied, even in future conservation intervention. It is however possible to recognise the risk that flooding may occur and if the support fabric is not colour fast in water this may cause significant damage to the object in the event of accident.

8.1.2 Sample Preparation

The paints were painted onto pieces of cotton and silk 8x8cm square (Figure 11). Due to the different manufacturers instructions it was decided to simplify the preparation of the samples. The samples were painted onto the fabric and left for 24 hours before being heat set using a conservation iron set to 90 degrees Celsius for 2.5 minutes each side (making a total of 5 minutes) through silicon release paper.

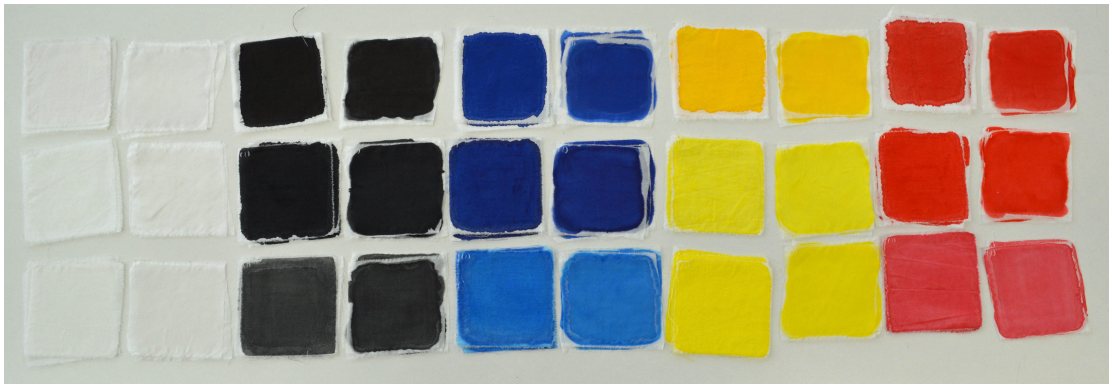

Figure 11: Samples Prepared for Wash Fastness Testing

Once the samples were prepared the colour was read using a colourimeter as outlined in Chapter 7: Evaluating Colour Change to get a base reading of the test colour.

8.1.3 Test Methodology

The samples were washed in soft water from the sink in the wet laboratory in a method similar to the procedure used when a textile conservator wet cleans an object.[83] It was decided to use only water rather than a detergent as silk and cotton usually use different types of detergent, anionic or non-ionic. It is possible that the addition of a detergent may change the wash-fastness for the paints and this may require further testing. Each sample was washed for 10 minutes in a bath of soft water while being lightly sponged on each side (Figure 12). The samples were then rinsed in one bath of soft water followed by a bath of deionised water. In conservation treatment where a detergent is used a larger number of wash baths would usually be required to remove the detergent completely, however as detergent was not used in this test it was decided that more rinse baths would not be necessary.

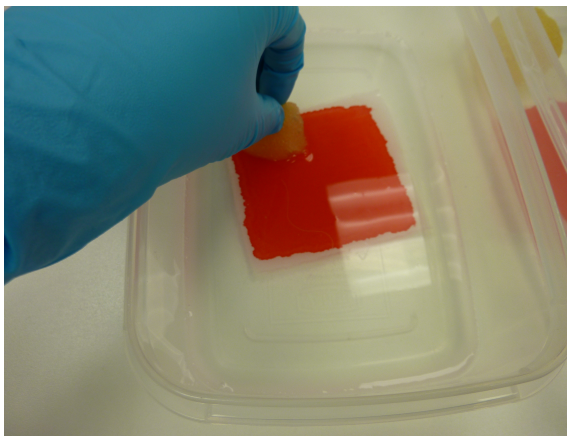

Figure 12: Sample during Wash Fastness Testing.

The samples were blotted with cotton calico to remove excess water and then air dried. The samples were then tested for any colour change using the colourimeter comparing the before and after readings (Chapter 7).

8.2 Results and Discussion

The following results outline the differences in colourimeter readings from before the wash fastness testing and after. As outlined in Chapter 7 the overall change in colour

[83] Tímár-Balázsy and Eastop, (1998), 255.

was calculated using the formula that combines the changes in the L*, a* and b* ranges in the CIELAB system.

The individual changes in L*, a* and b* averages in the CIELAB system were calculated by subtracting the average colour reading before testing from the average reading after testing as is done in the overall change formula, before they are added together.

The changes in the L*, a*, and b* show changes along different axes as seen in Figure 10 in Chapter 7. A positive change in L* value shows a lightening of the colour while a negative change shows darkening of the colour (i.e. movement along the axis from black to white or white to black). A positive change in the a* value is an increase in red while a negative change is a shift towards green. The b* value is more yellow if the change is positive while it is bluer if the change is negative.

Table 9: Average Changes in colour in the Deka Silk® Range

Deka Silk®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	-0.50	0.24	0.68	0.88
Red Cotton	-0.26	0.12	0.51	0.59
Yellow Silk	-0.35	0.33	-0.003	0.48
Yellow Cotton	-0.07	0.11	-0.42	0.44
Blue Silk	-0.38	0.31	-0.54	0.73
Blue Cotton	0.07	0.05	-0.07	**0.10**
Black Silk	-0.88	0.06	0.23	0.91
Black Cotton	-0.04	-0.04	0.17	0.18
White Silk	-0.25	0.09	0.03	0.27
White Cotton	-0.03	-0.04	0.26	0.26

Table 10: Average Changes in colour in the Pebeo Setasilk® Range

Pebeo Setasilk®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	-0.09	0.04	-0.10	0.14
Red Cotton	-0.09	0.40	-0.01	0.41
Yellow Silk	-0.18	0.04	-0.03	0.19
Yellow Cotton	0.01	0.06	-0.36	0.36
Blue Silk	-0.04	-0.27	0.17	0.32
Blue Cotton	-0.14	-0.01	-0.33	0.36
Black Silk	-0.68	0.10	-0.02	0.69
Black Cotton	-0.52	0.05	0.11	0.54
White Silk	-0.48	0.06	0.11	0.49
White Cotton	-0.09	0.05	-0.04	0.11

Table 11: Average Changes in colour in the Jacquard Neopaque® Range

Jacquard Neopaque®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	-0.19	0.16	0.07	0.25
Red Cotton	-0.09	0.20	0.09	0.24
Yellow Silk	-0.36	0.13	0.09	0.39
Yellow Cotton	-0.11	0.08	-0.13	0.18
Blue Silk	-0.72	-0.11	-0.58	**0.93**
Blue Cotton	-0.12	-0.05	-0.03	0.14
Black Silk	-0.82	0.12	0.11	0.84
Black Cotton	-0.21	0.02	0.10	0.24
White Silk	-0.30	0.04	0.06	0.31
White Cotton	-0.14	0.05	0.11	0.18

As shown in the above results there is minimal change in overall colour between the samples before and after the testing. The largest change in overall colour was the Jacquard Neopaque® Blue silk with an overall colour change of 0.93 (Table 11). The smallest change was the Deka Silk® Blue Cotton with an overall colour change of 0.10 (Table 9).

There is also minimal change in each of the CIELAB values with the majority of the changes in the L* value being towards black which indicates that the colour is slightly darker after testing. There are two exceptions the Deka Silk® Blue Cotton and the Pebeo Setasilk® Yellow Cotton. Both changes are very close to 0 (0.07 and 0.01 respectively). The changes in the a* and b* values show mixed results with the changes being insigificant for all values.

The wash fastness test results showed a minimal amount of change in colour with the most significant relative change being that of the Jacquard Neopaque® Blue Silk samples in Table 11 which had a mean overall change of 0.93. As previously stated in Chapter 7 previous research has been found that a change of colour greater than 2 is required to be observable by the human eye. This result is significantly lower than this value and it can therefore be considered that all changes in the colour through the wash fastness testing would be considered imperceptible. Therefore the changes are concluded to be an acceptable change.

With wash fastness testing it is also important to consider other aspects of the testing process. While the colourimeter readings show any change in colour it was also important to make observations through the washing process such as any perceptible colour loss or movement. The water in the different wash baths was observed closely at

the end of each washing procedure in order to ascertain if there was any colour loss that may have changed the colour of the water. Close observation of the water off each sample did not show any noticeable colour change to the water in the bath. This was a good indication that the paint was wash fast.

When painting the fabric samples an attempt was made at leaving an unpainted section at the edges of the sample. This was in order to be able to observe any movement of colour through the samples. With some of the samples this was difficult to achieve as the paints during the application process, and particularly on the silk samples had a tendency to be drawn outward through the fibres leaving a feathered edge along the painted area. This meant that observation of any bleeding of the paint in the fibre was more difficult to achieve. However the areas left unpainted on all samples showed no obvious sign of paint movement as far as it was possible to tell. This along with no perceptible change in the colour of the water during the washing process as well as the results of the colourimeter readings indicate that there was little or no movement of the paints during the washing fastness testing.

From the results of the wash fastness testing where there was no significant difference between the results of the three manufacturers it would appear that all three paint ranges are wash fast on both cotton and silk and therefore are unlikely to be problematic in the event of coming into contact with water, either with regards to further conservation treatment or in the event of flooding. There does not appear to be any one range that would be preferable to the others in terms of wash fastness. There also does not seem to be a significant difference between the paints when used on either the cotton or the silk.

Chapter 9: Light Ageing

This section will introduce testing of samples using light ageing, the methodology, and a discussion of the results with regards to the choice of fabric paints for use in textile conservation.

9.1 Introduction and Mathodology

9.1.1 Introduction to Light Ageing

Accelerated light ageing was undertaken to evaluate the paints for their fading potential when exposed to a light source, which mimics the lighting recommended for a museum environment. Accelerated ageing is used in order to gain understanding of the changes in colour expected over a long period of time while allowing the testing period to remain manageable. Fading is important as it changes the visual appearance of the support as well as being an indication that degradation is occurring as the colour change can indicate changes to the chemical structure of the material.

9.1.1 Sample Preparation

The paints were again painted onto pieces of cotton and silk 6.5x6.5cm in size and heat set using an iron as outlined above shown in Figure 13.

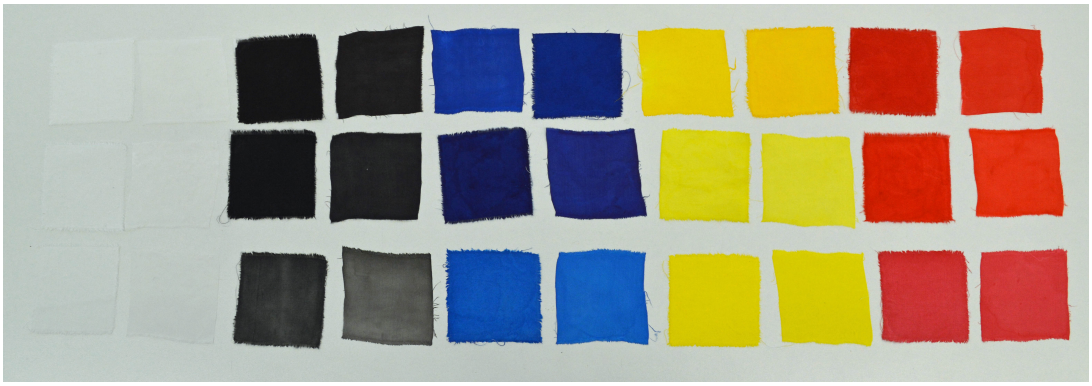

Figure 13: Samples Prepared for Light Ageing

Once the samples were prepared the colour was read using a colourimeter to get a base reading of the test colour as outlined in Chapter 7.

The samples were stitched to a piece of cotton shaped to the size of the test area in the chamber of the light ageing machine. This ensured that the samples would not move around in the chamber during the testing as a fan blows through the chamber to help control the temperature in the test chamber.

9.1.2 Test Methodology

The samples were placed in the chamber of the Q-Sun Xenon Test Chamber light ageing machine (Figure 14). A Blue Wool Standard was also placed in the chamber as a visual confirmation that the light in the chamber would fade a sample expected to fade when exposed to the light in this test. Blue Wool Standards 2,3, and 4 were used during testing.

Figure 14: Samples in Q-Sun Light Ageing Testing Chamber.

The lamp in the Q-Sun emits light at 142000 lux. A filter was installed in the Q-Sun to simulate light through glass. The samples were exposed to light in the testing chamber for a continuous period of 30.4 hours, for a total lux hours of 4320000. It was estimated that for 360 days per year with 8 hours or light per day at 150 lux an object would be exposed to 432000 lux hours per year. Thus 4320000 lux hours is equivalent to ten years of light.[84]

It was decided not to turn the samples during the light ageing as the paint was applied to only one side of the fabric. In conservation when paint is used as part of a support for an object only the painted side of the fabric is likely to be exposed to light when on display with the reverse of the support fabric most likely either against a display board or inside a 3-dimensional object.

The samples were then tested using the colourimeter as outlined in Chapter 7 to compare with the original colour.

[84] Personal Correspondence with Phillippa Duffus

9.2 Results and Discussion

The Blue Wool Standards 1 and 2 placed in the light ageing chamber as outlined in Section 9.1.2 were significantly faded. The Blue Wool Standard 4 was only slightly faded. This is consistent with what would be expected of the Blue Wool Standards in the period of time represented by the accelerated ageing period as outlined in section 9.1.2.

The changes in the light ageing results were calculated in the same way as the wash fastness test results using the formula from Chapter 7 and the same calculation for the L* a*, and b* values.

Table 12: A selection of average before readings with standard deviations

	L* Average Before	L* Standard Deviation	a* Average Before	a* Standard Deviation	b* Average Before	b* Standard Deviation
Deka Silk® Yellow Silk	85.52	0.49	4.36	2.60	96.81	2.18
Deka Silk® Yellow Cotton	82.15	0.22	12.26	0.39	102.08	0.13
Deka Silk® Blue Silk	36.68	1.28	15.80	0.92	-46.74	0.99
Deka Silk® White Silk	95.52	0.04	-0.06	0.03	3.43	0.03
Pebeo Setasilk® Red Silk	55.90	0.53	60.76	1.61	37.92	2.97
Pebeo Setasilk® Black Cotton	23.13	0.25	0.89	0.12	0.30	0.17
Jacquard Neopaque® Blue Cotton	43.79	1.59	5.82	1.19	-46.32	0.75
Jacquard Neopaque® Black Silk	48.14	9.93	0.83	0.06	2.56	1.07
Jacquard Neopaque® Black Cotton	37.00	1.85	0.97	0.07	1.46	0.06
Jacquard Neopaque® White Silk	95.40	0.14	-0.01	0.04	3.40	0.03

Table 12 highlights a selection of average colourimetric readings taken before testing with the standard deviation to show that some have significant standard deviations, which may affect the results. The full results can be seen in Appendix 5.

Table 13: Average Changes in colour in the Deka Silk® Range

Deka Silk®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	-0.20	-0.37	-0.23	0.47
Red Cotton	-0.05	-0.42	-0.43	0.60
Yellow Silk	**-0.17**	**0.52**	**-1.12**	**1.25**
Yellow Cotton	**-0.41**	**0.28**	**-1.21**	**1.31**
Blue Silk	**0.47**	**-0.70**	**0.70**	**1.10**
Blue Cotton	0.27	-0.62	0.72	0.99
Black Silk	-0.13	0.07	0.25	0.29
Black Cotton	0.27	-0.06	0.05	0.28
White Silk	-0.11	-0.02	0.16	0.20
White Cotton	0.10	0.26	0.06	0.28

Table 14: Average Changes in colour in the Pebeo Setasilk® Range

Pebeo Setasilk®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	**-0.31**	**0.76**	**1.55**	**1.76**
Red Cotton	-0.01	-0.18	-0.56	0.59
Yellow Silk	-0.29	0.41	-0.46	0.68
Yellow Cotton	-0.20	0.69	0.49	0.87
Blue Silk	0.03	-0.65	0.54	0.84
Blue Cotton	0.26	-0.65	0.17	0.72
Black Silk	0.20	0.11	0.11	0.26
Black Cotton	0.03	0.13	0.13	0.19
White Silk	-0.16	0.22	0.87	0.91
White Cotton	-0.14	0.26	0.57	0.64

Table 15: Average Changes in colour in the Jacquard Neopaque® Range

Jacquard Neopaque®	L* Average Change	a* Average Change	b* Average Change	Overall Change
Red Silk	-0.10	-0.53	-0.31	0.62
Red Cotton	0.14	-0.25	-0.36	0.46
Yellow Silk	-0.10	0.65	-0.38	0.75
Yellow Cotton	0.07	0.38	-0.46	0.60
Blue Silk	0.08	-0.26	0.83	0.87
Blue Cotton	**0.19**	**-0.66**	**0.98**	**1.20**
Black Silk	-0.02	0.11	0.21	0.24
Black Cotton	0.07	-0.01	0.00	0.07
White Silk	-0.06	0.07	0.24	0.25
White Cotton	-0.003	0.40	-0.22	0.46

The average overall change for each paint varies in range from 0.07 for the Jacquard Neopaque® Black Cotton (Table 15) to 1.76 for the Pebeo Setasilk® Red Silk (Table 14).

The L* value has a mixed result between darkening and lightening across all three paint ranges. This indicates that some paints have darkened during the light ageing. The a* and b* values are also a mixture of movement in both directions along the axes.

The results of the light ageing test are all found to be less than what is identified as a visibly perceptive change outlined in Chapter 7. There were a small number of paints that while below the visible change had a higher change in colour than the majority and it is important to consider these samples in order to determine whether they may affect the outcome when choosing paints to use. While the results were evaluated using the colourimeter the samples were also observed to see if any visual difference in the samples could be detected. This was the subjective view of only one person; however there appeared to be no visible difference in any of the colours after the ageing when compared to samples before.

The time in the ageing oven is equivalent to approximately 10 years of light exposure of daylight through glass at 150 lux for approximately 12 hours a day for 360 days (taking into consideration that most museums are closed for several days in the year such as Christmas Day).[85] The amount of time a textile is on display for is different depending on the museum. While some exhibitions may last for three months other exhibitions may last for 20 years. This usually depends on the museum and the resources available to the museum, such as conservation staff. Special exhibitions are often approximately three months in length, while permanent exhibitions are often planned for a change in ten years. This length of time is chosen for a number of reasons, including resources, the stress on the objects on display, and visitor requirements. Alongside this the equivalent of 10 years in the accelerated ageing chambers was calculated to just over 30 hours, which was felt to be a manageable time for the number of samples and the limited space in the light ageing chamber.

As stated previously the light ageing equipment had a filter allowing it to imitate light filtered through glass. Direct sunlight without the UV filtration that glass provides would likely cause fading of the colours faster than the light with the UV filtered. Different light sources can also change the speed of degradation and fading of an object depending on the amount of heat emitted from the light as well as the amount of UV the light emits.

[85] Personal Correspondance with Phillippa Duffus

These differences between different museum environments must be taken into consideration when choosing whether the use the paints, as it would be for dyed supports as well. If a museum has lower lux levels in the gallery than it should be taken that a change in colour will occur more slowly than in this case. Conversely a museum with higher lux levels will find fading occurs more rapidly. This also depends on the UV levels found in the light sources present in the museum.

It is important to note that in some cases the colours show results that indicate darkening of the paints in the L* axis during the light ageing and this could be significant as darkening will affect the visual impact as well as fading of painted infills. The reason for this darkening is difficult to identify as there does not appear to be much literature on ageing of paints causing them to become darker. While in general ageing darkening could be due to an accumulation of dirt this cannot be the reason here. The most likely cause of the change is a change in the chemical structure of the paints, similar to what causes paints to fade.[86] These changes however were minimal, and therefore unlikely to cause visual impact over the time period the testing is equivalent to. It is interesting to see that some colours do react differently in the light ageing test.

While fading of colours is significant when it becomes perceptible because it affects how people viewing it see the object, for example the patch may become more obvious if the colours change (either darker or lighter) it is also a sign that the fabric is deteriorating. This is something that is impossible to avoid completely, however it is important to use materials that degrade as slowly as possible, as well as trying to control the environment in order to reduce the rate of deterioration. Deterioration will be occurring even if there is no visual impact. However as just mentioned it is not possible to completely prevent deterioration, the rate of colour change is a good indication of the speed of deterioration of the material. It is also important to evaluate what is an acceptable rate of deterioration for use in a museum. If the material degrades so quickly that for example the colour loss is apparent after just a few months this would be unlikely to be considered an appropriate material to use. If it takes ten years for degradation to be noticeable this may also be considered inappropriate, but it depends on a number of factors including what the material is being used for.

[86] Robert L. Feller, 'Studies on the Darkening of Vermilion by Light,' in *Contributions to Conservation: A Collection of Robert Feller's Published Studies on Artists' Paints, Paper, and Varnishes,* (Pittsburgh: Carnegie Mellon University Press, 2002), 163.

With the exception of a very few the results from all three paint ranges appear to have little significant difference and as the colour change is not significant it would follow that any of the ranges may be used in textile conservation for use on support fabrics with regards to fading in light.

As mentioned above the largest overall change in colour appears to be the Pebeo Setasilk® red silk, which had an overall change of 1.76. The other colours above a value of 1 were the Deka Silk® yellow silk, the Deka Silk® yellow cotton, the Deka Silk® blue silk, and the Jacquard Neopaque® blue cotton samples, shown in bold in Tables 13, 14, and 15. While these colours fall below what is considered the visible range it is still useful to examine them to evaluate if this change is significant in terms of long term use, or if there are other reasons for this apparent change. As such the initial readings were evaluated and some of the significant readings were noted in Table 12. This table outlines the colours with the highest overall change as well as the colours with the lowest overall range. The significant difference between them appears to be that the colours with an apparent overall change in colour also show some high standard deviation in the initial colour readings between the three samples with one sample being significantly different to the other two or a wider range between the three samples than would be preferred.

Sample preparation therefore may account for some aberrations in the overall colour change. Although the samples were prepared at the same time in an attempt to ensure that the samples were prepared in the same conditions it is still difficult to ensure that all samples were prepared to ensure as similar final colours as possible. In a number of samples as the initial colour was slightly different to other samples however it is noted that the change in colour in each individual sample remained the same it is possible that the disparity between the colours affected the overall result. This does not seem to have affected the results significantly but must be factored in when assessing the colours for light fastness.

This difficulty in colour matching is one of the difficulties outlined originally in section 1.9, though that related more to matching a mixture of different colours the application process also appears to have limitations that can cause changes in colour. In this case the changes were reasonably small, but large enough to create a false result in the average overall colours change.

As with the wash fastness testing there does not appear to be any significant difference in the light fastness of the paints when comparing the cotton and the silk samples of each colour. The differences in the overall change in colour were small when comparing the same colour on the two different grounds. Neither the silk or the cotton were found to have a consistently higher change between the before and after colourimeter readings, rather in some cases the change in the silk was slightly higher while for other colours in each range the cotton had the higher change.

Chapter 10: Further Research

This section provides some suggestions for further research based on the results of the research and testing in this project.

These paints were chosen based on the literature, however as shown in Kaldany, Berman and Sigurdardottir's paper there are a number of other paints used in textile conservation.[87] It would be useful to be able to test a wider range as was undertaken in that study. This would be useful both in ensuring that the paints tested in that project and other paints that have now come into use are suitable for use in conservation.

Further Oddy testing would be worth considering as outlined in the discussion above, allowing a longer curing time as well as using prepared samples on fabric for the Oddy test. This would be worthwhile not just for the Pebeo Setasilk® range but also for the other paint samples.

During this project testing the paints in a range of environments, particularly changes in relative humidity was investigated, however it was found that effective testing of relative humidity would require a longer period of time and therefore meaningful results could not be obtained in the scope of this project. It was concluded that the testing undertaken would provide more significant results. Therefore a project in which the paints could be tested through a cyclical change in relative humidity would be considered worthwhile further testing in order to evaluate any significance that changes in relative humidity might have on the paints. This may include drying and cracking of the paint surface in low relative humidity.

