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SUSTAINABLE SOLAR SURFACE DECORATION: THE CORRELATION BETWEEN ANTHOTYPE PRINCIPLES WITH PLANT EXTRACTIONS AS A FORM OF ECO-PATTERNING FOR FABRICS.

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ABSTRACT

This paper discusses design research undertaken into the correlation between natural dyes (plant extractions) and the alternative photographic process of Anthotypes discovered in the early 19th Century. The paper explores the relationship between natural extracts (dyes) with their fastness properties in relation to the success of this photographic process and the potential this form of imaging has as a sustainable/health giving form of surface decoration for textiles: A form of Eco-patterning that relies upon light and natural substances/dyes not synthetic dyes as the colouring medium.

Instigated by the output of collaborative research between two different disciplines: That of textile design and early colouration methods with historical photographic imaging techniques. The research project considered the symbiotic relationship between natural plant extracts with the success of Anthotypes. The aim of which was to consider the question: Could this kind of photographic image making be applied as a future, sustainable method of design generation, colouration and patterning of fabric for fashion and interiors? The objective was in creating an alternative sustainable surface design process that relies upon light and natural substances/dyes not chemical dyestuffs and pigments as the main patterning and processing medium. The outcomes of which could also provide medicinal healing qualities by wearing clothing or sleeping on material that has been coloured with natural plant extracts (dyes), an added health bonus.

Keywords: Anthotypes, Fastness, Fugitive, Natural Dyes, Anti-Bacterial, Anti-Viral.

INTRODUCTION

The research recorded within this paper was based upon a design project which considered the correlation between natural dyes (plant extractions) with an early 19th Century photographic process known as ‘Anthotype’, in possessing the potential to evolve a form of eco-patterning that relies upon light and natural substances as the colouring and decorative medium. Initiated through an earlier research project titled the ‘Emerging Evidence’ presented at the FORMAT Conference 2015, that consisted of collaborative research between different disciplines: Fabric colouration (dyeing) and alternative photography. Two BA photographic students: Jane Jackson, Emily Pearson and the author explored the emergence of an image using the early photograph techniques of Cyanotypes and Anthotypes; initially investigated by Hershel (1792-1871) who discovered this form of photography in the 1840’s. The design work of Ness Greger entitled ‘Through the Woods’ submitted for her MA in Fashion & Textiles (2016) considered the fastness and

fugitive qualities of natural dyes alongside their potential healing qualities as a textile patterning technique for eco clothing. Some of this more recent project has been used to expand the original research that was carried out in 2015 bringing it to this current state of enquiry. The resulting project covered within this paper considered the symbiotic relationship between natural plant extracts with the success of Anthotypes, the aim of which as to consider the question: Could this kind of photographic image making be applied as a future, sustainable method of design generation, colouration and patterning of fabric for fashion and interiors? The purpose was to creating an alternative sustainable surface design process that relies upon light and natural substances/dyes not chemical dyestuffs and pigments as the main patterning and processing medium. The outcomes of which, could also provide medicinal healing qualities and well being (Chengaiah 2010) by wearing clothing or sleeping upon material that has been coloured with natural plant extracts (dyes), an added health bonus. (Aura) (Wells 2014)

The main objective of the research project was to look at the substantive and the fugitive properties of the colouration materials alongside different light wavelengths as a way of analysing the success or failure of using Anthotypes as an alternative sustainable surface design process. A more scientific/technical methodology was applied to a design process asking the questions: How and why do Anthotypes work? What is the correlation of both colorant and positive have with sunlight? Do differing wavelengths, artificial daylight and Ultraviolet light affect the quality and colour of images achieved on exposure? What relationship does this have with the fastness properties of the natural dyes /plant extracts employed within the process? What fibres and dyes potentially can add to the healing properties of the fabrics produced.
Early research into this field was carried out and recorded by Sir John Frederick William Herschel (1792-1871) in the early 1800s. Herschel is known to have coined the terminology “Photograph’ ‘Positive’ and ‘Negative’ (Fabbri 2012) as well as inventing and developing two photographic processes: The first being Cyanotype, often referred to as the ‘Blue-print’ process, which is the art of photographic printing in Prussian Blue, a mineral pigment and dye invented around c1700 (Ware 2014); the second being an Anthotype process which employs flower and plant extracts to coat papers that when exposed for long periods of time in natural day light will produce photographic images, sometimes referred to as Herschel’s Flower Essence Prints (Fabbri 2012).