It may also be useful to undertake a longer test of the paints in a light ageing chamber. While ten years under accelerated ageing conditions was considered a useful and practical length of time to test in this project further testing for longer periods might be considered to be worthwhile. It may also be useful to test the fabric paints alongside other fabric colouring options, in particular the dyes commonly used in conservation in order to compare the ageing properties of each.

As outlined in section 5.3 all paints were prepared in the same way, allowing them to dry for 24 hours before being heat set. Research into different methods of preparing the

[87] Kaldany, Berman, and Sigurdardottir, (1999).

samples would be useful to ensure the best preparation method for longevity of the paint. It would be useful to know if less than 24 hours was enough to dry the paints before heat setting while still maintaining that they are wash fast and light fast. Different heat settings and times may also be useful to know.

Chapter 11: Conclusion

This project intended to gain understanding of the knowledge of how fabric paints age in order to assess them for use in textile conservation, specifically for infilling loss. To achieve this aim it was intended to perform wash fastness and light ageing tests, as well as an Oddy test for volatile materials to see how the paints reacted in different environments. These tests were designed to ensure that the paints are unlikely to contain materials that could accelerate degradation in the object, that they are colour fast and they will not transfer colour onto the object in the presence of water. Fading was also an important consideration as a sign of degradation as well as something that affects the aesthetics of the object.

All three of the paint ranges that were tested produced a range of results with some faring better in one test than another. The Pebeo Setasilk® range did not perform as well in the Oddy test as the other two ranges did. All the paints performed reasonably well in the wash fastness and the light ageing, with the main issue being as discussed above explained by the differences in colour samples. The changes between the before and after colourimeter readings are small enough to be considered non-significant and therefore appropriate for use in textile conservation.

The most significant result from the testing is the Pebeo Setasilk® range results in the Oddy test. While the differences in the colour changes in the wash fastness and light ageing are within acceptable limits, and the flexibility testing is significant in terms of understanding some of the working properties when choosing the paint to use the Oddy test results suggest that paints other than the Pebeo Setasilk® range should be used in textile conservation.

In general the paints were relatively easy to use and apply to the fabric when preparing the samples. The process of painting and heat setting them was straight forward and from the results of the testing the paints were both wash fast and light fast within the acceptable range. The process of application is not as time consuming as dyeing fabric, however it could not be considered a quick process. As already mentioned trialling different times for the preparation of the paints may show that they can be prepared in much less time and therefore become even more useful when working under tight deadlines.

It is useful to have different materials for use in conservation that are known to be safe to use. It is particularly useful to have several options for a treatment, such as in this case colouring support fabrics, to choose from in order to choose the most appropriate for the object and the treatment. The fabric paints appear to be a good alternative to dyes for a number of reasons, as outlined in section 1.9. This project provides some information on the working and ageing properties of these fabric paints hopefully allowing the conservator to make an informed decision on when to use a fabric paint and whether the fabric paint will or will not harm the object over time. It would appear that of these particular fabric paints the Jacquard Neopaque® and the Deka Silk® ranges are suitable for use, while caution should be taken when considering the Pebeo Setasilk® range based on the results of the Oddy test.

As shown in the results of both the wash fastness and the light ageing tests there was no evidence that the paints work better on one type of fabric when compared to the other. This is useful to know when considering whether to use the paints on either type of fabric. The more significant comparison is the flexibility test, which showed that the application of paint to either the cotton or the silk increases the rigidity of the paint. This showed that in the majority of the samples the silk had a higher change in flexural rigidity than the cotton did, and this may affect either the decision to use the paints with the silk or whether the application of the paints onto silk may need diluting more than the paints when applied to cotton.

It may be useful to have more than one set of fabric paints available for use, as seen the tones of the colours can be different across the different manufacturers. This is not always practical however and therefore the conservator may simply chose a range based on personal preference. Mixing across the different paint ranges may be possible, though when considering the difference in fluidity between the Deka Silk® and the Jacquard Neopaque® for instance this might prevent the paints from easily mixing and it would be preferable to use only one range when mixing the correct colour for use on a support fabric.

The testing undertaken in this project has provided some information on properties of interest to textile conservators in terms of handling, colour fastness and the presence of volatile materials in the paints tested. It is hoped that the information can then be used to make decisions both on whether paints are used as well as which to use when assessing an object for treatment.

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Appendix A: List of Materials and Suppliers

Table A.1: List of Materials and Suppliers

Materials	Suppliers
Paints	George Weil & Sons Old Portsmouth Road Peasmarsh Guildford GU3 1LZ https://www.georgeweil.com/Default.aspx
Fabrics	Whaleys (Bradford) Ltd Harris Court Great Horton Bradford BD7 4EQ http://www.whaleys-bradford.ltd.uk/
Plastazote®	Paulamar Company Ltd Woodilee Industrial Estate Woodilee Road Kirkintilloch Glasgow G66 3TU http://www.paulamar.co.uk/default.aspx
Melinex	Preservation Equipment Ltd Vinces Road Diss Norfolk IP22 4HQ http://www.preservationequipment.com/Home
Metal Coupons (Oddy Test)	Fisher Scientific UK Ltd Bishop Meadow Road Loughborough LE11 5RG http://www.fisher.co.uk/
Acetone	Sigma-Aldrich Company Ltd The Old Brickyard New Road Gillingham Dorset SP8 4XT http://www.sigmaaldrich.com/united-kingdom.html

Appendix B: Paint MSTANDARD DEVIATIONS

SAFETY DATA SHEET (REGULATION (EC) No 1907/2006 - REACH) Version 5.1 (10/11/2010) - Page 1/4
Name: Setasilk : toutes couleurs / all colours - 181002

SAFETY DATA SHEET

Company: PEBEO S A

1 - IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Identification of the substance or preparation:
Name: Setasilk : toutes couleurs / all colours.
Product code: 181002.

Company/undertaking identification:
Registered company name: PEBEO S A.
Address: 305 AVENUE DU PIC DE BERTAGNE - BP106 -.13881.GEMENOS CEDEX.FRANCE.
Telephone: 33 (0) 4.42.32.08.08. Fax: 33 (0) 4.42.32.01.70.
cdedeyne@pebeo.com
www.pebeo.com

Emergency telephone: 33 (0) 1.45.42.59.59.
Association/Organisation: INRS / ORFILA http://www.centres-antipoison.net.

Use of the substance/preparation:
Paints & Varnishes for artists

2 - HAZARDS IDENTIFICATION
This product is not classified as flammable. Refer to the recommendations regarding the other products present on the site
This preparation is not classified as hazardous to health by directive 1999/45/EC.

3 - COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous substances present on their own:
(present in the preparation at a sufficient concentration to give it the toxicological characteristics it would have in a 100% pure
state)
This preparation contains no hazardous substance in this category.

Other substances representing a hazard:
No known substance in this category present.

Substances present at a concentration below the minimum danger threshold:
No known substance in this category present.

Other substances with occupational exposure limits:
No known substance in this category present.

4 - FIRST AID MEASURES
As a general rule, in case of doubt or if symptoms persist, always call a doctor.
NEVER induce swallowing in an unconscious person.

In the event of splashes or contact with eyes:
Wash thoroughly with soft, clean water for 15 minutes holding the eyelids open.
Refer the patient to an ophthalmologist, in particular if there is any redness, pain or visual impairment.

In the event of splashes or contact with skin:
Remove contaminated clothing and wash the skin thoroughly with soap and water or a recognised cleaner.
DO NOT use solvents or thinners.

In the event of swallowing:
In the event of swallowing, if the quantity is small (no more than one mouthful), rinse the mouth with water and consult a
doctor.
If swallowed accidentally, call a doctor to assess the need for monitoring and subsequent treatment in hospital. Show him the
label.

- Made under licence of European Label System® MSTANDARD DEVIATIONS software from InfoDyne - http://www.infodyne.fr -

SAFETY DATA SHEET (REGULATION (EC) No 1907/2006 - REACH) Name: Setasilk : toutes couleurs / all colours - 181002

5 - FIRE-FIGHTING MEASURES
Not relevant.

6 - ACCIDENTAL RELEASE MEASURES Personal precautions:
Consult the safety measures listed under headings 7 and 8.

Environmental precautions:

Contain and control the leaks or spills with non-combustible absorbent materials such as sand, earth, vermiculite, diatomaceous earth in drums for waste disposal.
Prevent any material from entering drains or waterways.

Methods for cleaning up:
Clean preferably with a detergent, do not use solvents.

7 - HANDLING AND STORAGE
The regulations relating to storage premises apply to workshops where the product is handled.

Fire prevention:
Prevent access by unauthorised personnel.

8 - EXPOSURE CONTROLS/PERSONAL PROTECTION
Use personal protection equipment as per Directive 89/686/EEC.
Technical measures:
Personnel shall wear regularly laundered overalls.
Respiratory protection:
Anti-gas filters :
Hand protection:
Type of gloves recommended :

- - Butyl rubber
- - Neoprene

9 - PHYSICAL AND CHEMICAL PROPERTIES General information:
Physical state:
Important health, safety and environmental information:
pH of the substance or preparation:
When a pH measure is possible, it has a value of: Boiling point/boiling range:
Flash point interval:
Vapour pressure:
Density:
Water solubility:
Other information:
melting point/melting range:
Self-ignition temperature:
Decomposition point/decomposition range : VOC (g/l):
fluid liquid
slightly basic.
9.00 .
not relevant.
not relevant.
Below 110 kPa (1.10 bar). > 1
Dilutable.
not relevant. not relevant. not relevant. 14.28
- Made under licence of European Label System® MSTANDARD DEVIATIONS software from InfoDyne - http://www.infodyne.fr -

10 - STABILITY AND REACTIVITY
The preparation is stable at the handling and storage conditions recommended per § 7 of the safety data sheet,
11 - TOXICOLOGICAL INFORMATION
The preparation contains no substance classified as hazardous per directive 67/548/EEC.
No data is available regarding the preparation itself.
Splashes in the eyes may cause irritation and reversible damage
12 - ECOLOGICAL INFORMATION
No ecological data on the product itself is available.
13 - DISPOSAL CONSIDERATIONS
Do not pour into drains or waterways.
Waste:
Recycle or dispose of waste in compliance with current legislation, preferably via a certified collector or company.
Do not contaminate the ground or water with waste, do not dispose of waste into the environment.
Soiled packaging:
Empty container completely. Keep label(s) on container.
Give to a certified disposal contractor.
Codes of wastes (Decision 2001/573/EC, Directive 2006/12/EEC, Directive 94/31/EEC on hazardous waste) :
20 01 27 * paint, inks, adhesives and resins containing dangerous substances
15 01 02 plastic packaging
14 - TRANSPORT INFORMATION
Exempt from transport classification and labelling.
Transport product in compliance with provisions of the ADR for road, RID for rail, IMDG for sea and ICAO/IATA for air
transport (ADR 2009 - IMDG 2008 - ICAO/IATA 2009).
15 - REGULATORY INFORMATION
This preparation is not classified as hazardous to health by directive 1999/45/EC.
This product is not classified as flammable.
Classification by:
So called 'all preparations' Directive 1999/45/EC and its adaptations.
EC regulation 1272/2008 (CLP) and its adaptations (EC regulation 790/2009).
Particular provisions:
NFPA 704 Label: Health=0 Flammability=1 Instability=1 Special Hazards=none
1
16 - OTHER INFORMATION
Since the user's working conditions are not known by us, the information supplied on this safety data sheet is based on our current level of knowledge and on national and community regulations.
The product must not be used for any purposes other than those specified under heading 1 without first obtaining written handling instructions.

It is at all times the responsibility of the user to take all necessary measures to comply with legal requirements and local regulations.
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The information given on this safety data sheet must be regarded as a description of the safety requirements relating to our product and not a guarantee of its properties
Full text of risk phrases appearing in section 3:

Difference Report

Revision: N°5 (10/11/2010) / Version: N°1 (10/11/2010) Revision: N°4 (04/02/2009) / Version: N°2 (09/06/2009)
9 - PHYSICAL AND CHEMICAL PROPERTIES Other information:
VOC (g/l):
melting point/melting range:
Self-ignition temperature:
Decomposition point/decomposition range : VOC (g/l):
Important health, safety and environmental information:
Boiling point/boiling range:
14.19
13 - DISPOSAL CONSIDERATIONS
Codes of wastes (Decision 2001/573/EC, Directive 2006/12/EEC, Directive 94/31/EEC on hazardous waste) :
08 01 11 * waste paint and varnish containing organic solvents or other dangerous substances 20 01 27 * paint, inks, adhesives and resins containing dangerous substances
15 01 02 plastic packaging
15 - REGULATORY INFORMATION
This preparation was classified in compliance with the directive known as <All preparations> 1999/45/EC and its adaptations
In addition directive 2008/58/EC with the 30° adaptation of directive 67/548/EEC (Hazardous substances) has been taken into account.
Classification by:
So called 'all preparations' Directive 1999/45/EC and its adaptations.
EC regulation 1272/2008 (CLP) and its adaptations (EC regulation 790/2009).
not relevant. not relevant. not relevant. 14.28
not relevant.
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MSTANDARD DEVIATIONS MATERIAL SAFETY DATA SHEET
RUPERT, GIBBON & SPIDER PO BOX 425, HEALDSBURG CA, 95448 TEL: (707) 433-9577 FAX: (707) 433-4906
Lumiere/Neopaque
MSTANDARD DEVIATIONS No: All Colors **Date:** 09/16/10

1. **Product Identification Product Code: All Colors**
2. **Composition/Information on Ingredients**
3. **Physical & Chemical Characteristics Boiling Point: 212 F**
   Vapor Pressure: 68 F
   Vapor Density: <1 water
   Solubility in Water: Dilutable
   Appearance & Odor: Colored liquids with a mild odor Specific Gravity: 1-1.5
   Melting Point: N/A
   Evaporation Rate: <1 H2O
4. **Fire & Explosion Data**
   Flash Point: Non-combustible
   Auto Ignition: N/A
   Extinguishing Media: N/A
   Special Fire Procedures: Material can splatter above 212 F. Polymer film can burn
   Unusual Hazards: N/A
5. **Reactivity Data Stable: Stable**
   Conditions to Avoid: N/A Incompatibility: N/A
   Hazardous Decomposition: N/A Hazardous Polymerization: Will not occur
6. **Health Hazards**
   Routes of Entry: Eyes, skin, ingestion and inhalation
   Acute: May be irritating to the eyes and skin. Vapor or mist spray can cause headache, nausea and nose irritation.
   Chronic: N/A
   Signs & Symptoms of Exposure: N/A
   Medical Conditions Aggravated: N/A
   Carcinogenic: Formaldehyde and trace amounts of acrylic monomers. Listed hazard values refer only to Formaldehyde in its gaseous form. These liquid paints contain the dissolved form.

Ingredients	%	ACGTH-TLV	OSHA-PEL	CAS No.
Formaldehyde	0.12-0.18	1 C ppm	1.0	50-00-0
Acrylic Polymers	25-30	NE	NE	N/A
Residual Monomers	<0.1	NR	NR	N/A

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7. **Emergency & First Aid Procedures**
   Inhalation: Move victim to fresh air.
   Eyes: Flush eyes with large amounts of water for at least 15 minutes. If irritation persists get medical attention.
   Skin: Wash affected areas with soap and water. If irritation persists get medical attention.
   Ingestion: Give 1-2 glasses of water or milk. Consult a physician. Never give anything by mouth to an unconscious person.
8. **Special Precautions & Spill/Leak Procedures**
   Handling & Storage: Keep from freezing. Product may coagulate. Keep containers tightly closed. Store in a cool place out of reach of children.
   Steps if Spilled: Keep spectators away. Floor may be slippery; use care to avoid falling. Dike and contain spill with inert material (sand, earth, absorbents). Transfer liquid to containers for recovery or disposal and solid diking material to separate containers for disposal. Keep large spills and cleaning runoffs out of municipal sewers and open bodies of water. Keep spill areas well ventilated.
   Waste Disposal: Allow paint to dry and dispose of dried paint in regular trash. Dispose of wet material in accordance with all state, local and federal regulations.
9. **Special Protection Information**
   Respiratory Protection: None required if good ventilation is maintained. Wear a NIOSH approved dust respirator suitable for concentrations and types of air contaminants encountered.

Ventilation: Mechanical local exhaust ventilation
Protective Gloves: Impervious rubber or plastic gloves
Eye Protection: Chemical splash goggles
Other Protection: N/A
Work/Hygienic Practices: N/A
Notice to Reader
The information contained in this MSTANDARD DEVIATIONS is based on data from sources considered to be reliable but Rupert, Gibbon & Spider Inc. does not guarantee the accuracy or completeness thereof. Rupert, Gibbon & Spider Inc. urges each customer or recipient of this MSTANDARD DEVIATIONS to study it carefully to become aware of and understand the hazards associated with this product. The reader should consider consulting reference works or individuals who are experts in ventilation, toxicology or fire and understand the data in this MSTANDARD DEVIATIONS.

1. Identification of substance

Trade name:	DEKA-Silk, different shades, nos. 35-00 to 35-92
Use:	Fabric paint, silk ink
Manufacturer:	DEKA Textilfarben GmbH Kapellenstraße 18 D-82008 Unterhaching Germany Phone: ++ 49 / (0) 89 / 66 50 64 - 0 Fax: ++ 49 / (0) 89 / 611 76 51 e-mail: info@deka-farben.de

2.Hazards identification

The product is not a dangerous preparation on the basis of the data on hand in accordance with the chemical law and EC guidelines.

**3. Composition / information on ingredients*

Preparation, polyacrylate copolymer, water, inorganic and organic pigments

**4. First aid measures*

Skin contact:	Instantly wash with water and soap and rinse thoroughly.
Eye contact:	Rinse opened eye for several minutes under running water.
Swallowing:	Rinse oropharynx with water. Do not induce vomit.
Inhalation:	Supply fresh air.
General information:	If complaints continue for a longer time consult doctor or eye doctor.

**5. Fire fighting measures*

Suitable fire-extinguisher:	Damp fog, extinguishing foam, carbon dioxide, extinguishing powder, sand
Unsuitable fire-extinguisher:	Strong jet of water to avoid container damage.

The paint will feed fire after evaporation of water and create fumes and gases, like carbon monoxide, nitrogen oxides. While no special procedures are required for this product, fire-fighters should be equipped with self-contained breathing apparatus to protect against potentially toxic and irritating fumes.

**6. Accidental release measures*

Personal precautions:	Ink makes slippery with water. Avoid eye and skin contact
Environmental precautions:	Do not allow paint to reach sewage system or water bodies.
Methods of cleaning up:	Absorb ink with liquid absorbent material like sand, sawdust, and universal binder. Clean up small amounts with cloth and dispose in accordance with local regulations.

**7. Handling and storage*

Handling:	Ensure fresh air at the workplace like open window, ventilation. Handle the paint with care and appropriate rules (TRGS 500).
Storage:	Keep container tightly closed. Keep away from food and luxury stimulants. Keep away from heat and frost. VCI store class 12, non flammable liquids.

**8. Exposure controls and personal protection*

General:	Avoid eye and skin contact. Ensure fresh air.
Hygiene:	Remove any soiled and impregnated garments, clean with cold water and soap. Before brake and after days work wash hands with water and soap. During working do not eat, drink, smoke or take snuff.

Protective cloth is for artist work, painting normally not required.

Hands:	If occasion arises wear protective gloves, rubber, like nitrile, polycloroprene, (CR), PVC; notice information of supplier, also for penetrating times.
Eyes:	None normally required, if occasion arises wear protective goggles.
Respiration:	None normally required, if occasion arises wear NIOSH approved mask aerosols, particles, organic, (combination filter: A, B, E, K, P).
Airbrushing:	Never brush against persons and faces. Provide good ventilation or use NIOSH approved mask. Use protective cloth.

9. Physical and chemical properties

Form:	liquid
Colour:	different shades
Odour:	not characteristic
Boiling Point:	100°C, water
Vapour pressure:	23hPa, water
Density, 20°C:	~1,01 g/ml, different shades
Water solubility:	miscible
pH-value, 20°C:	8-9
Flash point:	n.d.a.
Self inflammable:	n.a.
Danger of explosion:	n.a.

10. Stability and reactivity

Stability: Stable, if used according to specifications.
Reactivity: Stable, if used according to specifications.
Hazardous decomposition products: None, if used according to specifications.

11. Toxicological information

There are no data of the ready preparation available.
LD50° > 2000 mg/kg
° preparation, raw materials

Information from practical use

When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us. University Uppsala (S); G. Wieslander, S. Norback, C. Edling: Polymer Paint Col. J. 184 (4357), 448 (19084)

Eye contact: May cause moderate irritation and paste up eyelids.

**12. Ecological information*

Long years experience indicates that the paint does not cause significant environmental effects. There are no data of the ready preparation available. Keep out of soil, water, rivers, lakes and ground-water. Please note the local regulations for sewage and water.

13. Disposal considerations

Please note the local regulations for sewage. Dispose of remaining paint in accordance with applicable country, federal, state and local regulations. Dispose of packaging according to regulations on the disposal of packaging. Absolutely cleaned packaging can be recycled.
Suggestion for controlled waste disposal: burning.
EWC no. depends on way of use.

Solid waste:	EWC No. 08 01 12	Paint- and varnish rubbish ...
Liquid waste:	EWC No. 08 01 20	Paint- and printing inking rubbish ...

14. Transport information

Not dangerous according to ADR.
Keep container tightly closed. Keep away from heat and frost. Keep away from food and luxury stimulants.

**15. Regulatory information*

Observe the normal safety regulations when handling chemicals. No labeling in accordance with EC directives.
ChemVOCFarbV 2004/42/EC
VOC content: 0,2% <=6,3g/l
The silk inks are artist paints, customs no. 32 13 1000

National Regulations:

Verordnung brennbarer Flüssigkeiten (VbF): no
German water regulation: WGK 1 „schwach wassergefährdend" according VwVwS
CH: BAG T No. 63996 toxic class: free 1984

16. Other information

The used raw materials do not contain constructional, chemical formula, any soluble heavy metals like antimony, arsenic, cadmium, chromium, lead, mercury and selenium . Therefor the paints are in accordance with EN 71 „ safety of toys" part 3 „migration of special metals".

The applicable hygiene and legal regulations are to be observed.

The information is based upon the present knowledge and experience of our suppliers and manufacturers. The safety data sheet describes products with regard to their safety requirements. The information does not imply quality assurance.

n.d.a. no data available
n.a. not applicable
n.r. not restricted
* new details

Appendix C: Flexibility Test Data

Table C.1: Flexibility Test Data

	Flexometer Cotton (cm)	Flexometer Silk (cm)	Mass/Unit Area (g) Cotton	Mass/Unit Area (g) Silk
Control				
1	3.2	3.7	0.467	0.175
2	3.5	4.2	0.465	0.177
3	2.9	3.7	0.477	0.179
Average	**3.2**	**3.866666667**	**0.469666667**	**0.177**
Mass/Unit area			93.9	35.4
Flexural Rigidity			**307.69152**	**209.98926**
Deka Undiluted				
1	3.4	4.9	0.634	0.242
2	3.5	5.4	0.659	0.238
3	3.9	4.7	0.631	0.256
Average	**3.6**	**5**	**0.641333333**	**0.245333333**
Mass/unit area			128.3	49.1
Flexural Rigidity			**598.59648**	**613.75**
Seta Undiluted				
1	4.1	4.7	0.588	0.22
2	4.4	5.4	0.62	0.24
3	3.8	5.6	0.604	0.232
Average	**4.1**	**5.233333333**	**0.604**	**0.230666667**
Mass/unit area			120.8	46.1
Flexural Rigidity			**832.56568**	**648.20288**
Seta Lightening				
1	4.1	5.3	0.533	0.202
2	3.9	6.2	0.515	0.202
3	4.3	5.3	0.543	0.203
Average	**4.1**	**5.6**	**0.530333333**	**0.202333333**
Mass/unit area			106.1	40.5
Flexural Rigidity			**731.25181**	**711.2448**
Seta Red/Lightening				
1	3.8	5.7	0.546	0.194
2	3.6	5	0.519	0.208
3	3.5	4.9	0.582	0.215
Average	**3.633333333**	**5.2**	**0.549**	**0.205666667**
Mass/unit area			109.8	41.1
Flexural Rigidity			**512.28288**	**577.89888**
Neopaque Undiluted				
1	7.6	6	0.719	0.341
2	7.5	5.2	0.743	0.357
3	7.1	5.2	0.739	0.332
Average	**7.4**	**5.466666667**	**0.733666667**	**0.343333333**
Mass/unit area			146.7	68.7
Flexural Rigidity			**5944.63608**	**1142.99625**
Neopaque Diluted				
1	5.9	5.7	0.586	0.215
2	5.5	6	0.556	0.212
3	5.8	5.5	0.566	0.207
Average	**5.733333333**	**5.733333333**	**0.569333333**	**0.211333333**
Mass/unit area			113.9	42.3
Flexural Rigidity			**2109.34827**	**783.36639**

Appendix D: Wash Fastness Data

Table D.1: Colourimeter Readings Before Sample 1 – Deka Silk.