The employment of Cyanotypes based on the Mineral dye or Lake colour: Prussian blue as a Mineral dye to pattern fabric is well known and has been well documented. (Ware 2014) The process makes use of it sensitivity to light to be able to create photographic images or photograms on paper or fabric. (Hewitt 1995) but the use of the photographic process of Anthotypes on fabric is relatively unexplored and unknown.

The word Anthotype is derived from the Greek word *anthos* for flower. Herschel in his quest to explore the new science of photography applied his current knowledge of light, colour and botany and started to experiment with making images through light using extracted flower pigmentation. (James 2009)

In 1840 a paper published in the Philosophical Transactions of the Royal Society called ‘*On the Chemical Action of Rays of the Solar Spectrum on Preparations of Silver and other substances, both metallic and non-metallic, and on some photographic Processes*.’ Herschel mentioned Anthotypes for the first time. In it he described trying to speed up the

bleaching action of vegetable juices by isolating specific rays of the spectrum with a prim and noted the reaction, effect. (Fabbri 2011)

> *'We all know that colours of vegetable origin are usually considered to be destroyed and whitened by the continued action of light. The process, however, is too slow to be made the subject of any satisfactory series of experiments; and as a consequence, this subject, so interesting to the painter, the dyer, and general artist, has been allowed to remain un-investigated.'* (Herschel 1840)

By 1842, Herschel thus describes the experimentation.

> *'On the action of rays….. In operating on the colours of flowers I have usually proceeded as follows: The petals of the fresh flowers, or rather such parts of them as possessed a uniform tint, were crushed to a pulp in a marble mortar, either alone, or with the addition of alcohol, and the juice expressed by squeezing the pulp in a clean linen or cotton cloth. It was spread on paper with a flat brush, and dried in the air without artificial heat, or at the most with a gentle heat that rises in the ascending current of air from an Arnott stove.'* (Herschel 1842)

Herschel's experimentation with Anthotypes was very short-lived by early spring 1842 Herschel had suspended his tests on plant colours in favour of further broadening his search for new photosensitive substances.

The technique today remains unchanged for application to paper as an alternative photography technique. Where plant extracts are applied to the surface of 100% rag papers and exposed with a 'Positive' in contact with the coating and then left for hours/days/weeks or months to expose in natural daylight, eventually creating a photographic image. But very little has been written about the Anthotype process and the potential of its application to textiles rather than papers. Key texts currently available on Anthotypes are: Herschel's own writings published by the Philosophical Transactions of the Royal Society 1840 & 1842; the recordings of Herschel published by Hunt two years later in his book: '*Researches on Light: An Examination of All Phenomena connected with the chemical and molecular changes produced by the influence of the solar rays; embracing all the known photographic processes, and new discoveries in the art.'* and the more resent book 'Anthotypes' written by Marlin Fabbri (2011).

MATERIALS AND EXPERIMENTAL METHODS

Research and design interests into the fugitive nature of natural dyes made the obvious connection linking light fastness combined with wavelength to the success or failure of the Anthotype process for fabric as a sustainable eco form of decoration although initial research had highlighted connections with different light wavelengths even in the original writings of Herschel in his paper '*On the action of the rays of the Solar Spectrum on Vegetable Colours, and on new Photographic Processes'* and those of Hunt in 1844, which contained very early light research contained in a chart/graph that plots different substances and chemicals including Ferrocyanate of Potash (Cyanotype) and the plants that Herschel experimented with in early Anthotypes (Ten Week Stocks, Wallflowers, Corchorus Japonica and Green Leaves) against the Solar Spectra of Light, Heat and Energia (Hunt 1844)

Experimentation and investigations started by employing the natural plants and juice extractions of flowers and leaves obtained from the Cotesbach Hall Organic Gardens concentrating on creating Anthotypes as a eco form of patterning with the aim of understand the relationship that the natural colorant (Dye) has with types of light and its relationship as to the success or failure of this type of photographic process for fabrics.

As the research progressed the following questions of enquiry were posed:
Why and how do Anthotypes work?
What is the correlation between colorants and positives with sunlight?
Do differing wavelengths, artificial daylight and Ultraviolet light affect the quality and colour of images achieved on exposure?
What relationship does this have with the fastness properties of the natural dyes /plant extracts employed within the process?
What fibres and dyes potentially can add to the healing properties of the fabrics produced?