Before Sample 1	L	a	b
Black Silk 1	28.1	2.88	1.72
Black Silk 2	28.18	2.96	1.64
Black Silk 3	28.13	3.05	1.67
Black Silk Average	**28.13666667**	**2.963333333**	**1.676666667**
Standard Deviation	**0.040414519**	**0.085049005**	**0.040414519**
Black Cotton 1	22.43	3.27	2.05
Black Cotton 2	22.47	3.3	2.07
Black Cotton 3	22.42	3.42	2.03
Black Cotton Average	**22.44**	**3.33**	**2.05**
Standard Deviation	**0.026457513**	**0.079372539**	**0.02**
White Silk 1	95.23	0.44	3.02
White Silk 2	95.24	0.41	3.05
White Silk 3	95.24	0.4	3.05
White Silk Average	**95.23666667**	**0.416666667**	**3.04**
Standard Deviation	**0.005773503**	**0.02081666**	**0.017320508**
White Cotton 1	93.71	1.63	2.37
White Cotton 2	93.7	1.65	2.37
White Cotton 3	93.71	1.65	2.39
White Cotton Average	**93.70666667**	**1.643333333**	**2.376666667**
Standard Deviation	**0.005773503**	**0.011547005**	**0.011547005**
Red Silk 1	53.84	59.52	32.59
Red Silk 2	53.9	59.37	32.56
Red Silk 3	53.76	59.63	32.72
Red Silk Average	**53.83333333**	**59.50666667**	**32.62333333**
Standard Deviation	**0.070237692**	**0.130511813**	**0.085049005**
Red Cotton 1	47.09	62.18	36.06
Red Cotton 2	47.15	62.1	36.14
Red Cotton 3	47.09	62.22	36.06
Red Cotton Average	**47.11**	**62.16666667**	**36.08666667**
Standard Deviation	**0.034641016**	**0.061101009**	**0.046188022**
Yellow Silk 1	86.42	2.83	95.57
Yellow Silk 2	86.41	2.86	95.67
Yellow Silk 3	86.42	2.76	96.13
Yellow Silk Average	**86.41666667**	**2.816666667**	**95.79**
Standard Deviation	**0.005773503**	**0.051316014**	**0.29866369**
Yellow Cotton 1	83.69	9.38	100.04
Yellow Cotton 2	83.67	9.43	100.08
Yellow Cotton 3	83.69	9.38	100.06
Yellow Cotton Average	**83.68333333**	**9.396666667**	**100.06**
Standard Deviation	**0.011547005**	**0.028867513**	**0.02**
Blue Silk 1	38.12	14.65	-45.87
Blue Silk 2	38	14.92	-46.02
Blue Silk 3	38.05	14.79	-45.95
Blue Silk Average	**38.05666667**	**14.78666667**	**-45.94666667**
Standard Deviation	**0.060277138**	**0.135030861**	**0.075055535**
Blue Cotton 1	28.32	16.64	-40.51
Blue Cotton 2	28.34	16.58	-40.52
Blue Cotton 3	28.33	16.53	-40.49
Blue Cotton Average	**28.33**	**16.58333333**	**-40.50666667**
Standard Deviation	**0.01**	**0.055075705**	**0.015275252**

Table D.2. Colourimeter Readings After Sample 1 – Deka Silk.

Deka Silk	L	a	b
After Sample 1			
Black Silk 1	27.46	2.96	1.89
Black Silk 2	27.44	2.99	1.84
Black Silk 3	27.4	2.91	1.94
Black Silk Average	**27.43333333**	**2.953333333**	**1.89**
Standard Deviation	**0.030550505**	**0.040414519**	**0.05**
Black Cotton 1	22.42	3.23	2.22
Black Cotton 2	22.43	3.27	2.22
Black Cotton 3	22.46	3.15	2.3
Black Cotton Average	**22.43666667**	**3.216666667**	**2.246666667**
Standard Deviation	**0.02081666**	**0.061101009**	**0.046188022**
White Silk 1	94.94	0.59	3.05
White Silk 2	94.96	0.54	3.06
White Silk 3	94.96	0.55	3.06
White Silk Average	**94.95333333**	**0.56**	**3.056666667**
Standard Deviation	**0.011547005**	**0.026457513**	**0.005773503**
White Cotton 1	93.71	1.6	2.63
White Cotton 2	93.72	1.61	2.62
White Cotton 3	93.68	1.62	2.62
White Cotton Average	**93.70333333**	**1.61**	**2.623333333**
Standard Deviation	**0.02081666**	**0.01**	**0.005773503**
Red Silk 1	53.4	59.65	33.19
Red Silk 2	53.35	59.74	33.23
Red Silk 3	53.11	60.08	33.62
Red Silk Average	**53.28666667**	**59.82333333**	**33.34666667**
Standard Deviation	**0.155026879**	**0.226789183**	**0.237557011**
Red Cotton 1	47	61.95	36.14
Red Cotton 2	46.98	61.99	36.06
Red Cotton 3	47.03	61.83	36.13
Red Cotton Average	**47.00333333**	**61.92333333**	**36.11**
Standard Deviation	**0.025166115**	**0.08326664**	**0.043588989**
Yellow Silk 1	86.15	3.12	95.83
Yellow Silk 2	86.16	3.15	95.62
Yellow Silk 3	86.14	3.1	95.74
Yellow Silk Average	**86.15**	**3.123333333**	**95.73**
Standard Deviation	**0.01**	**0.025166115**	**0.105356538**
Yellow Cotton 1	83.6	9.55	99.66
Yellow Cotton 2	83.61	9.54	99.68
Yellow Cotton 3	83.64	9.48	99.62
Yellow Cotton Average	**83.61666667**	**9.523333333**	**99.65333333**
Standard Deviation	**0.02081666**	**0.037859389**	**0.030550505**
Blue Silk 1	37.07	15.5	-47.02
Blue Silk 2	37.16	15.51	-46.96
Blue Silk 3	37.02	15.51	-47.03
Blue Silk Average	**37.08333333**	**15.50666667**	**-47.00333333**
Standard Deviation	**0.070945989**	**0.005773503**	**0.037859389**
Blue Cotton 1	28.39	16.76	-40.52
Blue Cotton 2	28.41	16.61	-40.52
Blue Cotton 3	28.43	16.59	-40.56
Blue Cotton Average	**28.41**	**16.65333333**	**-40.53333333**
Standard Deviation	**0.02**	**0.092915732**	**0.023094011**

Table D.3: Colourimeter Readings Before Sample 2 – Deka Silk.

Deka Silk	L	a	b
Before Sample 2			
Black Silk 1	28.6	2.83	1.65
Black Silk 2	28.66	2.77	1.62
Black Silk 3	28.7	2.8	1.62
Black Silk Average	**28.65333333**	**2.8**	**1.63**
Standard Deviation	**0.05033223**	**0.03**	**0.017320508**
Black Cotton 1	22.99	3.33	1.96
Black Cotton 2	23.09	3.17	2.05
Black Cotton 3	23.08	3.21	1.98
Black Cotton Average	**23.05333333**	**3.236666667**	**1.996666667**
Standard Deviation	**0.055075705**	**0.08326664**	**0.047258156**
White Silk 1	95.43	0.21	3.13
White Silk 2	95.44	0.25	3.11
White Silk 3	95.42	0.27	3.11
White Silk Average	**95.43**	**0.243333333**	**3.116666667**
Standard Deviation	**0.01**	**0.030550505**	**0.011547005**
White Cotton 1	94.26	1.16	2.63
White Cotton 2	94.23	1.18	2.62
White Cotton 3	94.23	1.2	2.61
White Cotton Average	**94.24**	**1.18**	**2.62**
Standard Deviation	**0.017320508**	**0.02**	**0.01**
Red Silk 1	53.1	60.11	33.22
Red Silk 2	53.11	60.09	33.21
Red Silk 3	53.18	59.97	33.1
Red Silk Average	**53.13**	**60.05666667**	**33.17666667**
Standard Deviation	**0.043588989**	**0.075718778**	**0.066583281**
Red Cotton 1	48.37	61	34.68
Red Cotton 2	48.35	61.08	34.63
Red Cotton 3	48.3	61.08	34.78
Red Cotton Average	**48.34**	**61.05333333**	**34.69666667**
Standard Deviation	**0.036055513**	**0.046188022**	**0.076376262**
Yellow Silk 1	86.52	2.56	95.03
Yellow Silk 2	86.54	2.59	94.56
Yellow Silk 3	86.49	2.63	95.1
Yellow Silk Average	**86.51666667**	**2.593333333**	**94.89666667**
Standard Deviation	**0.025166115**	**0.035118846**	**0.293655127**
Yellow Cotton 1	84.06	8.44	98.78
Yellow Cotton 2	84.08	8.41	98.81
Yellow Cotton 3	84.05	8.45	98.67
Yellow Cotton Average	**84.06333333**	**8.433333333**	**98.75333333**
Standard Deviation	**0.015275252**	**0.02081666**	**0.073711148**
Blue Silk 1	38.77	14.5	-46.46
Blue Silk 2	38.72	14.42	-46.34
Blue Silk 3	38.77	14.49	-46.44
Blue Silk Average	**38.75333333**	**14.47**	**-46.41333333**
Standard Deviation	**0.028867513**	**0.043588989**	**0.064291005**
Blue Cotton 1	29.2	16.35	-40.87
Blue Cotton 2	29.26	16.34	-40.94
Blue Cotton 3	29.22	16.28	-40.86
Blue Cotton Average	**29.22666667**	**16.32333333**	**-40.89**
Standard Deviation	**0.030550505**	**0.037859389**	**0.043588989**

Table D.4: Colourimeter Readings After Sample 2 – Deka Silk.

Deka Silk	L	a	b
After Sample 2			
Black Silk 1	27.66	2.99	1.86
Black Silk 2	27.66	2.99	1.89
Black Silk 3	27.55	2.96	1.9
Black Silk Average	**27.62333333**	**2.98**	**1.883333333**
Standard Deviation	**0.06350853**	**0.017320508**	**0.02081666**
Black Cotton 1	23.04	3.21	2.15
Black Cotton 2	23.06	3.32	2.15
Black Cotton 3	23.07	3.43	2.1
Black Cotton Average	**23.05666667**	**3.32**	**2.133333333**
Standard Deviation	**0.015275252**	**0.11**	**0.028867513**
White Silk 1	95.1	0.32	3.16
White Silk 2	95.13	0.31	3.15
White Silk 3	95.1	0.34	3.12
White Silk Average	**95.11**	**0.323333333**	**3.143333333**
Standard Deviation	**0.017320508**	**0.015275252**	**0.02081666**
White Cotton 1	94.2	1.13	2.91
White Cotton 2	94.19	1.16	2.91
White Cotton 3	94.21	1.09	2.92
White Cotton Average	**94.2**	**1.126666667**	**2.913333333**
Standard Deviation	**0.01**	**0.035118846**	**0.005773503**
Red Silk 1	52.54	60.47	34.05
Red Silk 2	52.53	60.48	34.02
Red Silk 3	52.64	60.37	33.9
Red Silk Average	**52.57**	**60.44**	**33.99**
Standard Deviation	**0.060827625**	**0.060827625**	**0.079372539**
Red Cotton 1	48.43	60.61	34.53
Red Cotton 2	48.38	60.68	34.52
Red Cotton 3	48.34	60.73	34.51
Red Cotton Average	**48.38333333**	**60.67333333**	**34.52**
Standard Deviation	**0.045092498**	**0.060277138**	**0.01**
Yellow Silk 1	86.23	2.93	94.97
Yellow Silk 2	86.3	2.83	94.4
Yellow Silk 3	86.15	2.92	95.24
Yellow Silk Average	**86.22666667**	**2.893333333**	**94.87**
Standard Deviation	**0.075055535**	**0.055075705**	**0.428835633**
Yellow Cotton 1	83.97	8.53	98.3
Yellow Cotton 2	83.96	8.57	98.32
Yellow Cotton 3	83.97	8.59	98.33
Yellow Cotton Average	**83.96666667**	**8.563333333**	**98.31666667**
Standard Deviation	**0.005773503**	**0.030550505**	**0.015275252**
Blue Silk 1	38.72	14.51	-46.76
Blue Silk 2	38.76	14.56	-46.69
Blue Silk 3	38.12	14.97	-47.05
Blue Silk Average	**38.53333333**	**14.68**	**-46.83333333**
Standard Deviation	**0.358515458**	**0.252388589**	**0.190875177**
Blue Cotton 1	29.25	16.31	-41.03
Blue Cotton 2	29.26	16.41	-41.03
Blue Cotton 3	29.24	16.58	-41.11
Blue Cotton Average	**29.25**	**16.43333333**	**-41.05666667**
Standard Deviation	**0.01**	**0.136503968**	**0.046188022**

Table D.5: Colourimeter Readings Before Sample 3 – Deka Silk.

Deka Silk	L	a	b
Before Sample 3			
Black Silk 1	28.39	2.8	1.71
Black Silk 2	28.07	2.94	1.73
Black Silk 3	28.32	2.73	1.73
Black Silk Average	**28.26**	**2.823333333**	**1.723333333**
Standard Deviation	**0.168226038**	**0.106926766**	**0.011547005**
Black Cotton 1	22.35	3.16	1.96
Black Cotton 2	22.36	3.23	2.02
Black Cotton 3	22.37	3.23	1.99
Black Cotton Average	**22.36**	**3.206666667**	**1.99**
Standard Deviation	**0.01**	**0.040414519**	**0.03**
White Silk 1	95.49	0.18	3.16
White Silk 2	95.48	0.2	3.14
White Silk 3	95.49	0.19	3.17
White Silk Average	**95.48666667**	**0.19**	**3.156666667**
Standard Deviation	**0.005773503**	**0.01**	**0.015275252**
White Cotton 1	93.87	1.56	2.49
White Cotton 2	93.86	1.6	2.48
White Cotton 3	93.84	1.58	2.48
White Cotton Average	**93.85666667**	**1.58**	**2.483333333**
Standard Deviation	**0.015275252**	**0.02**	**0.005773503**
Red Silk 1	53.49	60.29	33.39
Red Silk 2	53.66	60.11	33.28
Red Silk 3	53.67	60.09	33.12
Red Silk Average	**53.60666667**	**60.16333333**	**33.26333333**
Standard Deviation	**0.101159939**	**0.110151411**	**0.135769412**
Red Cotton 1	49.44	59.68	33.08
Red Cotton 2	49.56	59.56	32.83
Red Cotton 3	49.46	59.69	33.01
Red Cotton Average	**49.48666667**	**59.64333333**	**32.97333333**
Standard Deviation	**0.064291005**	**0.072341781**	**0.128970281**
Yellow Silk 1	86.55	2.59	95.86
Yellow Silk 2	86.56	2.59	95.75
Yellow Silk 3	86.58	2.49	95.55
Yellow Silk Average	**86.56333333**	**2.556666667**	**95.72**
Standard Deviation	**0.015275252**	**0.057735027**	**0.157162336**
Yellow Cotton 1	83.43	9.44	99.55
Yellow Cotton 2	83.45	9.45	99.62
Yellow Cotton 3	83.45	9.4	99.73
Yellow Cotton Average	**83.44333333**	**9.43**	**99.63333333**
Standard Deviation	**0.011547005**	**0.026457513**	**0.090737717**
Blue Silk 1	38.62	14.65	-46.7
Blue Silk 2	38.66	14.72	-46.74
Blue Silk 3	38.51	14.77	-46.87
Blue Silk Average	**38.59666667**	**14.71333333**	**-46.77**
Standard Deviation	**0.077674535**	**0.060277138**	**0.088881944**
Blue Cotton 1	28.83	16.44	-40.56
Blue Cotton 2	28.92	16.27	-40.38
Blue Cotton 3	28.88	16.46	-40.45
Blue Cotton Average	**28.87666667**	**16.39**	**-40.46333333**
Standard Deviation	**0.045092498**	**0.104403065**	**0.090737717**

Table D.6: Colourimeter Readings After Sample 3 – Deka Silk.

Deka Silk	L	a	b
After Sample 3			
Black Silk 1	27.4	2.79	1.95
Black Silk 2	27.35	2.85	1.93
Black Silk 3	27.32	2.88	1.96
Black Silk Average	**27.35666667**	**2.84**	**1.946666667**
Standard Deviation	**0.040414519**	**0.045825757**	**0.015275252**
Black Cotton 1	22.24	3.13	2.16
Black Cotton 2	22.24	3.13	2.15
Black Cotton 3	22.22	3.09	2.15
Black Cotton Average	**22.23333333**	**3.116666667**	**2.153333333**
Standard Deviation	**0.011547005**	**0.023094011**	**0.005773503**
White Silk 1	95.32	0.23	3.2
White Silk 2	95.33	0.22	3.2
White Silk 3	95.33	0.24	3.19
White Silk Average	**95.32666667**	**0.23**	**3.196666667**
Standard Deviation	**0.005773503**	**0.01**	**0.005773503**
White Cotton 1	93.79	1.57	2.71
White Cotton 2	93.8	1.53	2.73
White Cotton 3	93.81	1.55	2.72
White Cotton Average	**93.8**	**1.55**	**2.72**
Standard Deviation	**0.01**	**0.02**	**0.01**
Red Silk 1	53.21	60.25	33.77
Red Silk 2	53.23	60.11	33.79
Red Silk 3	53.19	60.19	33.74
Red Silk Average	**53.21**	**60.18333333**	**33.76666667**
Standard Deviation	**0.02**	**0.070237692**	**0.025166115**
Red Cotton 1	48.77	60.58	34.68
Red Cotton 2	48.75	60.61	34.68
Red Cotton 3	48.76	60.7	34.61
Red Cotton Average	**48.76**	**60.63**	**34.65666667**
Standard Deviation	**0.01**	**0.06244998**	**0.040414519**
Yellow Silk 1	86.11	2.94	95.82
Yellow Silk 2	86.07	2.93	95.73
Yellow Silk 3	86.07	2.94	95.84
Yellow Silk Average	**86.08333333**	**2.936666667**	**95.79666667**
Standard Deviation	**0.023094011**	**0.005773503**	**0.058594653**
Yellow Cotton 1	83.43	9.47	99.18
Yellow Cotton 2	83.39	9.52	99.22
Yellow Cotton 3	83.39	9.54	99.22
Yellow Cotton Average	**83.40333333**	**9.51**	**99.20666667**
Standard Deviation	**0.023094011**	**0.036055513**	**0.023094011**
Blue Silk 1	38.64	14.79	-46.96
Blue Silk 2	38.66	14.69	-46.91
Blue Silk 3	38.67	14.65	-46.91
Blue Silk Average	**38.65666667**	**14.71**	**-46.92666667**
Standard Deviation	**0.015275252**	**0.072111026**	**0.028867513**
Blue Cotton 1	28.98	16.3	-40.45
Blue Cotton 2	28.97	16.41	-40.5
Blue Cotton 3	28.98	16.33	-40.45
Blue Cotton Average	**28.97666667**	**16.34666667**	**-40.46666667**
Standard Deviation	**0.005773503**	**0.056862407**	**0.028867513**

Deka Silk Statistics

Table D.7: Deka Silk Average Before colour readings

Deka Silk Before	L	a	b
Black Silk Average	28.35	2.862222	1.676666667
Standard Deviation	0.269832149	0.088338457	0.0466665
Black Cotton Average	22.61777667	3.257778	2.012222333
Standard Deviation	0.379315211	0.064319616	0.032885807
White Silk Average	95.38444667	0.283333333	3.104444667
Standard Deviation	0.131077571	0.118509503	0.059286055
White Cotton Average	93.93444667	1.467777667	2.493333333
Standard Deviation	0.275040233	0.251226504	0.121974351
Red Silk Average	53.52333333	59.90889	33.02111
Standard Deviation	0.35899446	0.352391523	0.347201937
Red Cotton Average	48.31222333	60.95444333	34.58555667
Standard Deviation	1.188578449	1.264573097	1.559641343
Yellow Silk Average	86.49889	2.655555667	95.46889
Standard Deviation	0.074929201	0.14072578	0.496791502
Yellow Cotton Average	83.72999667	9.086666667	99.48222
Standard Deviation	0.312623309	0.566048966	0.666312461
Blue Silk Average	38.46889	14.65666667	-46.37666667
Standard Deviation	0.36548541	0.165764961	0.412887663
Blue Cotton Average	28.81111333	16.43222	-40.62
Standard Deviation	0.451915401	0.135044053	0.23482885

Table D.8: Deka Silk Average After colour readings

Deka Silk After	L	a	b
Black Silk Average	27.47111	2.924444333	1.906666667
Standard Deviation	0.137285779	0.074336507	0.034801325
Black Cotton Average	22.57555667	3.217778	2.177777667
Standard Deviation	0.428881474	0.101671053	0.060492191
White Silk Average	95.13	0.371111	3.132222333
Standard Deviation	0.187471835	0.170108944	0.070658228
White Cotton Average	93.90111	1.428889	2.752222
Standard Deviation	0.26332052	0.263445636	0.147660736
Red Silk Average	53.02222333	60.14888667	33.70111333
Standard Deviation	0.393508614	0.309774482	0.326636847
Red Cotton Average	48.04888667	61.07555333	35.09555667
Standard Deviation	0.924857627	0.734515711	0.881187341
Yellow Silk Average	86.15333333	2.984444333	95.46555667
Standard Deviation	0.071728113	0.122217041	0.516843332
Yellow Cotton Average	83.66222333	9.198888667	99.05889
Standard Deviation	0.284419265	0.550447723	0.680473501
Blue Silk Average	38.09111	14.96555667	-46.92111
Standard Deviation	0.874939189	0.468857899	0.085136274
Blue Cotton Average	28.87889	16.47777667	-40.68555667
Standard Deviation	0.42845151	0.158087693	0.32311719

Table D.9: Deka Silk Average change in colour readings

Deka Silk	L change	a Change	b Change	Overall Change
Black Silk	-0.87889	0.062222333	0.23	**0.910614765**
Black Cotton	-0.04222	-0.04	0.165555333	**0.175473921**
White Silk	-0.254446667	0.087777667	0.027777667	**0.270591248**
White Cotton	-0.033336667	-0.038888667	0.258888667	**0.263907187**
Red Silk	-0.50111	0.239996667	0.680003333	**0.878131064**
Red Cotton	-0.263336667	0.12111	0.51	**0.586612165**
Yellow Silk	-0.345556667	0.328888667	-0.003333333	**0.47706213**
Yellow Cotton	-0.067773333	0.112222	-0.42333	**0.443165083**
Blue Silk	-0.37778	0.30889	-0.544443333	**0.731128787**
Blue Cotton	0.067776667	0.045556667	-0.065556667	**0.104722314**

Table D.10: Colourimeter Readings Before Sample 1 – Seta Silk.

Seta Silk	L	a	b
Before Sample 1			
Black Silk 1	31.07	0.7	0.98
Black Silk 2	30.57	0.7	1.05
Black Silk 3	30.28	0.69	1.11
Black Silk Average	**30.64**	**0.696666667**	**1.046666667**
Standard Deviation	**0.399624824**	**0.005773503**	**0.065064071**
Black Cotton 1	23.05	0.99	0.45
Black Cotton 2	23.02	0.91	0.43
Black Cotton 3	23.06	0.98	0.44
Black Cotton Average	**23.04333333**	**0.96**	**0.44**
Standard Deviation	**0.02081666**	**0.043588989**	**0.01**
White Silk 1	95.69	0.07	3.42
White Silk 2	95.71	0.07	3.41
White Silk 3	95.7	0.06	3.44
White Silk Average	**95.7**	**0.066666667**	**3.423333333**
Standard Deviation	**0.01**	**0.005773503**	**0.015275252**
White Cotton 1	95.22	-0.1	3.63
White Cotton 2	95.23	-0.11	3.64
White Cotton 3	95.21	-0.14	3.65
White Cotton Average	**95.22**	**-0.116666667**	**3.64**
Standard Deviation	**0.01**	**0.02081666**	**0.01**
Red Silk 1	57.33	60.58	37.52
Red Silk 2	57.28	60.71	37.56
Red Silk 3	57.14	60.77	37.8
Red Silk Average	**57.25**	**60.68666667**	**37.62666667**
Standard Deviation	**0.098488578**	**0.097125349**	**0.151437556**
Red Cotton 1	51.97	63.79	41.38
Red Cotton 2	51.91	63.86	41.33
Red Cotton 3	51.88	63.9	41.3
Red Cotton Average	**51.92**	**63.85**	**41.33666667**
Standard Deviation	**0.045825757**	**0.055677644**	**0.040414519**
Yellow Silk 1	93.85	-18.05	68.96
Yellow Silk 2	93.81	-18.07	69.05
Yellow Silk 3	93.87	-18.02	68.94
Yellow Silk Average	**93.84333333**	**-18.04666667**	**68.98333333**
Standard Deviation	**0.030550505**	**0.025166115**	**0.058594653**
Yellow Cotton 1	92.55	-17.42	76.74
Yellow Cotton 2	92.56	-17.46	76.72
Yellow Cotton 3	92.54	-17.43	76.73
Yellow Cotton Average	**92.55**	**-17.43666667**	**76.73**
Standard Deviation	**0.01**	**0.02081666**	**0.01**
Blue Silk 1	39.71	16.51	-46.57
Blue Silk 2	39.53	16.51	-46.68
Blue Silk 3	39.43	16.55	-46.68
Blue Silk Average	**39.55666667**	**16.52333333**	**-46.64333333**
Standard Deviation	**0.141891978**	**0.023094011**	**0.06350853**
Blue Cotton 1	29.26	17.66	-39.29
Blue Cotton 2	29.31	17.61	-39.32
Blue Cotton 3	29.36	17.57	-39.36
Blue Cotton Average	**29.31**	**17.61333333**	**-39.32333333**
Standard Deviation	**0.05**	**0.045092498**	**0.035118846**

Table D.11: Colourimeter Readings After Sample 1 – Seta Silk.

Seta Silk	L	a	b
After Sample 1			
Black Silk 1	29.63	0.73	1.08
Black Silk 2	29.7	0.82	1.02
Black Silk 3	30.09	0.79	1.02
Black Silk Average	**29.80666667**	**0.78**	**1.04**
Standard Deviation	**0.247857486**	**0.045825757**	**0.034641016**
Black Cotton 1	22.51	1.05	0.53
Black Cotton 2	22.47	1.16	0.5
Black Cotton 3	22.49	0.96	0.54
Black Cotton Average	**22.49**	**1.056666667**	**0.523333333**
Standard Deviation	**0.02**	**0.100166528**	**0.02081666**
White Silk 1	95.24	0.12	3.5
White Silk 2	95.25	0.15	3.52
White Silk 3	95.25	0.11	3.52
White Silk Average	**95.24666667**	**0.126666667**	**3.513333333**
Standard Deviation	**0.005773503**	**0.02081666**	**0.011547005**
White Cotton 1	95.13	-0.05	3.59
White Cotton 2	95.12	-0.06	3.6
White Cotton 3	95.12	-0.01	3.56
White Cotton Average	**95.12333333**	**-0.04**	**3.583333333**
Standard Deviation	**0.005773503**	**0.026457513**	**0.02081666**
Red Silk 1	57.08	60.81	37.7
Red Silk 2	57.06	60.85	37.67
Red Silk 3	57.07	60.79	37.65
Red Silk Average	**57.07**	**60.81666667**	**37.67333333**
Standard Deviation	**0.01**	**0.030550505**	**0.025166115**
Red Cotton 1	51.84	64.17	41.37
Red Cotton 2	51.86	64.17	41.39
Red Cotton 3	51.83	64.3	41.28
Red Cotton Average	**51.84333333**	**64.21333333**	**41.34666667**
Standard Deviation	**0.015275252**	**0.075055535**	**0.058594653**
Yellow Silk 1	93.64	-18	68.65
Yellow Silk 2	93.65	-18.03	68.69
Yellow Silk 3	93.64	-17.97	68.5
Yellow Silk Average	**93.64333333**	**-18**	**68.61333333**
Standard Deviation	**0.005773503**	**0.03**	**0.100166528**
Yellow Cotton 1	92.64	-17.41	76.47
Yellow Cotton 2	92.63	-17.44	76.5
Yellow Cotton 3	92.65	-17.46	76.46
Yellow Cotton Average	**92.64**	**-17.43666667**	**76.47666667**
Standard Deviation	**0.01**	**0.025166115**	**0.02081666**
Blue Silk 1	39.22	16.54	-46.74
Blue Silk 2	39.23	16.55	-46.72
Blue Silk 3	39.3	16.47	-46.64
Blue Silk Average	**39.25**	**16.52**	**-46.7**
Standard Deviation	**0.043588989**	**0.043588989**	**0.052915026**
Blue Cotton 1	29.1	17.62	-39.68
Blue Cotton 2	29.04	17.67	-39.6
Blue Cotton 3	29.01	17.69	-39.59
Blue Cotton Average	**29.05**	**17.66**	**-39.62333333**
Standard Deviation	**0.045825757**	**0.036055513**	**0.049328829**

Table D.12: Colourimeter Readings Before Sample 2 – Seta Silk.

Seta Silk	L	a	b
Before Sample 2			
Black Silk 1	31.64	0.74	1.14
Black Silk 2	31.64	0.76	1.11
Black Silk 3	32.12	0.72	1.14
Black Silk Average	**31.8**	**0.74**	**1.13**
Standard Deviation	**0.277128129**	**0.02**	**0.017320508**
Black Cotton 1	24.16	0.99	0.66
Black Cotton 2	24.17	1.2	0.58
Black Cotton 3	24.2	1.06	0.68
Black Cotton Average	**24.17666667**	**1.083333333**	**0.64**
Standard Deviation	**0.02081666**	**0.106926766**	**0.052915026**
White Silk 1	95.67	0.05	3.32
White Silk 2	95.67	0.07	3.31
White Silk 3	95.68	0.08	3.31
White Silk Average	**95.67333333**	**0.066666667**	**3.313333333**
Standard Deviation	**0.005773503**	**0.015275252**	**0.005773503**
White Cotton 1	95.44	-0.21	3.91
White Cotton 2	95.42	-0.2	3.9
White Cotton 3	95.44	-0.21	3.91
White Cotton Average	**95.43333333**	**-0.206666667**	**3.906666667**
Standard Deviation	**0.011547005**	**0.005773503**	**0.005773503**
Red Silk 1	57.86	60.06	36.3
Red Silk 2	57.89	60.01	36.37
Red Silk 3	57.95	59.87	36.21
Red Silk Average	**57.9**	**59.98**	**36.29333333**
Standard Deviation	**0.045825757**	**0.098488578**	**0.080208063**
Red Cotton 1	51.51	64.05	41.85
Red Cotton 2	51.51	64	41.82
Red Cotton 3	51.52	64.02	41.77
Red Cotton Average	**51.51333333**	**64.02333333**	**41.81333333**
Standard Deviation	**0.005773503**	**0.025166115**	**0.040414519**
Yellow Silk 1	93.97	-18.24	70.94
Yellow Silk 2	94	-18.28	70.92
Yellow Silk 3	93.92	-18.27	71.06
Yellow Silk Average	**93.96333333**	**-18.26333333**	**70.97333333**
Standard Deviation	**0.040414519**	**0.02081666**	**0.075718778**
Yellow Cotton 1	92.36	-17.48	77.75
Yellow Cotton 2	92.36	-17.45	77.76
Yellow Cotton 3	92.33	-17.45	77.68
Yellow Cotton Average	**92.35**	**-17.46**	**77.73**
Standard Deviation	**0.017320508**	**0.017320508**	**0.043588989**
Blue Silk 1	37.59	17.47	-45.78
Blue Silk 2	37.72	17.29	-45.71
Blue Silk 3	37.65	17.37	-45.75
Blue Silk Average	**37.65333333**	**17.37666667**	**-45.74666667**
Standard Deviation	**0.065064071**	**0.090184995**	**0.035118846**
Blue Cotton 1	29.34	17.16	-38.96
Blue Cotton 2	29.34	17.25	-38.96
Blue Cotton 3	29.32	17.29	-39.04
Blue Cotton Average	**29.33333333**	**17.23333333**	**-38.98666667**
Standard Deviation	**0.011547005**	**0.066583281**	**0.046188022**

Table D.13: Colourimeter Readings After Sample 2 – Seta Silk.

Seta Silk	L	a	b
After Sample 2			
Black Silk 1	31.45	0.78	1.05
Black Silk 2	31.06	0.76	1.22
Black Silk 3	31.12	0.82	1.19
Black Silk Average	**31.21**	**0.786666667**	**1.153333333**
Standard Deviation	**0.21**	**0.030550505**	**0.090737717**
Black Cotton 1	23.64	1.07	0.77
Black Cotton 2	23.67	1.11	0.77
Black Cotton 3	23.72	1.11	0.76
Black Cotton Average	**23.67666667**	**1.096666667**	**0.766666667**
Standard Deviation	**0.040414519**	**0.023094011**	**0.005773503**
White Silk 1	95.14	0.19	3.4
White Silk 2	95.16	0.13	3.41
White Silk 3	95.17	0.15	3.41
White Silk Average	**95.15666667**	**0.156666667**	**3.406666667**
Standard Deviation	**0.015275252**	**0.030550505**	**0.005773503**
White Cotton 1	95.33	-0.16	3.86
White Cotton 2	95.34	-0.18	3.87
White Cotton 3	95.34	-0.19	3.87
White Cotton Average	**95.33666667**	**-0.176666667**	**3.866666667**
Standard Deviation	**0.005773503**	**0.015275252**	**0.005773503**
Red Silk 1	57.8	59.96	36.21
Red Silk 2	57.9	59.88	35.94
Red Silk 3	57.98	59.71	35.93
Red Silk Average	**57.89333333**	**59.85**	**36.02666667**
Standard Deviation	**0.090184995**	**0.127671453**	**0.158850034**
Red Cotton 1	51.44	64.42	41.91
Red Cotton 2	51.38	64.6	41.84
Red Cotton 3	51.46	64.37	41.92
Red Cotton Average	**51.42666667**	**64.46333333**	**41.89**
Standard Deviation	**0.04163332**	**0.120968315**	**0.043588989**
Yellow Silk 1	93.81	-18.29	71.42
Yellow Silk 2	93.78	-18.31	71.54
Yellow Silk 3	93.71	-18.29	71.56
Yellow Silk Average	**93.76666667**	**-18.29666667**	**71.50666667**
Standard Deviation	**0.051316014**	**0.011547005**	**0.075718778**
Yellow Cotton 1	92.32	-17.41	77.54
Yellow Cotton 2	92.32	-17.42	77.52
Yellow Cotton 3	92.33	-17.41	77.56
Yellow Cotton Average	**92.32333333**	**-17.41333333**	**77.54**
Standard Deviation	**0.005773503**	**0.005773503**	**0.02**
Blue Silk 1	38.03	16.82	-45.2
Blue Silk 2	38.05	16.8	-45.17
Blue Silk 3	37.67	17.09	-45.51
Blue Silk Average	**37.91666667**	**16.90333333**	**-45.29333333**
Standard Deviation	**0.213853532**	**0.161967075**	**0.188237439**
Blue Cotton 1	29.14	17.21	-39.26
Blue Cotton 2	29.13	17.39	-39.32
Blue Cotton 3	29.17	17.31	-39.35
Blue Cotton Average	**29.14666667**	**17.30333333**	**-39.31**
Standard Deviation	**0.02081666**	**0.090184995**	**0.045825757**

Table D.14: Colourimeter Readings Before Sample 3 – Seta Silk.

Seta Silk	L	a	b
Before Sample 3			
Black Silk 1	30.02	0.86	1.07
Black Silk 2	30.04	0.76	1.11
Black Silk 3	30.44	0.64	1.07
Black Silk Average	**30.16666667**	**0.753333333**	**1.083333333**
Standard Deviation	**0.236924742**	**0.110151411**	**0.023094011**
Black Cotton 1	23.63	1.01	0.65
Black Cotton 2	23.58	1.07	0.58
Black Cotton 3	23.62	1.04	0.63
Black Cotton Average	**23.61**	**1.04**	**0.62**
Standard Deviation	**0.026457513**	**0.03**	**0.036055513**
White Silk 1	95.76	-0.04	3.47
White Silk 2	95.77	-0.04	3.46
White Silk 3	95.76	-0.04	3.48
White Silk Average	**95.76333333**	**-0.04**	**3.47**
Standard Deviation	**0.005773502**	**6.58545E-10**	**0.01**
White Cotton 1	95.27	-0.15	3.64
White Cotton 2	95.28	-0.13	3.63
White Cotton 3	95.29	-0.15	3.64
White Cotton Average	**95.28**	**-0.143333333**	**3.636666667**
Standard Deviation	**0.01**	**0.011547005**	**0.005773503**
Red Silk 1	57.47	60.38	37.16
Red Silk 2	57.61	60.27	36.81
Red Silk 3	57.51	60.39	36.95
Red Silk Average	**57.53**	**60.34666667**	**36.97333333**
Standard Deviation	**0.072111026**	**0.066583281**	**0.176162803**
Red Cotton 1	51.66	63.9	41.54
Red Cotton 2	51.59	63.91	41.47
Red Cotton 3	51.55	63.97	41.44
Red Cotton Average	**51.6**	**63.92666667**	**41.48333333**
Standard Deviation	**0.055677644**	**0.037859389**	**0.051316014**
Yellow Silk 1	93.56	-18.13	69.95
Yellow Silk 2	93.71	-18.06	69.72
Yellow Silk 3	93.67	-18.07	69.83
Yellow Silk Average	**93.64666667**	**-18.08666667**	**69.83333333**
Standard Deviation	**0.077674535**	**0.037859389**	**0.115036226**
Yellow Cotton 1	92.75	-17.61	75.21
Yellow Cotton 2	92.76	-17.63	75.26
Yellow Cotton 3	92.78	-17.64	75.17
Yellow Cotton Average	**92.76333333**	**-17.62666667**	**75.21333333**
Standard Deviation	**0.015275252**	**0.015275252**	**0.045092498**
Blue Silk 1	37.4	17.32	-44.79
Blue Silk 2	37.3	17.38	-44.85
Blue Silk 3	37.49	17.28	-44.74
Blue Silk Average	**37.39666667**	**17.32666667**	**-44.79333333**
Standard Deviation	**0.09504385**	**0.05033223**	**0.055075705**
Blue Cotton 1	29.1	17.02	-38.28
Blue Cotton 2	29.13	16.89	-38.33
Blue Cotton 3	29.13	16.98	-38.39
Blue Cotton Average	**29.12**	**16.96333333**	**-38.33333333**
Standard Deviation	**0.017320508**	**0.066583281**	**0.055075705**

Table D.15: Colourimeter Readings After Sample 3 – Seta Silk.

Seta Silk	L	a	b
After Sample 3			
Black Silk 1	29.36	0.97	1.04
Black Silk 2	29.51	0.98	1.03
Black Silk 3	29.78	0.8	0.98
Black Silk Average	**29.55**	**0.916666667**	**1.016666667**
Standard Deviation	**0.212837967**	**0.101159939**	**0.032145503**
Black Cotton 1	23.07	1.14	0.71
Black Cotton 2	23.1	1.14	0.77
Black Cotton 3	23.11	0.95	0.76
Black Cotton Average	**23.09333333**	**1.076666667**	**0.746666667**
Standard Deviation	**0.02081666**	**0.109696551**	**0.032145503**
White Silk 1	95.3	0.02	3.6
White Silk 2	95.3	-0.01	3.62
White Silk 3	95.3	-0.02	3.6
White Silk Average	**95.3**	**-0.003333333**	**3.606666667**
Standard Deviation	**1.90735E-06**	**0.02081666**	**0.011547005**
White Cotton 1	95.2	-0.07	3.61
White Cotton 2	95.19	-0.11	3.6
White Cotton 3	95.2	-0.11	3.6
White Cotton Average	**95.19666667**	**-0.096666667**	**3.603333333**
Standard Deviation	**0.005773503**	**0.023094011**	**0.005773503**
Red Silk 1	57.45	60.43	36.85
Red Silk 2	57.43	60.49	36.91
Red Silk 3	57.43	60.5	36.93
Red Silk Average	**57.43666667**	**60.47333333**	**36.89666667**
Standard Deviation	**0.011547005**	**0.037859389**	**0.04163332**
Red Cotton 1	51.53	64.3	41.41
Red Cotton 2	51.48	64.41	41.35
Red Cotton 3	51.51	64.3	41.38
Red Cotton Average	**51.50666667**	**64.33666667**	**41.38**
Standard Deviation	**0.025166115**	**0.06350853**	**0.03**
Yellow Silk 1	93.51	-17.96	69.55
Yellow Silk 2	93.49	-18.01	69.67
Yellow Silk 3	93.51	-17.94	69.47
Yellow Silk Average	**93.50333333**	**-17.97**	**69.56333333**
Standard Deviation	**0.011547005**	**0.036055513**	**0.100664459**
Yellow Cotton 1	92.75	-17.49	74.61
Yellow Cotton 2	92.72	-17.48	74.57
Yellow Cotton 3	92.76	-17.49	74.57
Yellow Cotton Average	**92.74333333**	**-17.48666667**	**74.58333333**
Standard Deviation	**0.02081666**	**0.005773503**	**0.023094011**
Blue Silk 1	37.09	17.12	-44.87
Blue Silk 2	37.28	17.15	-44.77
Blue Silk 3	37.62	16.74	-44.44
Blue Silk Average	**37.33**	**17.00333333**	**-44.69333333**
Standard Deviation	**0.268514432**	**0.22854613**	**0.225018518**
Blue Cotton 1	29.08	16.89	-38.64
Blue Cotton 2	29.1	16.81	-38.65
Blue Cotton 3	29.27	16.77	-38.8
Blue Cotton Average	**29.15**	**16.82333333**	**-38.69666667**
Standard Deviation	**0.104403065**	**0.061101009**	**0.089628864**

Seta Silk Statistics

Table D.16: Setasilk Average Before colour readings

Setasilk Before	L	a	b
Black Silk Average	30.86889	0.73	1.086666667
Standard Deviation	0.84037771	0.029626996	0.041766401
Black Cotton Average	23.61	1.027777667	0.566666667
Standard Deviation	0.56667	0.062568333	0.110151411
White Silk Average	95.71222	0.031111333	3.402222
Standard Deviation	0.046227657	0.061584221	0.080438753
White Cotton Average	95.31111	-0.155555667	3.727778
Standard Deviation	0.110014982	0.046228186	0.154931381
Red Silk Average	57.56	60.33778	36.96444333
Standard Deviation	0.326036808	0.353418868	0.666714421
Red Cotton Average	51.67777667	63.93333333	41.54444333
Standard Deviation	0.21420091	0.086856907	0.244135861
Yellow Silk Average	93.81777667	-18.13222333	69.92999667
Standard Deviation	0.159869067	0.115289716	0.998515565
Yellow Cotton Average	92.55444333	-17.50778	76.55777667
Standard Deviation	0.206700822	0.103620443	1.267143492
Blue Silk Average	38.20222333	17.07555667	-45.72777667
STANDARD DEVIATION	1.179984287	0.478895311	0.925144701
Blue Cotton Average	29.25444333	17.26999667	-38.88111
STANDARD DEVIATION	0.117014228	0.326547597	0.503370823

Table D.17: Setasilk Average After colour readings

Seta Silk After	L	a	b
Black Silk Average	30.18889	0.827778	1.07
Standard Deviation	0.89357098	0.077052274	0.073105396
Black Cotton Average	23.08666667	1.076667	0.678889
Standard Deviation	0.593363061	0.02	0.135086091
White Silk Average	95.23444667	0.093333667	3.508889
Standard Deviation	0.072442595	0.085049005	0.100074032
White Cotton Average	95.21889	-0.104444667	3.684444333
Standard Deviation	0.108391813	0.068664666	0.158125979
Red Silk Average	57.46666667	60.38	36.86555667
Standard Deviation	0.412483845	0.490046517	0.823770792
Red Cotton Average	51.59222333	64.33777667	41.53889
Standard Deviation	0.221112909	0.125003674	0.304526512
Yellow Silk Average	93.63777667	-18.08889	69.89444333
Standard Deviation	0.131757803	0.180566875	1.474815622
Yellow Cotton Average	92.56888667	-17.44555667	76.2
Standard Deviation	0.218844305	0.037468901	1.497626151
Blue Silk Average	38.16555667	16.80888667	-45.56222
Standard Deviation	0.983899603	0.255130613	1.030003639
Blue Cotton Average	29.11555667	17.26222	-39.21
Standard Deviation	0.056798148	0.41984723	0.471354101

Table D.18: Setasilk Average change in colour readings

Seta	L change	a Change	b Change	**Overall Change**
Black Silk	-0.68	0.097778	-0.016666667	**0.68719598**
Black Cotton	-0.523333333	0.048889333	0.112222333	**0.537458647**
White Silk	-0.477773333	0.062222333	0.106667	**0.49347424**
White Cotton	-0.09222	0.051111	-0.043333667	**0.113994164**
Red Silk	-0.093333333	0.04222	-0.098886667	**0.14238052**
Red Cotton	-0.085553333	0.404443333	-0.005553333	**0.413430311**
Yellow Silk	-0.18	0.043333333	-0.035553333	**0.188525376**
Yellow Cotton	0.014443333	0.062223333	-0.357776667	**0.363434308**
Blue Silk	-0.036666667	-0.26667	0.165556667	**0.316016365**
Blue Cotton	-0.138886667	-0.007776667	-0.32889	**0.357097486**

Table D.19: Colourimeter Readings Before Sample 1 – Jacquard Neopaque.