Initially plant and flower juices were extracted in the same manner as Herschel's initial experimentations in 1842 (Herschel 1842) using cheap Vodka and Surgical spirit for alcohol extraction with a Marble Mortar and painting the plant extracts onto the surface of the material. Information on the solubility of natural dyes in an alcohol was obtained from old dye books Hummel (1885), Bemiss (1806) and Berthollet (1824) to determine the best solvent to employ on the plants and flowers collected, with observations on the solutions obtained and solubility of colouring matter recorded. Ness Greger who employed fast and fugitive natural dyes; gathered locally in Derby or as standardised pure extracts purchased from reputable suppliers carried out further work using traditional dyeing procedures. The dyes were applied via the normal aqueous vat and exhaust bath systems along side alum and tannin mordants to form a base for experimentation, which resulted in very successful patterning however colour control is restricted due to natural dye selection and availability. Initial bases of madder and woad that process good light fastness properties were selected to colour natural and regenerated cellulosic fabrics such as organic cotton, ramie, banana, bamboo and soya, a medium shade to be over dyed with fugitive dyes such as elderberry, blackberry and turmeric, resulting in a mixed hue. These fabrics were covered in sections by either a black paper stencil or an acetate photographic positive to protect the fabric beneath from exposure to a light source, which was obtained from either an ultra violet light exposing box or daylight through glass over a period of time after which the positives were removed exposing an image on the dyed materials.

To further the research into the healing benefits of natural dyes, extensive secondary research was carried out on topical health applications of plants that produce a natural dye colour which revealed substantial research outputs into the healing properties of plants. For example, Turmeric (*Curcuma longa L.*) historically was perceived to have magical and protective properties, it has now been proven to have powerful anti-inflammatory properties. (Cardon 2007) In addition to Cardon's extensive monologue on 'Natural Dyes' that outlines the majority of their properties; the paper 'Medicinal importance of natural dyes - A review' outlines many natural dyes that are known to have anti-aging, antiseptic, anti-viral, anti-bacterial, anti-microbial, anti-inflammatory, anti-carcinogenic and anti-fungal properties. (Chengaiah et al 2010)

To fully explore the sustainability and ecological aspect of the research project, it became necessary to source alternative mordants to alum given that alum is the only element of natural dyeing that is produced via chemical processes. One such source has been

discovered by the Bebali Foundation based in Bali (Bebali Foundation, 2013) who are helping to alleviate rural poverty, empower women and protect the rainforest by selling fallen 'symplocos leaves' as a natural alternative to alum. This negates the need for industrial methods involved in the production of alum and creates colours nearly as strong as those created by alum; some experimentation was performed using this as an alum substitute. Tannic mordants employed already came from natural sources such as Oak Galls, Sumac and Pomegranate.

Base material choice was centred on cellulosic fibre bases: natural and regenerated both knitted and woven that are biodegradable: Ramie, a highly sustainable fabric, which is naturally resistant to bacteria, moulds and mildew; Bamboo is renowned for its softness, antibacterial, thermos-control and UV protection properties. It is ideal for allergy prone skin and is recognised as environmentally friendly due its fast growing nature that does not require fertilizers or pesticides; Soya was selected for its environmentally friendly production methods, low waste and the fact that plant stock is easily regenerated. Others considered and experimented upon were banana and milk fabrics, both waste bi-products of the food industry, and organic cotton.

RESULTS

According to Cristae, the analysis of the natural dyes listed in Colour Index revealed that almost 50% of all natural dyes used to colour textiles are flavonoid compounds. Most of the remaining natural dyes fall within three chemical classes, which are anthraquinones, naphthoquinones and indigoids. Although flavonoid compounds are not very light fast, anthraquinones and indigoids are noted for their excellent light fastness. Other aspects of chemical structure may affect the light fastness, such as the symmetry of the dye molecules: symmetrical dye molecules usually exhibit greater light fastness than non-symmetrical dye molecules, and larger dye molecules generally provide faster dyeing than smaller ones. (Cristae 2006) Cox-Crews (1982) in a study on 18 yellow natural dyes concluded that the mordant is more important than the dye itself in determining the light fastness of coloured textiles with the use of tin and alum mordant results in significantly more fading. The light source (the nature of the incident light) is very important during the photo-fading process; fugitive dyes are faded mainly by visible radiation, while dyes of high light fastness are faded mainly by UV radiation.