Neopaque	L	a	b
Before Sample 1			
Black Silk 1	43.59	0.82	2.19
Black Silk 2	43.14	0.88	2.26
Black Silk 3	43.84	0.82	2.18
Black Silk Average	**43.52333333**	**0.84**	**2.21**
Standard Deviation	**0.354729944**	**0.034641016**	**0.043588989**
Black Cotton 1	34.69	1.09	1.21
Black Cotton 2	34.69	1.07	1.21
Black Cotton 3	34.71	1.12	1.21
Black Cotton Average	**34.69666667**	**1.093333333**	**1.21**
Standard Deviation	**0.011547005**	**0.025166115**	**0**
White Silk 1	94.96	0.1	4.3
White Silk 2	94.93	0.17	4.29
White Silk 3	94.9	0.16	4.28
White Silk Average	**94.93**	**0.143333333**	**4.29**
Standard Deviation	**0.03**	**0.037859389**	**0.01**
White Cotton 1	95.17	-0.04	3.9
White Cotton 2	95.16	-0.02	3.88
White Cotton 3	95.15	-0.03	3.9
White Cotton Average	**95.16**	**-0.03**	**3.893333333**
Standard Deviation	**0.01**	**0.01**	**0.011547005**
Red Silk 1	65.28	46.06	9.69
Red Silk 2	65.36	46.08	9.67
Red Silk 3	65.4	45.99	9.66
Red Silk Average	**65.34666667**	**46.04333333**	**9.673333333**
Standard Deviation	**0.061101009**	**0.047258156**	**0.015275252**
Red Cotton 1	55.29	58.18	19.09
Red Cotton 2	55.31	58.1	19.16
Red Cotton 3	55.3	58.1	19.02
Red Cotton Average	**55.3**	**58.12666667**	**19.09**
Standard Deviation	**0.01**	**0.046188022**	**0.07**
Yellow Silk 1	93.12	-16.58	79.65
Yellow Silk 2	93.19	-16.54	79.28
Yellow Silk 3	93.19	-16.53	79.29
Yellow Silk Average	**93.16666667**	**-16.55**	**79.40666667**
Standard Deviation	**0.040414519**	**0.026457513**	**0.210792157**
Yellow Cotton 1	91.98	-15.74	93.68
Yellow Cotton 2	91.97	-15.67	93.64
Yellow Cotton 3	91.99	-15.65	93.57
Yellow Cotton Average	**91.98**	**-15.68666667**	**93.63**
Standard Deviation	**0.01**	**0.047258156**	**0.055677644**
Blue Silk 1	61.82	-5.99	-40.17
Blue Silk 2	61.85	-5.99	-40.16
Blue Silk 3	61.89	-5.94	-40.13
Blue Silk Average	**61.85333333**	**-5.973333333**	**-40.15333333**
Standard Deviation	**0.035118846**	**0.028867513**	**0.02081666**
Blue Cotton 1	48.69	3.14	-47.15
Blue Cotton 2	48.68	3.11	-47.14
Blue Cotton 3	48.71	3.05	-47.12
Blue Cotton Average	**48.69333333**	**3.1**	**-47.13666667**
Standard Deviation	**0.015275252**	**0.045825757**	**0.015275252**

Table D.20: Colourimeter Readings After Sample 1 – Jacquard Neopaque.

Neopaque	L	a	b
After Sample 1			
Black Silk 1	42.95	1	2.31
Black Silk 2	43.19	0.97	2.25
Black Silk 3	43.16	1.01	2.27
Black Silk Average	**43.1**	**0.993333333**	**2.276666667**
Standard Deviation	**0.130766968**	**0.02081666**	**0.030550505**
Black Cotton 1	34.63	1.05	1.28
Black Cotton 2	34.6	0.98	1.33
Black Cotton 3	34.59	1.09	1.3
Black Cotton Average	**34.60666667**	**1.04**	**1.303333333**
Standard Deviation	**0.02081666**	**0.055677644**	**0.025166115**
White Silk 1	94.66	0.18	4.41
White Silk 2	94.67	0.17	4.41
White Silk 3	94.69	0.16	4.38
White Silk Average	**94.67333333**	**0.17**	**4.4**
Standard Deviation	**0.015275252**	**0.01**	**0.017320508**
White Cotton 1	95.04	0.01	3.96
White Cotton 2	95.03	0.02	3.95
White Cotton 3	95.05	-0.01	3.96
White Cotton Average	**95.04**	**0.006666667**	**3.956666667**
Standard Deviation	**0.01**	**0.015275252**	**0.005773503**
Red Silk 1	65.17	46.22	9.74
Red Silk 2	65.19	46.24	9.78
Red Silk 3	65.28	46.12	9.72
Red Silk Average	**65.21333333**	**46.19333333**	**9.746666667**
Standard Deviation	**0.058594653**	**0.064291005**	**0.030550505**
Red Cotton 1	55.18	58.31	19.15
Red Cotton 2	55.2	58.28	19.11
Red Cotton 3	55.17	58.33	19.05
Red Cotton Average	**55.18333333**	**58.30666667**	**19.10333333**
Standard Deviation	**0.015275252**	**0.025166115**	**0.05033223**
Yellow Silk 1	92.86	-16.4	79.42
Yellow Silk 2	92.85	-16.45	79.44
Yellow Silk 3	92.79	-16.47	79.68
Yellow Silk Average	**92.83333333**	**-16.44**	**79.51333333**
Standard Deviation	**0.037859389**	**0.036055513**	**0.144683563**
Yellow Cotton 1	91.89	-15.62	93.67
Yellow Cotton 2	91.85	-15.5	93.63
Yellow Cotton 3	91.88	-15.58	93.68
Yellow Cotton Average	**91.87333333**	**-15.56666667**	**93.66**
Standard Deviation	**0.02081666**	**0.061101009**	**0.026457513**
Blue Silk 1	61.35	-6.15	-40.71
Blue Silk 2	61.34	-6.24	-40.68
Blue Silk 3	61.27	-6.19	-40.75
Blue Silk Average	**61.32**	**-6.193333333**	**-40.71333333**
Standard Deviation	**0.043588989**	**0.045092498**	**0.035118846**
Blue Cotton 1	48.53	3.01	-47.15
Blue Cotton 2	48.53	3.09	-47.15
Blue Cotton 3	48.52	3.11	-47.14
Blue Cotton Average	**48.52666667**	**3.07**	**-47.14666667**
Standard Deviation	**0.005773503**	**0.052915026**	**0.005773503**

Table D.21: Colourimeter Readings Before Sample 2 – Jacquard Neopaque.

Neopaque	L	a	b
Before Sample 2			
Black Silk 1	42.85	0.85	2.2
Black Silk 2	42.97	0.78	2.21
Black Silk 3	42.62	0.94	2.22
Black Silk Average	**42.81333333**	**0.856666667**	**2.21**
Standard Deviation	**0.177857621**	**0.080208063**	**0.01**
Black Cotton 1	34.86	1.01	1.28
Black Cotton 2	34.87	1.03	1.28
Black Cotton 3	34.83	1.1	1.27
Black Cotton Average	**34.85333333**	**1.046666667**	**1.276666667**
Standard Deviation	**0.02081666**	**0.047258156**	**0.005773503**
White Silk 1	95.36	-0.02	4.09
White Silk 2	95.35	0	4.08
White Silk 3	95.35	-0.02	4.07
White Silk Average	**95.35333333**	**-0.013333333**	**4.08**
Standard Deviation	**0.005773503**	**0.011547005**	**0.01**
White Cotton 1	94.68	-0.16	3.57
White Cotton 2	94.67	-0.15	3.58
White Cotton 3	94.69	-0.17	3.59
White Cotton Average	**94.68**	**-0.16**	**3.58**
Standard Deviation	**0.01**	**0.01**	**0.01**
Red Silk 1	65.53	46.02	9.66
Red Silk 2	65.55	46.01	9.64
Red Silk 3	65.33	46.29	9.77
Red Silk Average	**65.47**	**46.10666667**	**9.69**
Standard Deviation	**0.121655251**	**0.158850034**	**0.07**
Red Cotton 1	54.79	58.31	19.48
Red Cotton 2	54.78	58.38	19.45
Red Cotton 3	54.7	58.41	19.51
Red Cotton Average	**54.75666667**	**58.36666667**	**19.48**
Standard Deviation	**0.049328829**	**0.051316014**	**0.03**
Yellow Silk 1	93.04	-16.56	80.67
Yellow Silk 2	93.08	-16.58	80.62
Yellow Silk 3	93.08	-16.55	80.38
Yellow Silk Average	**93.06666667**	**-16.56333333**	**80.55666667**
Standard Deviation	**0.023094011**	**0.015275252**	**0.155026879**
Yellow Cotton 1	92.07	-15.92	93.73
Yellow Cotton 2	92.07	-15.9	93.66
Yellow Cotton 3	92.09	-15.9	93.62
Yellow Cotton Average	**92.07666667**	**-15.90666667**	**93.67**
Standard Deviation	**0.011547005**	**0.011547005**	**0.055677644**
Blue Silk 1	62.83	-6.22	-39.29
Blue Silk 2	62.83	-6.17	-39.33
Blue Silk 3	62.83	-6.21	-39.31
Blue Silk Average	**62.83**	**-6.2**	**-39.31**
Standard Deviation	**0**	**0.026457513**	**0.02**
Blue Cotton 1	49.97	1.97	-46.94
Blue Cotton 2	49.97	2.01	-46.93
Blue Cotton 3	50	1.86	-46.87
Blue Cotton Average	**49.98**	**1.946666667**	**-46.91333333**
Standard Deviation	**0.017320508**	**0.077674535**	**0.037859389**

Table D.22: Colourimeter Readings After Sample 2 – Jacquard Neopaque.

Neopaque	L	a	b
After Sample 2			
Black Silk 1	41.73	0.94	2.37
Black Silk 2	41.67	0.99	2.38
Black Silk 3	41.58	0.95	2.37
Black Silk Average	**41.66**	**0.96**	**2.373333333**
Standard Deviation	**0.075498344**	**0.026457513**	**0.005773503**
Black Cotton 1	34.72	1.12	1.38
Black Cotton 2	34.71	1.16	1.39
Black Cotton 3	34.76	1.11	1.38
Black Cotton Average	**34.73**	**1.13**	**1.383333333**
Standard Deviation	**0.026457513**	**0.026457513**	**0.005773503**
White Silk 1	95.04	0.02	4.04
White Silk 2	95.03	0.05	4.04
White Silk 3	95.02	0.03	4.04
White Silk Average	**95.03**	**0.033333333**	**4.04**
Standard Deviation	**0.01**	**0.015275252**	**0**
White Cotton 1	94.52	-0.13	3.69
White Cotton 2	94.51	-0.1	3.7
White Cotton 3	94.52	-0.13	3.71
White Cotton Average	**94.51666667**	**-0.12**	**3.7**
Standard Deviation	**0.005773503**	**0.017320508**	**0.01**
Red Silk 1	65.21	46.37	9.84
Red Silk 2	65.21	46.31	9.86
Red Silk 3	65.2	46.39	9.81
Red Silk Average	**65.20666667**	**46.35666667**	**9.836666667**
Standard Deviation	**0.005773503**	**0.04163332**	**0.025166115**
Red Cotton 1	54.82	58.48	19.58
Red Cotton 2	54.75	58.53	19.55
Red Cotton 3	54.81	58.48	19.57
Red Cotton Average	**54.79333333**	**58.49666667**	**19.56666667**
Standard Deviation	**0.037859389**	**0.028867513**	**0.015275252**
Yellow Silk 1	92.69	-16.45	81.18
Yellow Silk 2	92.69	-16.44	81.18
Yellow Silk 3	92.56	-16.41	80.82
Yellow Silk Average	**92.64666667**	**-16.43333333**	**81.06**
Standard Deviation	**0.075055535**	**0.02081666**	**0.207846097**
Yellow Cotton 1	92	-15.86	93.62
Yellow Cotton 2	91.99	-15.85	93.68
Yellow Cotton 3	91.99	-15.86	93.58
Yellow Cotton Average	**91.99333333**	**-15.85666667**	**93.62666667**
Standard Deviation	**0.005773503**	**0.005773503**	**0.05033223**
Blue Silk 1	61.87	-6.15	-39.99
Blue Silk 2	61.91	-6.16	-39.95
Blue Silk 3	61.91	-6.28	-39.94
Blue Silk Average	**61.89666667**	**-6.196666667**	**-39.96**
Standard Deviation	**0.023094011**	**0.072341781**	**0.026457513**
Blue Cotton 1	49.85	1.95	-47
Blue Cotton 2	49.87	1.84	-46.97
Blue Cotton 3	49.86	1.96	-47.04
Blue Cotton Average	**49.86**	**1.916666667**	**-47.00333333**
Standard Deviation	**0.01**	**0.066583281**	**0.035118846**

Table D.23: Colourimeter Readings Before Sample 3 – Jacquard Neopaque.

Neopaque	L	a	b
Before Sample 3			
Black Silk 1	41.2	0.95	2.1
Black Silk 2	41.51	0.92	2.08
Black Silk 3	41.31	0.89	2.1
Black Silk Average	**41.34**	**0.92**	**2.093333333**
Standard Deviation	**0.157162336**	**0.03**	**0.011547005**
Black Cotton 1	36.88	1.08	1.34
Black Cotton 2	36.94	1.06	1.35
Black Cotton 3	36.9	1.06	1.31
Black Cotton Average	**36.90666667**	**1.066666667**	**1.333333333**
Standard Deviation	**0.030550505**	**0.011547005**	**0.02081666**
White Silk 1	95.25	0.08	3.45
White Silk 2	95.25	0.08	3.44
White Silk 3	95.25	0.07	3.44
White Silk Average	**95.25**	**0.076666667**	**3.443333333**
Standard Deviation	**0**	**0.005773503**	**0.005773503**
White Cotton 1	94.41	0.06	3.72
White Cotton 2	94.4	0.08	3.71
White Cotton 3	94.4	0.09	3.71
White Cotton Average	**94.40333333**	**0.076666667**	**3.713333333**
Standard Deviation	**0.005773502**	**0.015275252**	**0.005773503**
Red Silk 1	64.99	46.79	10.07
Red Silk 2	65.24	46.5	9.92
Red Silk 3	65.23	46.45	10
Red Silk Average	**65.15333333**	**46.58**	**9.996666667**
Standard Deviation	**0.141539158**	**0.183575598**	**0.075055535**
Red Cotton 1	56.54	57.01	18.06
Red Cotton 2	56.56	56.96	18.02
Red Cotton 3	56.65	56.9	17.99
Red Cotton Average	**56.58333333**	**56.95666667**	**18.02333333**
Standard Deviation	**0.058594653**	**0.055075705**	**0.035118846**
Yellow Silk 1	93.16	-16.56	78.22
Yellow Silk 2	93.16	-16.56	78.35
Yellow Silk 3	93.19	-16.58	78.27
Yellow Silk Average	**93.17**	**-16.56666667**	**78.28**
Standard Deviation	**0.017320508**	**0.011547005**	**0.065574385**
Yellow Cotton 1	91.95	-15.76	93.58
Yellow Cotton 2	91.96	-15.76	93.44
Yellow Cotton 3	91.94	-15.78	93.62
Yellow Cotton Average	**91.95**	**-15.76666667**	**93.54666667**
Standard Deviation	**0.01**	**0.011547005**	**0.094516313**
Blue Silk 1	62.48	-6.09	-39.36
Blue Silk 2	62.14	-6.15	-39.67
Blue Silk 3	62.48	-6.23	-39.34
Blue Silk Average	**62.36666667**	**-6.156666667**	**-39.45666667**
Standard Deviation	**0.196299092**	**0.070237692**	**0.185022521**
Blue Cotton 1	50.56	2.06	-47.48
Blue Cotton 2	50.66	2.01	-47.42
Blue Cotton 3	50.6	2.06	-47.46
Blue Cotton Average	**50.60666667**	**2.043333333**	**-47.45333333**
Standard Deviation	**0.05033223**	**0.028867513**	**0.030550505**

Table D.24: Colourimeter Readings After Sample 3 – Jacquard Neopaque.

Neopaque	L	a	b
After Sample 3			
Black Silk 1	40.12	1.07	2.25
Black Silk 2	40.76	0.96	2.14
Black Silk 3	40.47	1.04	2.15
Black Silk Average	**40.45**	**1.023333333**	**2.18**
Standard Deviation	**0.320468407**	**0.056862407**	**0.060827625**
Black Cotton 1	36.43	1.14	1.46
Black Cotton 2	36.47	1.06	1.44
Black Cotton 3	36.55	1.06	1.44
Black Cotton Average	**36.48333333**	**1.086666667**	**1.446666667**
Standard Deviation	**0.061101009**	**0.046188022**	**0.011547005**
White Silk 1	94.94	0.13	3.55
White Silk 2	94.94	0.11	3.56
White Silk 3	94.93	0.14	3.54
White Silk Average	**94.93666667**	**0.126666667**	**3.55**
Standard Deviation	**0.005773503**	**0.015275252**	**0.01**
White Cotton 1	94.28	0.15	3.86
White Cotton 2	94.24	0.13	3.84
White Cotton 3	94.25	0.13	3.84
White Cotton Average	**94.25666667**	**0.136666667**	**3.846666667**
Standard Deviation	**0.02081666**	**0.011547005**	**0.011547005**
Red Silk 1	64.99	46.66	9.97
Red Silk 2	65	46.6	9.98
Red Silk 3	64.97	46.68	10.01
Red Silk Average	**64.98666667**	**46.64666667**	**9.986666667**
Standard Deviation	**0.015275252**	**0.04163332**	**0.02081666**
Red Cotton 1	56.39	57.3	18.16
Red Cotton 2	56.42	57.21	18.25
Red Cotton 3	56.4	57.27	18.2
Red Cotton Average	**56.40333333**	**57.26**	**18.20333333**
Standard Deviation	**0.015275252**	**0.045825757**	**0.045092498**
Yellow Silk 1	92.84	-16.44	77.94
Yellow Silk 2	92.88	-16.42	77.91
Yellow Silk 3	92.85	-16.43	77.98
Yellow Silk Average	**92.85666667**	**-16.43**	**77.94333333**
Standard Deviation	**0.02081666**	**0.01**	**0.035118846**
Yellow Cotton 1	91.84	-15.76	93.23
Yellow Cotton 2	91.79	-15.66	93.13
Yellow Cotton 3	91.8	-15.71	93.17
Yellow Cotton Average	**91.81**	**-15.71**	**93.17666667**
Standard Deviation	**0.026457513**	**0.05**	**0.05033223**
Blue Silk 1	61.65	-6.23	-40.01
Blue Silk 2	61.66	-6.24	-39.99
Blue Silk 3	61.69	-6.3	-39.97
Blue Silk Average	**61.66666667**	**-6.256666667**	**-39.99**
Standard Deviation	**0.02081666**	**0.037859389**	**0.02**
Blue Cotton 1	50.47	2.01	-47.46
Blue Cotton 2	50.54	1.87	-47.39
Blue Cotton 3	50.55	1.95	-47.45
Blue Cotton Average	**50.52**	**1.943333333**	**-47.43333333**
Standard Deviation	**0.043588989**	**0.070237692**	**0.037859389**

Jacquard Neopaque Statistics

Table D.25: Jacquard Neopaque Average Before colour readings

Neopaque Before	L	a	b
Average	42.55888667	0.872222333	2.171111
Standard Deviation	1.113682419	0.042207538	0.067357724
Average	35.48555667	1.068889	1.273333333
Standard Deviation	1.233210411	0.023412216	0.061734044
Average	95.17777667	0.068889	3.937777667
Standard Deviation	0.220713003	0.078622082	0.44088734
Average	94.74777667	-0.037777667	3.728888667
Standard Deviation	0.38286111	0.118525045	0.157244638
Average	65.32333333	46.24333333	9.786666667
Standard Deviation	0.159619617	0.29327687	0.182056453
Average	55.54666667	57.81667	18.86444333
Standard Deviation	0.937979223	0.754387169	0.754074751
Average	93.13444667	-16.56	79.41444667
Standard Deviation	0.058719925	0.008819802	1.138354923
Average	92.00222333	-15.78668	93.61555667
Standard Deviation	0.066194634	0.111352594	0.06292082
Average	62.35	-6.11	-39.64
Standard Deviation	0.488548349	0.120323892	0.450564966
Average	49.76	2.363333333	-47.16777667
Standard Deviation	0.975457579	0.639800291	0.271340595

Table D.26: Jacquard Neopaque Average After colour readings

Neopaque After	L	a	b
Average	41.73666667	0.992222	2.276666667
Standard Deviation	1.326662479	0.031681114	0.0966665
Average	35.27333333	1.085555667	1.377777667
Standard Deviation	1.049700682	0.045010291	0.071828304
Average	94.88	0.11	3.996666667
Standard Deviation	0.184964832	0.069841312	0.426653646
Average	94.60444667	0.007778	3.834444667
Standard Deviation	0.39897372	0.128337107	0.128769275
Average	65.13555667	46.39889	9.856667
Standard Deviation	0.128982629	0.229600055	0.121243557
Average	55.45999667	58.02111333	18.95777667
Standard Deviation	0.839900788	0.6659543	0.693226744
Average	92.77889	-16.43444333	79.50555333
Standard Deviation	0.115099023	0.005092115	1.558349553
Average	91.89222	-15.71111333	93.48778
Standard Deviation	0.093113352	0.145003206	0.269944061
Average	61.62778	-6.215555667	-40.22111
Standard Deviation	0.29029536	0.035642463	0.426538857
Average	49.63555667	2.310001	-47.19444333
Standard Deviation	1.015441889	0.658313443	0.218944556

Table D.27: Jacquard Neopaque Average change in colour readings

Neopaque	L change	a Change	b Change	**Overall Change**
Black Silk	-0.82222	0.119999667	0.105555667	**0.83760829**
Black Cotton	-0.212223333	0.016666667	0.104444333	**0.237118409**
White Silk	-0.297776667	0.041111	0.058889	**0.306315151**
White Cotton	-0.14333	0.045555667	0.105556	**0.183741331**
Red Silk	-0.187776667	0.155556667	0.070000333	**0.253688785**
Red Cotton	-0.08667	0.204443333	0.093333333	**0.240873154**
Yellow Silk	-0.355556667	0.125556667	0.091106667	**0.387924534**
Yellow Cotton	-0.110003333	0.075566667	-0.127776667	**0.184764529**
Blue Silk	-0.72222	-0.105555667	-0.58111	**0.932969753**
Blue Cotton	-0.124443333	-0.053332333	-0.026666667	**0.137991275**

Appendix E: Light Ageing Data

Table E.1: Colourimeter Readings Before Sample 1 – Deka Silk.

Deka Silk	L	a	b
Before Sample 1			
Black Silk 1	28.68	2.46	0.91
Black Silk 2	28.59	2.52	0.94
Black Silk 3	28.64	2.46	0.93
Black Silk Average	**28.63666667**	**2.48**	**0.926666667**
Standard Deviation	**0.045092498**	**0.034641016**	**0.015275252**
Black Cotton 1	21.62	3.22	2
Black Cotton 2	21.67	3.02	2.04
Black Cotton 3	21.65	3.14	2.07
Black Cotton Average	**21.64666667**	**3.126666667**	**2.036666667**
Standard Deviation	**0.025166115**	**0.100664459**	**0.035118846**
White Silk 1	95.55	-0.07	3.41
White Silk 2	95.59	-0.1	3.43
White Silk 3	95.57	-0.08	3.42
White Silk Average	**95.57**	**-0.083333333**	**3.42**
Standard Deviation	**0.02**	**0.015275252**	**0.01**
White Cotton 1	94.31	-0.37	3.29
White Cotton 2	94.34	-0.35	3.29
White Cotton 3	94.32	-0.35	3.26
White Cotton Average	**94.32333333**	**-0.356666667**	**3.28**
Standard Deviation	**0.015275252**	**0.011547005**	**0.017320508**
Red Silk 1	52.51	59.48	33.35
Red Silk 2	52.25	59.69	33.88
Red Silk 3	52.05	60.04	34.3
Red Silk Average	**52.27**	**59.73666667**	**33.84333333**
Standard Deviation	**0.230651252**	**0.282901632**	**0.47606022**
Red Cotton 1	46.54	60.47	35.31
Red Cotton 2	46.53	60.43	35.26
Red Cotton 3	46.55	60.42	35.21
Red Cotton Average	**46.54**	**60.44**	**35.26**
Standard Deviation	**0.01**	**0.026457513**	**0.05**
Yellow Silk 1	85.99	1.65	94.97
Yellow Silk 2	85.86	1.71	94.8
Yellow Silk 3	85.85	1.72	94.8
Yellow Silk Average	**85.9**	**1.693333333**	**94.85666667**
Standard Deviation	**0.078102497**	**0.037859389**	**0.098149546**
Yellow Cotton 1	82.33	11.85	101.99
Yellow Cotton 2	82.34	11.8	101.93
Yellow Cotton 3	82.32	11.81	101.95
Yellow Cotton Average	**82.33**	**11.82**	**101.9566667**
Standard Deviation	**0.01**	**0.026457513**	**0.030550505**
Blue Silk 1	38.24	14.8	-46.01
Blue Silk 2	38.2	14.86	-46.01
Blue Silk 3	38.04	14.71	-45.94
Blue Silk Average	**38.16**	**14.79**	**-45.98666667**
Standard Deviation	**0.105830052**	**0.075498344**	**0.040414519**
Blue Cotton 1	33.65	15.38	-42.95
Blue Cotton 2	33.6	15.49	-43.07
Blue Cotton 3	33.63	15.44	-43.04
Blue Cotton Average	**33.62666667**	**15.43666667**	**-43.02**
Standard Deviation	**0.025166115**	**0.055075705**	**0.06244998**

Table E.2: Colourimeter Readings After Sample 1 – Deka Silk.