In order to establish a clear method of how to manipulate the differing light fastness of natural dyes, a literary search was carried out with Patricia Crews (1982), Gill Dalby (1985), Herschel (1842) and David Lee (2007) recording extensive research regarding methods and techniques and have rated natural dyes based on their light fastness. Their studies show that although the majority of natural dyes fade at differing rates when exposed to natural daylight there are a handful of natural dyes that show a strong light fastness, these include Madder, Indigo and Woad. Therefore the mixing of these light fast dyes with fugitive dyes can potentially create a colour that changes over time. More work is planned in the future to investigate the influence of different wavelengths at opposing ends of the spectrum.

By using an Anthotype processes as a patterning technique, very successful results were created on a wide range of fabric types but this was reliant upon a strong natural light source which is not always available in the UK so may be more successfully employed in countries with high light levels throughout the year or through the employment of ultra violet light sources but these tend to only be successful with the fading of yellows and

oranges.

The colour pallet that can be employed is limited to a small collection of fast and fugitive dyestuff that process potential healing properties created by over dyeing and layering. The use of a mordant such as alum at times increased the fugitive properties of the dyes but others such as tannic acid provided the chosen dye substances with a higher fastness rating but thus restricted the potential of using Anthotype techniques to produce the patterning. Observations were made that the fabrics and patterns produce continued to fade during time and exposure to natural daylight. If such patterning is to be commercially successful this is a design that that would have to be accepted by the consumer or other ways of stabilising the designs to stop further fading would need to be investigated into such as the use of UV blockers and other substances that would slow down the fading process. (Cristea 2006) Other sustainable patterning was created by exploring the pH sensitivity of the dye stuff, for example elderberry that can change colour dramatically from pink/blue to olive green with a higher pH value and if applied to cellulosic fibres would cause little fibre damage and a customised patterning solution could be created by utilising such properties.

CONCLUSIONS

"The Artists go on boldly, and are not afraid to be Chemists,
the Chemists gain courage and long to be Artists."
The Athenæum 1858

As an eco form of patterning that uses light as the main catalyst for cloth decoration the use of cyanotypes is well known (Hewitt 1995) and the revival of light sensitive vat dyestuffs is well documented and commercially successful (House 1981) (Epp 1995) but the application of natural dyes as Anthotypes is still at investigatory stages and will rely on changes in attitude to the permanence of a pattern or colour but provides an interesting challenge in eco patterning to take into further research.

The choice of sustainable materials both in the form of fibres, natural dyes and mordants add to the eco-friendliness of the patterning technique and builds upon the health aspects of the process. According to Li Yi–You in his paper: 'The Soybean Protein Fibre - A Healthy & Comfortable Fibre for the 21st Century'

> '*The soybean protein fibre, with its good affinity to human skin, contains several amino acids and has good health effects. In the fibre-spinning process of the soybean protein fibre, the addition of Chinese herbal medicine with the effects of manner of a chemical bond. The medical effect is outstanding and permanent, avoiding the disadvantage that the medical effect is less long-lasting when functional products of cotton goods are developed with the after-finishing method.*'

By considering such potential aspects in fibre development with similar properties being provided to Lycel and Bamboo regenerated fibres prior to extruding or through the use of natural colorants, the potential health giving aspects of a material can be improved considerably. The sustainable and health aspects of natural dyes due to the fact that they are now known to contain anti-viral and anti-bacterial properties (Cardon 2007) more textile companies across the world are promoting positive health giving attributes to a variety of products they market for example Aura Herbal Textiles based in India. Their website states: *'These ingredients are not only medicinal, regenerative and healthy also*

our process helps avoid over 8000 chemicals used in synthetic processes and saves over 2000 litres of water per garment.'

Although some very successful outputs were achieved, this research project plans to be extended by looking at different solubility of colouring materials touched upon by Hubble in 1885 and expanded upon by Lee "Natures Palette: The Science of Plant Colour (2007) improvements in application of the colouring material will be considered and explored. As well as methods for increasing the light fastness by applying after mordant such as Iron or Copper acetates to the Anthotypes after exposure or as recent research has revealed the use of UV blockers such as Vitamin C, (Cristea 2006) lemon and lime juice extracts of banana peel (Salah 2010) that does not normally affect the colour of the patterning produced.

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