Deka Silk	L	a	b
After Sample 1			
Black Silk 1	28.72	2.85	1.45
Black Silk 2	28.78	2.65	1.53
Black Silk 3	28.41	2.84	1.49
Black Silk Average	**28.63666667**	**2.78**	**1.49**
Standard Deviation	**0.19857828**	**0.112694277**	**0.04**
Black Cotton 1	21.84	3.12	2.09
Black Cotton 2	21.85	2.97	2.07
Black Cotton 3	21.84	3.12	2.06
Black Cotton Average	**21.84333333**	**3.07**	**2.073333333**
Standard Deviation	**0.005773503**	**0.08660254**	**0.015275252**
White Silk 1	95.4	-0.04	3.45
White Silk 2	95.36	-0.01	3.48
White Silk 3	95.49	-0.05	3.46
White Silk Average	**95.41666667**	**-0.033333333**	**3.463333333**
Standard Deviation	**0.066583281**	**0.02081666**	**0.015275252**
White Cotton 1	94.66	0.25	4.06
White Cotton 2	94.65	0.26	4.06
White Cotton 3	94.65	0.25	4.07
White Cotton Average	**94.65333333**	**0.253333333**	**4.063333333**
Standard Deviation	**0.005773503**	**0.005773503**	**0.005773503**
Red Silk 1	52.38	60.08	33.79
Red Silk 2	52.02	60.21	34.15
Red Silk 3	51.96	60.28	34.21
Red Silk Average	**52.12**	**60.19**	**34.05**
Standard Deviation	**0.227156334**	**0.101488916**	**0.227156334**
Red Cotton 1	46.64	61.01	35.28
Red Cotton 2	46.66	60.99	35.26
Red Cotton 3	46.67	60.99	35.25
Red Cotton Average	**46.65666667**	**60.99666667**	**35.26333333**
Standard Deviation	**0.015275252**	**0.011547005**	**0.015275252**
Yellow Silk 1	86.16	2.85	90.37
Yellow Silk 2	86.14	2.88	90.51
Yellow Silk 3	86.15	2.8	90.31
Yellow Silk Average	**86.15**	**2.843333333**	**90.39666667**
Standard Deviation	**0.01**	**0.040414519**	**0.102632029**
Yellow Cotton 1	82.03	12.3	101
Yellow Cotton 2	82	12.36	100.97
Yellow Cotton 3	82.03	12.29	101.03
Yellow Cotton Average	**82.02**	**12.31666667**	**101**
Standard Deviation	**0.017320508**	**0.037859389**	**0.03**
Blue Silk 1	38.11	14.57	-45.93
Blue Silk 2	38.16	14.57	-45.83
Blue Silk 3	38.08	14.52	-45.93
Blue Silk Average	**38.11666667**	**14.55333333**	**-45.89666667**
Standard Deviation	**0.040414519**	**0.028867513**	**0.057735027**
Blue Cotton 1	34.06	14.44	-41.61
Blue Cotton 2	34.07	14.47	-41.66
Blue Cotton 3	34.08	14.35	-41.63
Blue Cotton Average	**34.07**	**14.42**	**-41.63333333**
Standard Deviation	**0.01**	**0.06244998**	**0.025166115**

Table E.3: Colourimeter Readings Before Sample 2 – Deka Silk.

Deka Silk	L	a	b
Before Sample 2			
Black Silk 1	27.86	2.57	1.6
Black Silk 2	27.82	2.57	1.63
Black Silk 3	27.78	2.75	1.56
Black Silk Average	**27.82**	**2.63**	**1.596666667**
Standard Deviation	**0.04**	**0.103923048**	**0.035118846**
Black Cotton 1	21.99	3.27	2.08
Black Cotton 2	21.98	3.31	2.02
Black Cotton 3	22	3.11	2.08
Black Cotton Average	**21.99**	**3.23**	**2.06**
Standard Deviation	**0.01**	**0.105830052**	**0.034641016**
White Silk 1	95.5	-0.07	3.4
White Silk 2	95.5	-0.09	3.4
White Silk 3	95.51	-0.07	3.41
White Silk Average	**95.50333333**	**-0.076666667**	**3.403333333**
Standard Deviation	**0.005773503**	**0.011547005**	**0.005773503**
White Cotton 1	95.39	-0.23	3.76
White Cotton 2	95.39	-0.25	3.77
White Cotton 3	95.38	-0.22	3.77
White Cotton Average	**95.38666667**	**-0.233333333**	**3.766666667**
Standard Deviation	**0.005773503**	**0.015275252**	**0.005773503**
Red Silk 1	51.69	60.75	33.83
Red Silk 2	51.63	60.79	33.74
Red Silk 3	51.67	60.76	33.68
Red Silk Average	**51.66333333**	**60.76666667**	**33.75**
Standard Deviation	**0.030550505**	**0.02081666**	**0.075498344**
Red Cotton 1	45.33	61.89	36.48
Red Cotton 2	45.27	62	36.37
Red Cotton 3	45.29	62.01	36.45
Red Cotton Average	**45.29666667**	**61.96666667**	**36.43333333**
Standard Deviation	**0.030550505**	**0.066583281**	**0.056862407**
Yellow Silk 1	84.95	6.91	99.31
Yellow Silk 2	84.96	6.85	99.19
Yellow Silk 3	84.97	6.96	98.99
Yellow Silk Average	**84.96**	**6.906666667**	**99.16333333**
Standard Deviation	**0.01**	**0.055075705**	**0.161658075**
Yellow Cotton 1	81.9	12.56	102.08
Yellow Cotton 2	81.88	12.58	102.08
Yellow Cotton 3	81.92	12.49	102.04
Yellow Cotton Average	**81.9**	**12.54333333**	**102.0666667**
Standard Deviation	**0.02**	**0.047258156**	**0.023094011**
Blue Silk 1	35.96	16.63	-47.91
Blue Silk 2	35.95	16.62	-47.91
Blue Silk 3	36.15	16.44	-47.78
Blue Silk Average	**36.02**	**16.56333333**	**-47.86666667**
Standard Deviation	**0.112694277**	**0.106926766**	**0.075055535**
Blue Cotton 1	28.5	16.38	-39.95
Blue Cotton 2	28.41	16.51	-40.02
Blue Cotton 3	28.45	16.29	-39.95
Blue Cotton Average	**28.45333333**	**16.39333333**	**-39.97333333**
Standard Deviation	**0.045092498**	**0.1106044**	**0.040414519**

Table E.4: Colourimeter Readings After Sample 2 – Deka Silk.

Deka Silk	L	a	b
After Sample 2			
Black Silk 1	27.51	2.53	1.74
Black Silk 2	27.58	2.52	1.67
Black Silk 3	27.67	2.55	1.65
Black Silk Average	**27.58666667**	**2.533333333**	**1.686666667**
Standard Deviation	**0.080208063**	**0.015275252**	**0.047258156**
Black Cotton 1	22.24	3.06	2.09
Black Cotton 2	22.22	3.39	2.04
Black Cotton 3	22.26	3.01	2.12
Black Cotton Average	**22.24**	**3.153333333**	**2.083333333**
Standard Deviation	**0.02**	**0.206478409**	**0.040414519**
White Silk 1	95.53	-0.2	3.75
White Silk 2	95.51	-0.16	3.75
White Silk 3	95.51	-0.14	3.74
White Silk Average	**95.51666667**	**-0.166666667**	**3.746666667**
Standard Deviation	**0.011547005**	**0.030550505**	**0.005773503**
White Cotton 1	95.24	-0.16	3.54
White Cotton 2	95.26	-0.18	3.53
White Cotton 3	95.22	-0.12	3.54
White Cotton Average	**95.24**	**-0.153333333**	**3.536666667**
Standard Deviation	**0.02**	**0.030550505**	**0.005773503**
Red Silk 1	51.41	60.51	33.56
Red Silk 2	51.41	60.43	33.5
Red Silk 3	51.35	60.57	33.61
Red Silk Average	**51.39**	**60.50333333**	**33.55666667**
Standard Deviation	**0.034641016**	**0.070237692**	**0.055075705**
Red Cotton 1	45.17	61.04	35.66
Red Cotton 2	45.16	61.07	35.69
Red Cotton 3	45.17	61.02	35.64
Red Cotton Average	**45.16666667**	**61.04333333**	**35.66333333**
Standard Deviation	**0.005773503**	**0.025166115**	**0.025166115**
Yellow Silk 1	84.44	7.01	100.39
Yellow Silk 2	84.43	6.99	100.38
Yellow Silk 3	84.42	6.99	100.28
Yellow Silk Average	**84.43**	**6.996666667**	**100.35**
Standard Deviation	**0.01**	**0.011547005**	**0.060827625**
Yellow Cotton 1	81.62	12.72	101.55
Yellow Cotton 2	81.59	12.81	101.52
Yellow Cotton 3	81.66	12.8	101.26
Yellow Cotton Average	**81.62333333**	**12.77666667**	**101.4433333**
Standard Deviation	**0.035118846**	**0.049328829**	**0.159478316**
Blue Silk 1	36.82	15.67	-46.96
Blue Silk 2	36.85	15.6	-46.87
Blue Silk 3	36.96	15.5	-46.8
Blue Silk Average	**36.87666667**	**15.59**	**-46.87666667**
Standard Deviation	**0.073711148**	**0.085440037**	**0.080208063**
Blue Cotton 1	28.66	15.93	-39.5
Blue Cotton 2	28.66	15.93	-39.5
Blue Cotton 3	28.64	15.91	-39.51
Blue Cotton Average	**28.65333333**	**15.92333333**	**-39.50333333**
Standard Deviation	**0.011547005**	**0.011547005**	**0.005773503**

Table E.5: Colourimeter Readings Before Sample 3 – Deka Silk.

Deka Silk	L	a	b
Before Sample 3			
Black Silk 1	28.05	2.65	1.59
Black Silk 2	28.04	2.71	1.59
Black Silk 3	28.03	2.65	1.6
Black Silk Average	**28.04**	**2.67**	**1.593333333**
Standard Deviation	**0.01**	**0.034641016**	**0.005773503**
Black Cotton 1	22.15	3.44	1.78
Black Cotton 2	22.19	3.17	1.88
Black Cotton 3	22.18	3.21	1.76
Black Cotton Average	**22.17333333**	**3.273333333**	**1.806666667**
Standard Deviation	**0.02081666**	**0.14571662**	**0.064291005**
White Silk 1	95.45	-0.01	3.47
White Silk 2	95.48	-0.02	3.47
White Silk 3	95.54	-0.03	3.46
White Silk Average	**95.49**	**-0.02**	**3.466666667**
Standard Deviation	**0.045825757**	**0.01**	**0.005773503**
White Cotton 1	95.27	-0.26	3.75
White Cotton 2	95.26	-0.2	3.73
White Cotton 3	95.26	-0.26	3.75
White Cotton Average	**95.26333333**	**-0.24**	**3.743333333**
Standard Deviation	**0.005773503**	**0.034641016**	**0.011547005**
Red Silk 1	52.19	60.48	33.34
Red Silk 2	52.13	60.6	33.46
Red Silk 3	52.19	60.5	33.33
Red Silk Average	**52.17**	**60.52666667**	**33.37666667**
Standard Deviation	**0.034641016**	**0.064291005**	**0.072341781**
Red Cotton 1	45.25	62.46	36.9
Red Cotton 2	45.23	62.57	36.87
Red Cotton 3	45.26	62.49	36.86
Red Cotton Average	**45.24666667**	**62.50666667**	**36.87666667**
Standard Deviation	**0.015275252**	**0.056862407**	**0.02081666**
Yellow Silk 1	85.65	4.4	96.89
Yellow Silk 2	85.74	4.43	96.01
Yellow Silk 3	85.69	4.57	96.3
Yellow Silk Average	**85.69333333**	**4.466666667**	**96.4**
Standard Deviation	**0.045092498**	**0.090737717**	**0.448441746**
Yellow Cotton 1	82.24	12.39	102.2
Yellow Cotton 2	82.21	12.44	102.19
Yellow Cotton 3	82.23	12.42	102.26
Yellow Cotton Average	**82.22666667**	**12.41666667**	**102.2166667**
Standard Deviation	**0.015275252**	**0.025166115**	**0.037859389**
Blue Silk 1	35.75	16.16	-46.54
Blue Silk 2	35.84	16.12	-46.37
Blue Silk 3	36.01	15.93	-46.22
Blue Silk Average	**35.86666667**	**16.07**	**-46.37666667**
Standard Deviation	**0.132035349**	**0.122882057**	**0.160104133**
Blue Cotton 1	27.4	16.99	-40
Blue Cotton 2	27.42	16.93	-39.96
Blue Cotton 3	27.4	17.07	-40.02
Blue Cotton Average	**27.40666667**	**16.99666667**	**-39.99333333**
Standard Deviation	**0.011547005**	**0.070237692**	**0.030550505**

Table E.6: Colourimeter Readings After Sample 3 – Deka Silk.

Deka Silk	L	a	b
After Sample 3			
Black Silk 1	27.92	2.54	1.73
Black Silk 2	27.87	2.74	1.67
Black Silk 3	27.83	2.72	1.68
Black Silk Average	**27.87333333**	**2.666666667**	**1.693333333**
Standard Deviation	**0.045092498**	**0.110151411**	**0.032145503**
Black Cotton 1	22.54	3.14	1.92
Black Cotton 2	22.51	3.41	1.88
Black Cotton 3	22.52	3.15	1.9
Black Cotton Average	**22.52333333**	**3.233333333**	**1.9**
Standard Deviation	**0.015275252**	**0.1530795**	**0.02**
White Silk 1	95.31	-0.04	3.57
White Silk 2	95.31	-0.07	3.57
White Silk 3	95.3	-0.03	3.56
White Silk Average	**95.30666667**	**-0.046666667**	**3.566666667**
Standard Deviation	**0.005773503**	**0.02081666**	**0.005773503**
White Cotton 1	95.39	-0.16	3.34
White Cotton 2	95.37	-0.17	3.37
White Cotton 3	95.36	-0.16	3.36
White Cotton Average	**95.37333333**	**-0.163333333**	**3.356666667**
Standard Deviation	**0.015275252**	**0.005773503**	**0.015275252**
Red Silk 1	51.96	59.34	32.72
Red Silk 2	52.04	59.15	32.65
Red Silk 3	52	59.27	32.62
Red Silk Average	**52**	**59.25333333**	**32.66333333**
Standard Deviation	**0.04**	**0.096090235**	**0.051316014**
Red Cotton 1	45.14	61.64	36.35
Red Cotton 2	45.1	61.63	36.4
Red Cotton 3	45.13	61.6	36.31
Red Cotton Average	**45.12333333**	**61.62333333**	**36.35333333**
Standard Deviation	**0.02081666**	**0.02081666**	**0.045092498**
Yellow Silk 1	85.47	4.77	96.24
Yellow Silk 2	85.46	4.75	96.47
Yellow Silk 3	85.45	4.82	96.21
Yellow Silk Average	**85.46**	**4.78**	**96.30666667**
Standard Deviation	**0.01**	**0.036055513**	**0.142243922**
Yellow Cotton 1	81.59	12.5	100.09
Yellow Cotton 2	81.59	12.49	100.21
Yellow Cotton 3	81.58	12.52	100.19
Yellow Cotton Average	**81.58666667**	**12.50333333**	**100.1633333**
Standard Deviation	**0.005773503**	**0.015275252**	**0.064291005**
Blue Silk 1	36.46	15.15	-45.35
Blue Silk 2	36.48	15.11	-45.31
Blue Silk 3	36.46	15.31	-45.38
Blue Silk Average	**36.46666667**	**15.19**	**-45.34666667**
Standard Deviation	**0.011547005**	**0.105830052**	**0.035118846**
Blue Cotton 1	27.56	16.64	-39.69
Blue Cotton 2	27.58	16.6	-39.69
Blue Cotton 3	27.57	16.66	-39.67
Blue Cotton Average	**27.57**	**16.63333333**	**-39.68333333**
Standard Deviation	**0.01**	**0.030550505**	**0.011547005**

Deka Silk Statistics

Table E.7: Deka Silk Average Before colour readings

Deka Silk Before	L	a	b
Black Silk Average	28.16555667	2.593333333	1.372222333
Standard Deviation	0.422564586	0.100166528	0.385865838
Black Cotton Average	21.93666667	3.21	1.967778
Standard Deviation	0.26735	0.075350706	0.140013117
White Silk Average	95.52111	-0.06	3.43
Standard Deviation	0.042861361	0.03480099	0.032829848
White Cotton Average	94.99111	-0.276666667	3.596666667
Standard Deviation	0.581593316	0.06936247	0.274489439
Red Silk Average	52.03444333	60.34333667	33.65666667
Standard Deviation	0.325259634	0.53891867	0.246933639
Red Cotton Average	45.69444667	61.63778	36.19
Standard Deviation	0.732697297	1.071871119	0.835351776
Yellow Silk Average	85.51777667	4.355555667	96.80666667
Standard Deviation	0.493977965	2.608442475	2.181940288
Yellow Cotton Average	82.15222333	12.26	102.0800333
Standard Deviation	0.224458748	0.386277994	0.130511813
Blue Silk Average	36.68222333	15.80777667	-46.74333667
Standard Deviation	1.282086358	0.915284453	0.992186138
Blue Cotton Average	29.82889	16.27555667	-40.99555333
Standard Deviation	3.330348928	0.786640273	1.753250761

Table E.8: Deka Silk Average After colour readings

Deka Silk After	L	a	b
Black Silk Average	28.03222333	2.66	1.623333333
Standard Deviation	0.542734114	0.123468574	0.115518147
Black Cotton Average	22.20222	3.152222	2.018888667
Standard Deviation	0.341570631	0.081672168	0.10308194
White Silk Average	95.41333667	-0.082222333	3.592222333
Standard Deviation	0.105039675	0.073434496	0.143385303
White Cotton Average	95.08888667	-0.021111	3.652222333
Standard Deviation	0.383048861	0.237728063	0.367231514
Red Silk Average	51.83666667	59.98222	33.42333333
Standard Deviation	0.391450295	0.650387881	0.70288507
Red Cotton Average	45.64889	61.22111	35.75999667
Standard Deviation	0.873032064	0.349113141	0.551392177
Yellow Silk Average	85.34666667	4.873333333	95.68444667
Standard Deviation	0.865582655	2.078239438	5.005753283
Yellow Cotton Average	81.74333333	12.53222333	100.8688667
Standard Deviation	0.240300483	0.231357123	0.649997664
Blue Silk Average	37.15333667	15.11111	-46.04000333
Standard Deviation	0.859088664	0.522818225	0.775005376
Blue Cotton Average	30.09777667	15.65888667	-40.27333
Standard Deviation	3.482430133	1.130112884	1.181228174

Table E.9: Deka Silk Average change in colour readings

Deka	L change	a Change	b Change	**Overall Change**
Black Silk	-0.133333333	0.066666667	0.251111	**0.292025609**
Black Cotton	0.265553333	-0.057778	0.051110667	**0.276530596**
White Silk	-0.107773333	-0.022222333	0.162222333	**0.196022981**
White Cotton	0.097776667	0.255555667	0.055555667	**0.279204956**
Red Silk	-0.197776667	-0.361116667	-0.233333333	**0.473249724**
Red Cotton	-0.045556667	-0.41667	-0.430003333	**0.600493268**
Yellow Silk	-0.17111	0.517777667	-1.12222	**1.247697909**
Yellow Cotton	-0.40889	0.272223333	-1.211166667	**1.306989392**
Blue Silk	0.471113333	-0.696666667	0.703333333	**1.096343922**
Blue Cotton	0.268886667	-0.61667	0.722223333	**0.987009864**

Table E.10: Colourimeter Readings Before Sample 1 – SetaSilk.

SetaColour	L	a	b
Before Sample 1			
Black Silk 1	29.71	0.36	0.71
Black Silk 2	30.27	0.37	0.58
Black Silk 3	30.15	0.45	0.59
Black Silk Average	**30.04333333**	**0.393333333**	**0.626666667**
Standard Deviation	**0.294844592**	**0.049328829**	**0.072341781**
Black Cotton 1	23.2	0.85	0.11
Black Cotton 2	23.25	0.63	0.08
Black Cotton 3	23.22	0.77	0.13
Black Cotton Average	**23.22333333**	**0.75**	**0.106666667**
Standard Deviation	**0.025166115**	**0.111355287**	**0.025166115**
White Silk 1	94.82	-0.84	2.97
White Silk 2	94.87	-0.84	3
White Silk 3	94.69	-0.81	3.01
White Silk Average	**94.79333333**	**-0.83**	**2.993333333**
Standard Deviation	**0.092915732**	**0.017320508**	**0.02081666**
White Cotton 1	94.39	-0.57	2.76
White Cotton 2	94.41	-0.6	2.76
White Cotton 3	94.37	-0.62	2.81
White Cotton Average	**94.39**	**-0.596666667**	**2.776666667**
Standard Deviation	**0.02**	**0.025166115**	**0.028867513**
Red Silk 1	56.36	59.03	34.72
Red Silk 2	56.37	59.07	34.6
Red Silk 3	56.61	58.7	34.15
Red Silk Average	**56.44666667**	**58.93333333**	**34.49**
Standard Deviation	**0.141539158**	**0.203059925**	**0.300499584**
Red Cotton 1	48.34	61.67	41.71
Red Cotton 2	48.3	61.65	41.67
Red Cotton 3	48.32	61.68	41.64
Red Cotton Average	**48.32**	**61.66666667**	**41.67333333**
Standard Deviation	**0.02**	**0.015275252**	**0.035118846**
Yellow Silk 1	93.38	-18.27	71.26
Yellow Silk 2	93.35	-18.29	71.35
Yellow Silk 3	93.31	-18.31	71.46
Yellow Silk Average	**93.34666667**	**-18.29**	**71.35666667**
Standard Deviation	**0.035118846**	**0.02**	**0.100166528**
Yellow Cotton 1	92.87	-18.56	74.68
Yellow Cotton 2	92.88	-18.55	74.65
Yellow Cotton 3	92.88	-18.57	74.69
Yellow Cotton Average	**92.87666667**	**-18.56**	**74.67333333**
Standard Deviation	**0.005773503**	**0.01**	**0.02081666**
Blue Silk 1	36.22	17.84	-44.09
Blue Silk 2	36.44	17.65	-43.85
Blue Silk 3	35.62	18.35	-44.54
Blue Silk Average	**36.09333333**	**17.94666667**	**-44.16**
Standard Deviation	**0.424421174**	**0.361985267**	**0.350285598**
Blue Cotton 1	25.43	17.21	-33.55
Blue Cotton 2	25.45	17.19	-33.59
Blue Cotton 3	25.43	17.16	-33.59
Blue Cotton Average	**25.43666667**	**17.18666667**	**-33.57666667**
Standard Deviation	**0.011547005**	**0.025166115**	**0.023094011**

Table E.11: Colourimeter Readings After Sample 1 – SetaSilk.

SetaColour	L	a	b
After Sample 1			
Black Silk 1	29.82	0.82	1.07
Black Silk 2	29.8	0.88	1.04
Black Silk 3	30.21	0.8	1.03
Black Silk Average	**29.94333333**	**0.833333333**	**1.046666667**
Standard Deviation	**0.231156513**	**0.04163332**	**0.02081666**
Black Cotton 1	23.23	0.99	0.44
Black Cotton 2	23.27	1.06	0.48
Black Cotton 3	23.22	1.18	0.37
Black Cotton Average	**23.24**	**1.076666667**	**0.43**
Standard Deviation	**0.026457513**	**0.096090235**	**0.055677644**
White Silk 1	94.6	-0.03	4.31
White Silk 2	94.73	-0.05	4.29
White Silk 3	94.65	-0.07	4.34
White Silk Average	**94.66**	**-0.05**	**4.313333333**
Standard Deviation	**0.065574385**	**0.02**	**0.025166115**
White Cotton 1	94.3	0.01	4.54
White Cotton 2	94.31	0.06	4.54
White Cotton 3	94.27	0	4.54
White Cotton Average	**94.29333333**	**0.023333333**	**4.54**
Standard Deviation	**0.02081666**	**0.032145503**	**0**
Red Silk 1	55.66	61.63	39.78
Red Silk 2	55.82	61.48	39.29
Red Silk 3	55.51	61.74	40.1
Red Silk Average	**55.66333333**	**61.61666667**	**39.72333333**
Standard Deviation	**0.155026879**	**0.130511813**	**0.407962417**
Red Cotton 1	48.33	61.5	41.25
Red Cotton 2	48.26	61.54	41.09
Red Cotton 3	48.27	61.51	41.11
Red Cotton Average	**48.28666667**	**61.51666667**	**41.15**
Standard Deviation	**0.037859389**	**0.02081666**	**0.087177979**
Yellow Silk 1	93.03	-17.73	70.6
Yellow Silk 2	92.93	-17.8	70.88
Yellow Silk 3	93	-17.78	70.7
Yellow Silk Average	**92.98666667**	**-17.77**	**70.72666667**
Standard Deviation	**0.051316014**	**0.036055513**	**0.141891978**
Yellow Cotton 1	92.86	-17.32	74.52
Yellow Cotton 2	92.89	-17.39	74.46
Yellow Cotton 3	92.87	-17.33	74.41
Yellow Cotton Average	**92.87333333**	**-17.34666667**	**74.46333333**
Standard Deviation	**0.015275252**	**0.037859389**	**0.055075705**
Blue Silk 1	35.65	17.28	-43.5
Blue Silk 2	35.62	17.28	-43.41
Blue Silk 3	35.6	17.28	-43.43
Blue Silk Average	**35.62333333**	**17.28**	**-43.44666667**
Standard Deviation	**0.025166115**	**0**	**0.047258156**
Blue Cotton 1	25.71	16.7	-33.32
Blue Cotton 2	25.68	16.52	-33.35
Blue Cotton 3	25.65	16.73	-33.41
Blue Cotton Average	**25.68**	**16.65**	**-33.36**
Standard Deviation	**0.03**	**0.113578167**	**0.045825757**

Table E.12: Colourimeter Readings Before Sample 2 – SetaSilk.

SetaColour	L	a	b
Before Sample 2			
Black Silk 1	29.29	0.78	0.98
Black Silk 2	29.26	0.72	1.02
Black Silk 3	29.5	0.76	1.04
Black Silk Average	**29.35**	**0.753333333**	**1.013333333**
Standard Deviation	**0.130766968**	**0.030550505**	**0.030550505**
Black Cotton 1	23.33	0.99	0.37
Black Cotton 2	23.32	0.96	0.39
Black Cotton 3	23.29	0.96	0.34
Black Cotton Average	**23.31333333**	**0.97**	**0.366666667**
Standard Deviation	**0.02081666**	**0.017320508**	**0.025166115**
White Silk 1	95.44	-0.04	3.39
White Silk 2	95.45	-0.05	3.39
White Silk 3	95.45	-0.02	3.41
White Silk Average	**95.44666667**	**-0.036666667**	**3.396666667**
Standard Deviation	**0.005773503**	**0.015275252**	**0.011547005**
White Cotton 1	95.32	-0.16	3.66
White Cotton 2	95.32	-0.11	3.64
White Cotton 3	95.33	-0.12	3.64
White Cotton Average	**95.32333333**	**-0.13**	**3.646666667**
Standard Deviation	**0.005773503**	**0.026457513**	**0.011547005**
Red Silk 1	55.94	61.29	39.44
Red Silk 2	56.06	61.18	39.05
Red Silk 3	55.6	61.7	39.98
Red Silk Average	**55.86666667**	**61.39**	**39.49**
Standard Deviation	**0.238607069**	**0.274043792**	**0.467011777**
Red Cotton 1	49.06	64.06	43.41
Red Cotton 2	49.02	64.17	43.33
Red Cotton 3	49.02	64.14	43.38
Red Cotton Average	**49.03333333**	**64.12333333**	**43.37333333**
Standard Deviation	**0.023094011**	**0.056862407**	**0.040414519**
Yellow Silk 1	93.31	-18.05	70.52
Yellow Silk 2	93.32	-18.11	70.47
Yellow Silk 3	93.32	-18.09	70.46
Yellow Silk Average	**93.31666667**	**-18.08333333**	**70.48333333**
Standard Deviation	**0.005773503**	**0.030550505**	**0.032145503**
Yellow Cotton 1	90.4	-16.9	78.69
Yellow Cotton 2	90.41	-16.87	78.65
Yellow Cotton 3	90.45	-16.87	78.7
Yellow Cotton Average	**90.42**	**-16.88**	**78.68**
Standard Deviation	**0.026457513**	**0.017320508**	**0.026457513**
Blue Silk 1	33.24	18.98	-42.35
Blue Silk 2	33.7	18.68	-42.02
Blue Silk 3	33.67	18.75	-42.08
Blue Silk Average	**33.53666667**	**18.80333333**	**-42.15**
Standard Deviation	**0.257358375**	**0.156950098**	**0.175783958**
Blue Cotton 1	25.63	17.35	-34.06
Blue Cotton 2	25.63	17.3	-34.02
Blue Cotton 3	25.65	17.31	-34.09
Blue Cotton Average	**25.63666667**	**17.32**	**-34.05666667**
Standard Deviation	**0.011547005**	**0.026457513**	**0.035118846**

Table E.13: Colourimeter Readings After Sample 2 – SetaSilk.

SetaColour	L	a	b
After Sample 2			
Black Silk 1	29.23	0.8	0.98
Black Silk 2	29.29	0.61	1.05
Black Silk 3	29.66	0.76	0.94
Black Silk Average	**29.39333333**	**0.723333333**	**0.99**
Standard Deviation	**0.232880513**	**0.100166528**	**0.055677644**
Black Cotton 1	23.3	0.85	0.36
Black Cotton 2	23.35	0.92	0.42
Black Cotton 3	23.28	0.95	0.4
Black Cotton Average	**23.31**	**0.906666667**	**0.393333333**
Standard Deviation	**0.036055513**	**0.051316014**	**0.030550505**
White Silk 1	95.16	-0.09	4.09
White Silk 2	95.16	-0.14	4.12
White Silk 3	95.18	-0.11	4.11
White Silk Average	**95.16666667**	**-0.113333333**	**4.106666667**
Standard Deviation	**0.011547005**	**0.025166115**	**0.015275252**
White Cotton 1	95.16	-0.07	3.7
White Cotton 2	95.14	-0.07	3.68
White Cotton 3	95.14	-0.02	3.68
White Cotton Average	**95.14666667**	**-0.053333333**	**3.686666667**
Standard Deviation	**0.011547005**	**0.028867513**	**0.011547005**
Red Silk 1	55.76	61.3	39.32
Red Silk 2	55.72	61.31	39.65
Red Silk 3	55.68	61.34	39.46
Red Silk Average	**55.72**	**61.31666667**	**39.47666667**
Standard Deviation	**0.04**	**0.02081666**	**0.16563011**
Red Cotton 1	49.09	64.23	43.01
Red Cotton 2	49.1	64.16	43.02
Red Cotton 3	49.08	64.2	42.95
Red Cotton Average	**49.09**	**64.19666667**	**42.99333333**
Standard Deviation	**0.01**	**0.035118846**	**0.037859389**
Yellow Silk 1	92.83	-17.88	70.4
Yellow Silk 2	92.84	-17.92	70.48
Yellow Silk 3	93.06	-17.83	70.15
Yellow Silk Average	**92.91**	**-17.87666667**	**70.34333333**
Standard Deviation	**0.13**	**0.045092498**	**0.172143351**
Yellow Cotton 1	90.24	-16.57	77.95
Yellow Cotton 2	90.17	-16.56	77.95
Yellow Cotton 3	90.15	-16.54	77.94
Yellow Cotton Average	**90.18666667**	**-16.55666667**	**77.94666667**
Standard Deviation	**0.047258156**	**0.015275252**	**0.005773503**
Blue Silk 1	33.75	18.28	-41.8
Blue Silk 2	33.84	18.19	-41.66
Blue Silk 3	33.82	18.28	-41.7
Blue Silk Average	**33.80333333**	**18.25**	**-41.72**
Standard Deviation	**0.047258156**	**0.051961524**	**0.072111026**
Blue Cotton 1	25.97	16.62	-33.97
Blue Cotton 2	25.98	16.69	-33.94
Blue Cotton 3	25.93	16.83	-33.97
Blue Cotton Average	**25.96**	**16.71333333**	**-33.96**
Standard Deviation	**0.026457513**	**0.106926766**	**0.017320508**

Table E.14: Colourimeter Readings Before Sample 3 – SetaSilk.

SetaColour	L	a	b
Before Sample 3			
Black Silk 1	30.33	0.8	1.18
Black Silk 2	30.41	0.83	1.18
Black Silk 3	30.12	0.71	1.19
Black Silk Average	**30.28666667**	**0.78**	**1.183333333**
Standard Deviation	**0.149777613**	**0.06244998**	**0.005773503**
Black Cotton 1	22.87	0.87	0.48
Black Cotton 2	22.84	0.98	0.37
Black Cotton 3	22.84	1.01	0.39
Black Cotton Average	**22.85**	**0.953333333**	**0.413333333**
Standard Deviation	**0.017320508**	**0.073711148**	**0.058594653**
White Silk 1	95.27	0	3.31
White Silk 2	95.28	-0.07	3.31
White Silk 3	95.27	-0.01	3.29
White Silk Average	**95.27333333**	**-0.026666667**	**3.303333333**
Standard Deviation	**0.005773503**	**0.037859389**	**0.011547005**
White Cotton 1	95.27	-0.06	3.77
White Cotton 2	95.25	-0.06	3.77
White Cotton 3	95.25	-0.08	3.79
White Cotton Average	**95.25666667**	**-0.066666667**	**3.776666667**
Standard Deviation	**0.011547005**	**0.011547005**	**0.011547005**
Red Silk 1	55.43	61.94	39.65
Red Silk 2	55.37	61.97	39.83
Red Silk 3	55.35	61.99	39.85
Red Silk Average	**55.38333333**	**61.96666667**	**39.77666667**
Standard Deviation	**0.04163332**	**0.025166115**	**0.110151411**
Red Cotton 1	49.49	63.7	42.83
Red Cotton 2	49.46	63.66	42.82
Red Cotton 3	49.46	63.73	42.8
Red Cotton Average	**49.47**	**63.69666667**	**42.81666667**
Standard Deviation	**0.017320508**	**0.035118846**	**0.015275252**
Yellow Silk 1	92.93	-18.14	72.12
Yellow Silk 2	92.93	-18.12	72.06
Yellow Silk 3	92.94	-18.09	72.14
Yellow Silk Average	**92.93333333**	**-18.11666667**	**72.10666667**
Standard Deviation	**0.005773503**	**0.025166115**	**0.04163332**
Yellow Cotton 1	91.59	-17.47	79.23
Yellow Cotton 2	91.63	-17.41	79.23
Yellow Cotton 3	91.63	-17.45	79.27
Yellow Cotton Average	**91.61666667**	**-17.44333333**	**79.24333333**
Standard Deviation	**0.023094011**	**0.030550505**	**0.023094011**
Blue Silk 1	31.72	19.07	-39.56
Blue Silk 2	31.49	19.3	-39.8
Blue Silk 3	31.52	19.58	-39.95
Blue Silk Average	**31.57666667**	**19.31666667**	**-39.77**
Standard Deviation	**0.125033329**	**0.25540817**	**0.196723156**
Blue Cotton 1	24.8	17.12	-32.38
Blue Cotton 2	24.79	17.04	-32.35
Blue Cotton 3	24.77	17.19	-32.4
Blue Cotton Average	**24.78666667**	**17.11666667**	**-32.37666667**
Standard Deviation	**0.015275252**	**0.075055535**	**0.025166115**

Table E.15: Colourimeter Readings After Sample 3 – SetaSilk.

SetaColour	L	a	b
After Sample 3			
Black Silk 1	31.26	0.62	1.07
Black Silk 2	30.66	0.74	1.14
Black Silk 3	30.94	0.7	1.16
Black Silk Average	**30.95333333**	**0.686666667**	**1.123333333**
Standard Deviation	**0.30022214**	**0.061101009**	**0.047258156**
Black Cotton 1	22.95	1.06	0.48
Black Cotton 2	22.93	1.13	0.4
Black Cotton 3	22.91	1.06	0.46
Black Cotton Average	**22.93**	**1.083333333**	**0.446666667**
Standard Deviation	**0.02**	**0.040414519**	**0.04163332**
White Silk 1	95.22	-0.08	3.88
White Silk 2	95.24	-0.06	3.86
White Silk 3	95.17	-0.06	3.89
White Silk Average	**95.21**	**-0.066666667**	**3.876666667**
Standard Deviation	**0.036055513**	**0.011547005**	**0.015275252**
White Cotton 1	95.14	0.01	3.68
White Cotton 2	95.12	-0.02	3.7
White Cotton 3	95.11	0.02	3.69
White Cotton Average	**95.12333333**	**0.003333333**	**3.69**
Standard Deviation	**0.015275252**	**0.02081666**	**0.01**
Red Silk 1	55.23	61.83	39.68
Red Silk 2	55.54	61.46	38.87
Red Silk 3	55.42	61.63	39.12
Red Silk Average	**55.39666667**	**61.64**	**39.22333333**
Standard Deviation	**0.156311655**	**0.185202592**	**0.414769012**
Red Cotton 1	49.4	63.26	41.98
Red Cotton 2	49.45	63.19	42.02
Red Cotton 3	49.42	63.28	42.08
Red Cotton Average	**49.42333333**	**63.24333333**	**42.02666667**
Standard Deviation	**0.025166115**	**0.047258156**	**0.05033223**
Yellow Silk 1	92.46	-17.63	71.66
Yellow Silk 2	92.56	-17.62	71.43
Yellow Silk 3	92.59	-17.62	71.37
Yellow Silk Average	**92.53666667**	**-17.62333333**	**71.48666667**
Standard Deviation	**0.068068593**	**0.005773503**	**0.1530795**
Yellow Cotton 1	91.26	-16.95	78.33
Yellow Cotton 2	91.24	-16.91	78.29
Yellow Cotton 3	91.25	-16.9	78.38
Yellow Cotton Average	**91.25**	**-16.92**	**78.33333333**
Standard Deviation	**0.01**	**0.026457513**	**0.045092498**
Blue Silk 1	31.84	18.64	-39.28
Blue Silk 2	31.96	18.45	-39.21
Blue Silk 3	31.77	18.68	-39.39
Blue Silk Average	**31.85666667**	**18.59**	**-39.29333333**
Standard Deviation	**0.096090235**	**0.122882057**	**0.090737717**
Blue Cotton 1	25.02	16.35	-32.21
Blue Cotton 2	24.98	16.37	-32.19
Blue Cotton 3	24.99	16.25	-32.12
Blue Cotton Average	**24.99666667**	**16.32333333**	**-32.17333333**
Standard Deviation	**0.02081666**	**0.064291005**	**0.047258156**

SetaSilk Statistics

Table E.16: Setasilk Average Before colour readings

Seta Silk Before	L	a	b
Black Silk Average	29.89333333	0.642222	0.941111
Standard Deviation	0.486016381	0.215956206	0.285274029
Black Cotton Average	23.12888667	0.891111	0.295555667
Standard Deviation	0.245679323	0.122489522	0.165238086
White Silk Average	95.17111	-0.297778	3.231111
Standard Deviation	0.338452338	0.460944891	0.211143534
White Cotton Average	94.99	-0.264444667	3.400000333
Standard Deviation	0.520683098	0.289450387	0.543721743
Red Silk Average	55.89889	60.76333333	37.91889
Standard Deviation	0.532401714	1.610844878	2.972963151
Red Cotton Average	48.94111	63.16222333	42.62111
Standard Deviation	0.245679323	0.122489522	0.165238086
Yellow Silk Average	93.10444333	-18.16333333	71.31555667
Standard Deviation	0.245679323	0.122489522	0.165238086
Yellow Cotton Average	91.63778	-17.62777667	76.42666667
Standard Deviation	0.245679323	0.122489522	0.165238086
Blue Silk Average	33.73555667	18.68889	-42.02666667
Standard Deviation	0.245679323	0.122489522	0.165238086
Blue Cotton Average	25.28667	17.20778	-33.33667
Standard Deviation	0.245679323	0.122489522	0.165238086

Table E.17: Setasilk Average After colour readings

Seta Silk After	L	a	b
Black Silk Average	30.09666333	0.747777667	1.053333333
Standard Deviation	0.791222683	0.076327486	0.066916009
Black Cotton Average	23.16	1.022222333	0.423333333
Standard Deviation	0.202237484	0.100129342	0.027284835
White Silk Average	95.01222333	-0.076666667	4.098889
Standard Deviation	0.305802763	0.032829289	0.218436883
White Cotton Average	94.85444333	-0.008889	3.972222333
Standard Deviation	0.486078511	0.039767472	0.491712707
Red Silk Average	55.59333333	61.52444667	39.47444333
Standard Deviation	0.17265637	0.18031758	0.250007437
Red Cotton Average	48.93333333	62.98555667	42.05666667
Standard Deviation	0.584300712	1.358468004	0.922031031
Yellow Silk Average	92.81111333	-17.75666667	70.85222333
Standard Deviation	0.240746609	0.127195213	0.581918653
Yellow Cotton Average	91.43666667	-16.94111333	76.91444333
Standard Deviation	1.353022107	0.395422976	2.13151212
Blue Silk Average	33.76111	18.04	-41.48666667
Standard Deviation	1.883684895	0.679779376	2.086478282
Blue Cotton Average	25.54555667	16.56222	-33.16444333
Standard Deviation	0.495537516	0.209294043	0.909246518

Table E.18: Setasilk Average change in colour readings

Seta	L change	a Change	b Change	**Overall Change**
Black Silk	0.20333	0.105555667	0.112222333	**0.255105742**
Black Cotton	0.031113333	0.131111333	0.127777667	**0.185702325**
White Silk	-0.158886667	0.221111333	0.867778	**0.909490985**
White Cotton	-0.135556667	0.255555667	0.572222	**0.641188214**
Red Silk	-0.305556667	0.761113333	1.555553333	**1.758523402**
Red Cotton	-0.007776667	-0.176666667	-0.564443333	**0.591496293**
Yellow Silk	-0.29333	0.406666667	-0.463333333	**0.682713735**
Yellow Cotton	-0.201113333	0.686663333	0.487776667	**0.865955647**
Blue Silk	0.025553333	-0.64889	0.54	**0.84457753**
Blue Cotton	0.258886667	-0.64556	0.172226667	**0.716541726**

Table E.19: Colourimeter Readings Before Sample 1 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
Before Sample 1			
Black Silk 1	36.77	0.75	1.32
Black Silk 2	36.66	0.77	1.34
Black Silk 3	36.61	0.78	1.33
Black Silk Average	**36.68**	**0.766666667**	**1.33**
Standard Deviation	**0.081853528**	**0.015275252**	**0.01**
Black Cotton 1	35.79	0.99	1.39
Black Cotton 2	35.84	1.02	1.4
Black Cotton 3	35.84	1.06	1.4
Black Cotton Average	**35.82333333**	**1.023333333**	**1.396666667**
Standard Deviation	**0.028867513**	**0.035118846**	**0.005773503**
White Silk 1	95.35	0.04	3.41
White Silk 2	95.3	0.06	3.3
White Silk 3	95.33	0.01	3.42
White Silk Average	**95.32666667**	**0.036666667**	**3.376666667**
Standard Deviation	**0.025166115**	**0.025166115**	**0.066583281**
White Cotton 1	94.16	-0.84	3.89
White Cotton 2	94.2	-0.83	3.87
White Cotton 3	94.18	-0.81	3.89
White Cotton Average	**94.18**	**-0.826666667**	**3.883333333**
Standard Deviation	**0.02**	**0.015275252**	**0.011547005**
Red Silk 1	56.32	57.21	18.46
Red Silk 2	56.47	57.05	18.38
Red Silk 3	56.52	56.92	18.26
Red Silk Average	**56.43666667**	**57.06**	**18.36666667**
Standard Deviation	**0.1040833**	**0.14525839**	**0.100664459**
Red Cotton 1	49.48	58.49	21.33
Red Cotton 2	49.49	58.49	21.3
Red Cotton 3	49.52	58.45	21.37
Red Cotton Average	**49.49666667**	**58.47666667**	**21.33333333**
Standard Deviation	**0.02081666**	**0.023094011**	**0.035118846**
Yellow Silk 1	91.08	-15.3	97.1
Yellow Silk 2	91	-15.34	97.51
Yellow Silk 3	91.17	-15.35	96.85
Yellow Silk Average	**91.08333333**	**-15.33**	**97.15333333**
Standard Deviation	**0.085049005**	**0.026457513**	**0.333216646**
Yellow Cotton 1	88.67	-10.38	106.72
Yellow Cotton 2	88.68	-10.4	106.75
Yellow Cotton 3	88.65	-10.35	106.81
Yellow Cotton Average	**88.66666667**	**-10.37666667**	**106.76**
Standard Deviation	**0.015275252**	**0.025166115**	**0.045825757**
Blue Silk 1	60.46	-5.47	-40.64
Blue Silk 2	59.97	-5.47	-41.02
Blue Silk 3	60.2	-5.59	-40.84
Blue Silk Average	**60.21**	**-5.51**	**-40.83333333**
Standard Deviation	**0.245153013**	**0.069282032**	**0.190087699**
Blue Cotton 1	42.63	6.29	-45.73
Blue Cotton 2	42.4	6.37	-45.61
Blue Cotton 3	42.42	6.55	-45.7
Blue Cotton Average	**42.48333333**	**6.403333333**	**-45.68**
Standard Deviation	**0.127410099**	**0.133166562**	**0.06244998**

Table E.20: Colourimeter Readings After Sample 1 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
After Sample 1			
Black Silk 1	36.51	1.13	1.89
Black Silk 2	36.61	1.11	1.9
Black Silk 3	36.58	1.09	1.86
Black Silk Average	**36.56666667**	**1.11**	**1.883333333**
Standard Deviation	**0.051316014**	**0.02**	**0.02081666**
Black Cotton 1	36.06	1.02	1.38
Black Cotton 2	36.02	1.07	1.41
Black Cotton 3	35.95	0.98	1.37
Black Cotton Average	**36.01**	**1.023333333**	**1.386666667**
Standard Deviation	**0.055677644**	**0.045092498**	**0.02081666**
White Silk 1	95.38	0.08	3.63
White Silk 2	95.31	0.09	3.62
White Silk 3	95.27	0.11	3.63
White Silk Average	**95.32**	**0.093333333**	**3.626666667**
Standard Deviation	**0.055677644**	**0.015275252**	**0.005773503**
White Cotton 1	94.4	0.18	3.62
White Cotton 2	94.45	0.18	3.66
White Cotton 3	94.41	0.17	3.66
White Cotton Average	**94.42**	**0.176666667**	**3.646666667**
Standard Deviation	**0.026457513**	**0.005773503**	**0.023094011**
Red Silk 1	56.5	56.43	17.88
Red Silk 2	56.37	56.59	18.01
Red Silk 3	56.47	56.43	17.95
Red Silk Average	**56.44666667**	**56.48333333**	**17.94666667**
Standard Deviation	**0.068068593**	**0.092376043**	**0.065064071**
Red Cotton 1	49.79	58.74	21.1
Red Cotton 2	49.8	58.72	21.19
Red Cotton 3	49.79	58.77	21.19
Red Cotton Average	**49.79333333**	**58.74333333**	**21.16**
Standard Deviation	**0.005773503**	**0.025166115**	**0.051961524**
Yellow Silk 1	91.14	-13.84	97.38
Yellow Silk 2	90.99	-13.82	98.03
Yellow Silk 3	90.92	-13.84	98.34
Yellow Silk Average	**91.01666667**	**-13.83333333**	**97.91666667**
Standard Deviation	**0.112398102**	**0.011547005**	**0.489931968**
Yellow Cotton 1	89.03	-9.39	106.82
Yellow Cotton 2	89	-9.36	107.04
Yellow Cotton 3	89.02	-9.46	106.97
Yellow Cotton Average	**89.01666667**	**-9.403333333**	**106.9433333**
Standard Deviation	**0.015275252**	**0.051316014**	**0.112398102**
Blue Silk 1	60.15	-5.5	-39.62
Blue Silk 2	59.93	-5.47	-39.81
Blue Silk 3	60.28	-5.64	-39.51
Blue Silk Average	**60.12**	**-5.536666667**	**-39.64666667**
Standard Deviation	**0.17691806**	**0.090737717**	**0.151767366**
Blue Cotton 1	42.69	5.51	-44.06
Blue Cotton 2	42.68	5.53	-44.05
Blue Cotton 3	42.51	5.66	-43.95
Blue Cotton Average	**42.62666667**	**5.566666667**	**-44.02**
Standard Deviation	**0.101159939**	**0.081445278**	**0.060827625**

Table E.21: Colourimeter Readings Before Sample 2 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
Before Sample 2			
Black Silk 1	54.2	0.87	3.21
Black Silk 2	54.39	0.87	3.15
Black Silk 3	54.38	0.88	3.18
Black Silk Average	**54.32333333**	**0.873333333**	**3.18**
Standard Deviation	**0.106926766**	**0.005773503**	**0.03**
Black Cotton 1	36.04	0.96	1.5
Black Cotton 2	36.1	1.01	1.48
Black Cotton 3	36.03	1	1.49
Black Cotton Average	**36.05666667**	**0.99**	**1.49**
Standard Deviation	**0.037859389**	**0.026457513**	**0.01**
White Silk 1	95.57	-0.03	3.39
White Silk 2	95.55	-0.04	3.41
White Silk 3	95.56	-0.02	3.39
White Silk Average	**95.56**	**-0.03**	**3.396666667**
Standard Deviation	**0.01**	**0.01**	**0.011547005**
White Cotton 1	95.35	-0.08	3.77
White Cotton 2	95.35	-0.03	3.77
White Cotton 3	95.37	-0.07	3.77
White Cotton Average	**95.35666667**	**-0.06**	**3.77**
Standard Deviation	**0.011547005**	**0.026457513**	**0**
Red Silk 1	55.7	57.57	19.43
Red Silk 2	55.67	57.63	19.45
Red Silk 3	55.69	57.58	19.42
Red Silk Average	**55.68666667**	**57.59333333**	**19.43333333**
Standard Deviation	**0.015275252**	**0.032145503**	**0.015275252**
Red Cotton 1	53.18	58.13	19.52
Red Cotton 2	53.19	58.1	19.5
Red Cotton 3	53.18	58.16	19.52
Red Cotton Average	**53.18333333**	**58.13**	**19.51333333**
Standard Deviation	**0.005773503**	**0.03**	**0.011547005**
Yellow Silk 1	91.78	-15.04	95.5
Yellow Silk 2	91.78	-15	95.48
Yellow Silk 3	91.61	-15.08	96.17
Yellow Silk Average	**91.72333333**	**-15.04**	**95.71666667**
Standard Deviation	**0.098149546**	**0.04**	**0.392725519**
Yellow Cotton 1	89.74	-11.32	105.82
Yellow Cotton 2	89.73	-11.32	105.88
Yellow Cotton 3	89.72	-11.27	105.76
Yellow Cotton Average	**89.73**	**-11.30333333**	**105.82**
Standard Deviation	**0.01**	**0.028867513**	**0.06**
Blue Silk 1	50.93	2.05	-46.87
Blue Silk 2	50.93	2.03	-46.87
Blue Silk 3	50.93	2.01	-46.86
Blue Silk Average	**50.93**	**2.03**	**-46.86666667**
Standard Deviation	**0**	**0.02**	**0.005773503**
Blue Cotton 1	43.31	6.65	-47.18
Blue Cotton 2	43.35	6.57	-47.11
Blue Cotton 3	43.34	6.62	-47.16
Blue Cotton Average	**43.33333333**	**6.613333333**	**-47.15**
Standard Deviation	**0.02081666**	**0.040414519**	**0.036055513**

Table E.22: Colourimeter Readings After Sample 2 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
After Sample 2			
Black Silk 1	54	0.92	3.24
Black Silk 2	54.07	0.94	3.23
Black Silk 3	54.38	0.9	3.2
Black Silk Average	**54.15**	**0.92**	**3.223333333**
Standard Deviation	**0.202237484**	**0.02**	**0.02081666**
Black Cotton 1	36.03	0.98	1.52
Black Cotton 2	36.02	0.98	1.51
Black Cotton 3	36.09	0.98	1.52
Black Cotton Average	**36.04666667**	**0.98**	**1.516666667**
Standard Deviation	**0.037859389**	**0**	**0.005773503**
White Silk 1	95.42	0.08	3.42
White Silk 2	95.43	0.09	3.41
White Silk 3	95.41	0.04	3.43
White Silk Average	**95.42**	**0.07**	**3.42**
Standard Deviation	**0.01**	**0.026457513**	**0.01**
White Cotton 1	95.31	0.06	3.6
White Cotton 2	95.31	0.04	3.59
White Cotton 3	95.32	0.07	3.59
White Cotton Average	**95.31333333**	**0.056666667**	**3.593333333**
Standard Deviation	**0.005773503**	**0.015275252**	**0.005773503**
Red Silk 1	55.45	57.5	19.39
Red Silk 2	55.33	57.67	19.44
Red Silk 3	55.34	57.68	19.46
Red Silk Average	**55.37333333**	**57.61666667**	**19.43**
Standard Deviation	**0.066583281**	**0.101159939**	**0.036055513**
Red Cotton 1	53.24	57.74	19.18
Red Cotton 2	53.23	57.74	19.14
Red Cotton 3	53.23	57.77	19.16
Red Cotton Average	**53.23333333**	**57.75**	**19.16**
Standard Deviation	**0.005773503**	**0.017320508**	**0.02**
Yellow Silk 1	91.59	-14.91	94.69
Yellow Silk 2	91.48	-14.86	95.26
Yellow Silk 3	91.66	-14.85	94.22
Yellow Silk Average	**91.57666667**	**-14.87333333**	**94.72333333**
Standard Deviation	**0.090737717**	**0.032145503**	**0.520800666**
Yellow Cotton 1	89.71	-11.28	105.41
Yellow Cotton 2	89.72	-11.29	105.42
Yellow Cotton 3	89.7	-11.24	105.35
Yellow Cotton Average	**89.71**	**-11.27**	**105.3933333**
Standard Deviation	**0.01**	**0.026457513**	**0.037859389**
Blue Silk 1	51.04	1.76	-46.6
Blue Silk 2	51.24	1.8	-46.4
Blue Silk 3	51.01	1.94	-46.62
Blue Silk Average	**51.09666667**	**1.833333333**	**-46.54**
Standard Deviation	**0.125033329**	**0.094516313**	**0.121655251**
Blue Cotton 1	43.51	6.12	-46.58
Blue Cotton 2	43.51	6.12	-46.57
Blue Cotton 3	43.54	6.09	-46.57
Blue Cotton Average	**43.52**	**6.11**	**-46.57333333**
Standard Deviation	**0.017320508**	**0.017320508**	**0.005773503**

Table E. 23: Colourimeter Readings Before Sample 3 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
Before Sample 3			
Black Silk 1	53.3	0.91	3.18
Black Silk 2	53.69	0.82	3.15
Black Silk 3	53.29	0.89	3.22
Black Silk Average	**53.42666667**	**0.873333333**	**3.183333333**
Standard Deviation	**0.228108161**	**0.047258156**	**0.035118846**
Black Cotton 1	39.13	0.97	1.47
Black Cotton 2	39.15	0.84	1.52
Black Cotton 3	39.12	0.86	1.52
Black Cotton Average	**39.13333333**	**0.89**	**1.503333333**
Standard Deviation	**0.015275252**	**0.07**	**0.028867513**
White Silk 1	95.31	-0.07	3.45
White Silk 2	95.27	-0.03	3.43
White Silk 3	95.36	-0.03	3.42
White Silk Average	**95.31333333**	**-0.043333333**	**3.433333333**
Standard Deviation	**0.045092498**	**0.023094011**	**0.015275252**
White Cotton 1	95.32	-0.05	3.97
White Cotton 2	95.32	-0.06	3.97
White Cotton 3	95.36	-0.06	3.98
White Cotton Average	**95.33333333**	**-0.056666667**	**3.973333333**
Standard Deviation	**0.023094011**	**0.005773503**	**0.005773503**
Red Silk 1	55.91	57.4	18.92
Red Silk 2	55.85	57.45	19.03
Red Silk 3	55.81	57.61	18.96
Red Silk Average	**55.85666667**	**57.48666667**	**18.97**
Standard Deviation	**0.05033223**	**0.109696551**	**0.055677644**
Red Cotton 1	52.86	58.74	20.11
Red Cotton 2	52.9	58.64	20.2
Red Cotton 3	52.95	58.48	20.3
Red Cotton Average	**52.90333333**	**58.62**	**20.20333333**
Standard Deviation	**0.045092498**	**0.13114877**	**0.09504385**
Yellow Silk 1	91.7	-15.33	95.73
Yellow Silk 2	91.7	-15.26	95.68
Yellow Silk 3	91.69	-15.28	95.74
Yellow Silk Average	**91.69666667**	**-15.29**	**95.71666667**
Standard Deviation	**0.005773502**	**0.036055513**	**0.032145502**
Yellow Cotton 1	90	-11.65	104.51
Yellow Cotton 2	90	-11.63	104.55
Yellow Cotton 3	89.99	-11.61	104.48
Yellow Cotton Average	**89.99666667**	**-11.63**	**104.5133333**
Standard Deviation	**0.005773502**	**0.02**	**0.035118846**
Blue Silk 1	52.54	0.27	-46.4
Blue Silk 2	52.55	0.34	-46.4
Blue Silk 3	52.57	0.29	-46.33
Blue Silk Average	**52.55333333**	**0.3**	**-46.37666667**
Standard Deviation	**0.015275252**	**0.036055513**	**0.040414519**
Blue Cotton 1	45.55	4.53	-46.16
Blue Cotton 2	45.56	4.42	-46.13
Blue Cotton 3	45.56	4.41	-46.11
Blue Cotton Average	**45.55666667**	**4.453333333**	**-46.13333333**
Standard Deviation	**0.005773503**	**0.066583281**	**0.025166115**

Table E.24: Colourimeter Readings After Sample 3 – Jacquard Neopaque.

Jacquard Neopaque	L	a	b
After Sample 3			
Black Silk 1	53.81	0.79	3.21
Black Silk 2	53.82	0.78	3.22
Black Silk 3	53.36	0.87	3.26
Black Silk Average	**53.66333333**	**0.813333333**	**3.23**
Standard Deviation	**0.262741952**	**0.049328829**	**0.026457513**
Black Cotton 1	39.25	0.87	1.49
Black Cotton 2	39.15	0.82	1.49
Black Cotton 3	39.06	0.93	1.48
Black Cotton Average	**39.15333333**	**0.873333333**	**1.486666667**
Standard Deviation	**0.09504385**	**0.055075705**	**0.005773503**
White Silk 1	95.23	0.02	3.87
White Silk 2	95.21	-0.02	3.89
White Silk 3	95.4	0.02	3.86
White Silk Average	**95.28**	**0.006666667**	**3.873333333**
Standard Deviation	**0.104403065**	**0.023094011**	**0.015275252**
White Cotton 1	95.12	0.04	3.73
White Cotton 2	95.13	0.04	3.72
White Cotton 3	95.13	0.02	3.73
White Cotton Average	**95.12666667**	**0.033333333**	**3.726666667**
Standard Deviation	**0.005773503**	**0.011547005**	**0.005773503**
Red Silk 1	55.77	56.54	18.54
Red Silk 2	55.9	56.4	18.43
Red Silk 3	55.87	56.42	18.4
Red Silk Average	**55.84666667**	**56.45333333**	**18.45666667**
Standard Deviation	**0.068068593**	**0.075718778**	**0.073711148**
Red Cotton 1	52.94	58.03	19.62
Red Cotton 2	52.95	57.98	19.65
Red Cotton 3	53	57.9	19.68
Red Cotton Average	**52.96333333**	**57.97**	**19.65**
Standard Deviation	**0.032145503**	**0.065574385**	**0.03**
Yellow Silk 1	91.64	-14.99	94.58
Yellow Silk 2	91.65	-15.02	94.66
Yellow Silk 3	91.53	-15.03	95.14
Yellow Silk Average	**91.60666667**	**-15.01333333**	**94.79333333**
Standard Deviation	**0.066583281**	**0.02081666**	**0.302875112**
Yellow Cotton 1	89.87	-11.53	103.36
Yellow Cotton 2	89.86	-11.5	103.35
Yellow Cotton 3	89.86	-11.51	103.45
Yellow Cotton Average	**89.86333333**	**-11.51333333**	**103.3866667**
Standard Deviation	**0.005773502**	**0.015275252**	**0.055075706**
Blue Silk 1	52.71	-0.24	-45.44
Blue Silk 2	52.77	-0.28	-45.35
Blue Silk 3	52.71	-0.28	-45.41
Blue Silk Average	**52.73**	**-0.266666667**	**-45.4**
Standard Deviation	**0.034641016**	**0.023094011**	**0.045825757**
Blue Cotton 1	45.8	3.9	-45.43
Blue Cotton 2	45.82	3.78	-45.43
Blue Cotton 3	45.8	3.8	-45.42
Blue Cotton Average	**45.80666667**	**3.826666667**	**-45.42666667**
Standard Deviation	**0.011547005**	**0.064291005**	**0.005773503**

Jacquard Neopaque Statistics

Table E.25: Jacquard Neopaque Average Before colour readings

Neopaque Before	L	a	b
Black Silk Average	48.14333333	0.837777667	2.564444333
Standard Deviation	9.937656217	0.061583644	1.069061451
Black Cotton Average	37.00444443	0.967777667	1.463333333
Standard Deviation	1.84735946	0.069388733	0.058118347
White Silk Average	95.4	-0.012222	3.402222333
Standard Deviation	0.138724349	0.042860739	0.028738566
White Cotton Average	94.95666667	-0.314444667	3.875555333
Standard Deviation	0.672714237	0.443600683	0.101889383
Red Silk Average	55.99333337	57.38	18.92333333
Standard Deviation	0.393234451	0.282212843	0.534859068
Red Cotton Average	51.8611111	58.40889	20.34999667
Standard Deviation	2.052449266	0.251933714	0.918821709
Yellow Silk Average	91.5011111	-15.22	96.19555667
Standard Deviation	0.362051784	0.157162336	0.829456038
Yellow Cotton Average	89.46444447	-11.10333333	105.6977667
Standard Deviation	0.703643948	0.650159997	1.128326621
Blue Silk Average	54.56444443	-1.06	-44.69222333
Standard Deviation	4.956109966	3.949696191	3.350868293
Blue Cotton Average	43.7911111	5.823333	-46.32111
Standard Deviation	1.586982965	1.191091936	0.752775528

Table E.26: Jacquard Neopaque Average After colour readings

Neopaque After	L	a	b
Black Silk Average	48.12666667	0.947777667	2.778888667
Standard Deviation	10.01420761	0.150271509	0.775581122
Black Cotton Average	37.07	0.958888667	1.463333667
Standard Deviation	1.804309865	0.077196284	0.068068593
White Silk Average	95.34	0.056666667	3.64
Standard Deviation	0.072111026	0.044845091	0.226960413
White Cotton Average	94.95333333	0.088889	3.655555667
Standard Deviation	0.471215261	0.076908074	0.067109948
Red Silk Average	55.88889	56.85111	18.61111333
Standard Deviation	0.537914106	0.663164071	0.753628907
Red Cotton Average	51.99666333	58.15444333	19.99
Standard Deviation	1.912912265	0.521718918	1.04244904
Yellow Silk Average	91.40000333	-14.57333	95.81111
Standard Deviation	0.332315112	0.644670458	1.823804317
Yellow Cotton Average	89.53111	-10.72777667	105.24
Standard Deviation	0.449224439	1.156306849	1.78160346
Blue Silk Average	54.64889	-1.323333667	-43.86222333
Standard Deviation	4.807985565	3.796924194	3.695005741
Blue Cotton Average	43.98444667	5.167778	-45.34
Standard Deviation	1.640086287	1.192785279	1.278869536

Table E.27: Jacquard Neopaque Average change in colour readings

Neopaque	L change	a Change	b Change	**Overall Change**
Black Silk	-0.016666667	0.11	0.214444333	**0.241586734**
Black Cotton	0.065555567	-0.008889	3.33333E-07	**0.066155473**
White Silk	-0.06	0.068888667	0.237777667	**0.254723119**
White Cotton	-0.003333333	0.403333667	-0.219999667	**0.459444242**
Red Silk	-0.104443367	-0.52889	-0.31222	**0.622988264**
Red Cotton	0.135552233	-0.254446667	-0.359996667	**0.461210488**
Yellow Silk	-0.101107767	0.64667	-0.384446667	**0.759081095**
Yellow Cotton	0.066665533	0.375556667	-0.457766667	**0.595850169**
Blue Silk	0.084445567	-0.263333667	0.83	**0.874857516**
Blue Cotton	0.193335567	-0.655555	0.98111	**1.195703906**

School: Culture and Creative Arts	**Section:** Centre For Textile Conservation and Technical Art History	**Location:** Room number(s) 305, 306	**Reference No:** R52,13-14_____	**Related COSHH Form (if applicable):** C02/12 & C66/13-14

Description of activity:

Dissertation research involving oddy testing preparing painted slides and using an oven.
Preparation of painted samples, cutting samples of fabric, painting on fabric.
Use of the light ageing oven.
and wet cleaning of painted fabric samples with water.

Persons at risk:

Students and Staff

Is operator training/supervision required? If yes, please specify:

Yes, tutor will be present if necessary

Hazards/ Risks	Current controls	Are these adequate?	What action is required if not adequately controlled?
Using glasswear, risk of breakages, cuts.	Take care when using glassware, ensure tidy workspace to prevent risk of breakages. Safe disposal of glass in the glass bin if required.	**Yes**	
Use of acetone for Oddy testing	Use in fume hood, safe storage and disposal of chemicals.	**No**	**COSHH form required**

Use of lead, silver and copper for Oddy testing	Use in fume hood, safe storage and disposal of metals	**No**	**COSHH form required**
Using sharp implements, scissors, scalpels for preparation of samples.	Safe handling of equipment, ensure tidy workspace to prevent risk of injury. Protect scalpel blades when not in use.	**Yes**	
Using light ageing chamber	Risk of water spillage and slippage on water. Ensure water is emptied regularly.	**Yes**	

Completed by (print name and position, and sign): **Melissa Bolin**	**Date:** **20/05/2014**
Approved by (print name and position, and sign):	**Date:**

Appendix 7: COSHH Forms

University of Glasgow

COSHH Assessment Form

School: Culture and Creative Arts
Section: Centre for Textile Conservation and Technical Art History
Project Title:

File ref: C66/13-14_____
Related Assessment Form: R52/13/14____
Date: 20/05/2014

Room Number(s): 309, 319a, 319b, 315

Building: Robertson Building Level 3

Persons involved:
Students and Tutors

Description of procedure:
Using acetone to clean glassware and metal coupons for Oddy test.

Substance used	Quantities used	Frequency of use	Hazards identified	Exposure route
Acetone	100ml	Once	Skin and Eye irritant Toxicity Flammable	Contact via skin and eye Inhalation Exposure to ignition source

Could a less hazardous substance (or form of the substance) be used instead? ~~**yes**~~ **/ no**

Justify not using it: N?A
Most appropriate substance for procedure

What measures have you taken to control risk?

Engineering controls:
Extraction.

Personal Protective Equipment:
Lab coat, gloves.

Management measures:
Label appropriately, store in flammable cabinet, allow small amounts to evaporate under extraction.

Checks on control measures: Tutor Supervision

Is health surveillance required? ~~**yes/**~~**no**

Training requirements: N/A

Emergency procedures:
Contact with eyes or skin, flush with water for 15 minutes.
Ingestion, seek medical attention and do not induce vomiting
Inhalation, move to fresh air, if continuing symptoms seek medical attention

Waste disposal:
Dispose of large quantities in non-chlorinated Container
Allow small quantities to evaporate under extraction

Name and position of assessor:
Melissa Bolin, Student

Signature:

Name of supervisor (student work only):
Anita Quye, Tutor

Signature: 

Name of Head of School or nominee:

Signature:

University of Glasgow | School of Culture & Creative Arts

Declaration of Originality Form

This form **must** be completed and signed and submitted with all assignments.
Please complete the information below (using BLOCK CAPITALS).

Student ID Number ……2042584……
Course Name …..Dissertation……
Assignment Title ……Dissertation……..
…… Word Count …20072…

An extract from the University's Statement on Plagiarism is provided overleaf. Please read carefully THEN read and sign the declaration below.

I confirm that this assignment is my own work and that I have:

Read and understood the guidance on plagiarism in the Undergraduate/Postgraduate Class Handbook, including the University of Glasgow Statement on Plagiarism	☐
Clearly referenced, in both the text and the bibliography or references, all sources used in the work	☐
Fully referenced (including page numbers) and used inverted commas for all text quoted from books, journals, web, archives etc.	☐
Provided the sources for all tables, figures/illustrations, data, etc. that are not my own work	☐
Not made use of the work of any other student(s) past or present, or of other unpublished material, without acknowledgement	☐
Not sought or used the services of any professional agencies to produce this work	☐
In addition, I understand that any false claim in respect of this work will result in disciplinary action in accordance with University regulations	☐

DECLARATION:

I am aware of and understand the University's policy on plagiarism and I certify that this assignment is my own work**,** except where indicated by referencing, and that I have followed the good academic practices noted above

Signed…… Date ……