# NATURAL DYES: THICKENING MADDER, WELD, AND WOAD FOR SCREEN-PRINTING OF TURKISH INSPIRED TEXTILE PRINTS

by

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# Abstract

The overarching goals of the project were to acknowledge both traditional and modern aspects of Turkish culture, inform designers and researchers of natural dye and screen printing methods, and advance the developing practices of sustainable design. Mixed methodologies of scientific and practice-based research guided the project.

A collection of 25 prints inspired by the Anatolian region of Turkey were screen-printed with thickened natural dyes onto sustainable fibered fabrics. The research of traditional Turkish art and culture led to the inspirational concepts and brought the textile prints to fruition. Understanding the dyeing practices, regional traditions, and political rule of this nation informed the design process and directly influenced the composition and imagery of the designs. The final outcomes were exhibited at the Kansas State University student union art gallery.

Research was conducted on the use of natural plant-based dyes madder, weld, and woad for screen-printing by determining the most effective thickener and thickening method. Thickening agents gum tragacanth and gum arabic were tested for fabric hand and the printed natural dyes were tested for colorfastness to light. Gum tragacanth at a ratio of .9875 g agent to 10 ml water emerged as the most smooth and pliable when evaluating fabric hand. Colorfastness to light was as expected for madder and woad with excellent to good fastness. Weld had an unexpectedly low rating indicating further study is needed.

The developing practices of sustainable design were advanced as I used sustainable materials (natural dyes, natural gums, naturally fibered fabrics) and methods (hand screen-printing) throughout the project. The information from this project may be valuable to artisans to further develop their natural dye and screen-printing techniques; to researchers to provide a

foundation for testing additional thickened dyes; and to industry professionals to modify their practices.

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# Chapter 1. Introduction

In every civilization from distant ages to the present, the art of dyeing has played an important role in adding beauty to the world. Traditionally, fibers were naturally dyed with plants and insects to provide uniformity of color to textiles. The history of natural dye is more than 4,000 years old and much information has been passed through generations (Cardon, 2007). Until the invention of synthetic dyes in 1856, textiles were dyed with natural dyes. Since then use of synthetic dyes has dominated the textile industry. Interest in natural dyes resurfaced during the arts and crafts movement of the late 1960s-1970s. Within the past ten years, there has been a movement to expand the use of natural dyes in the textile field with a focus on the environmental and world cultural aspects of natural dyeing and its restoration (Böhmer, 2002).

In recent years, the use of synthetic dyes has declined because of awareness of the adverse environmental effects caused by the effluents from factories as well as carcinogenic additives used in the making of these dyes. In particular, the vivid azo dyes have been banned due to their carcinogenic elements. Therefore, attention has been directed toward the development of natural dyes for industrial use especially for fabrics being exported to developed countries, such as The United States, Germany and Japan (Hartl, 2003). Reviving the historical art of dyeing with non-toxic, non-pollutant, eco-friendly natural dyes can provide an alternative to synthetic dyes.

An area of personal interest is surface design created from natural dyes. I have found little research on the use of thickened natural dyes to create surface designs such as screen-printing and stamping. Looking at historic art and textiles, I wondered how our ancestors used these natural dyes to produce the magnificent prints we see today in many museums. They had to have used natural dyes and a thickening agent to create a print paste for the ancient printmaking methods: Intaglio, Monotype and Relief. I had to look outside the realm of just textiles and see printing as a whole. I found resources on medieval paintings that discussed the use of natural dyes and thickening agents. Some even included ancient recipes from the fourteenth century (Thompson, 1956). Research into the thickening agents brought up two particular plant-based gums that were used most often: gum arabic and gum tragacanth. Both of which were found in ancient recipes and are readily available today.

I also chose to narrow my search to a specific region of the world, Europe and the present-day country of Turkey, in particular. The Anatolian region of Turkey is rich in textile history and use of natural dyes for their famous flat weaves and rugs. During my research of this culture, I found cooperatives and other initiatives that practice sustainable textile methods, including the revival of natural dyes.

## *Objectives*

The overarching goals of this project were to acknowledge and preserve traditional cultures, inform designers and researchers, and advance the developing practices of sustainable design. These goals are multifaceted but all include the revitalization of natural dyes. The objectives of this project were to:

1. Determine the most effective thickener and thickening method for natural dyes of madder, weld and woad for use with screen-printing onto sustainable fabrics. The two thickening agents tested were gum arabic and gum tragacanth;
2. Create motifs for screen-printing inspired by the Anatolian region;
3. Design and produce textile prints based on findings from thickening research and inspiration;

4. Exhibit outcomes in a public venue and submit for juried review. The exhibition of my design project was shown at the William T. Kemper Art Gallery – Kansas State University, April 28 through May 17, 2010.

# Chapter 2. Contextual Review

## *Background*

### *Natural Dyes*

Color from plants can be seen in use throughout the whole of recorded history and across cultural and geographical boundaries. Archaeological finds indicate that dyes from natural sources have been used to color textiles for at least 4,000 years. However, natural substances were used as body paints, cosmetics, and colorants for pottery and baskets long before they were applied to textile fibers (Dean, 1999). According to Hartl (2003), about 1,100 known plants can be used for dyeing. There have been many published books and articles on the history of dyeing. Cardon (1996), in particular, states,

> The most important characteristic of all this early literature on dyeing is that it indicates a very sure empirical knowledge, among dyers, of what works and what does not, of what will give a technically satisfactory and lasting result, and of what solution is easy or cheap merely to get transitory colors. Some sources explicitly make the difference, others do not, some recipes are complete, and others are not. It is moreover true that to make their way through such a mass of information, which at first sight may seem somewhat confusing, historians must determine its rationale (p. 53).

There are three types of natural dyes, substantive (also known as direct), vat, and mordant (also known as adjective). Substantive dyes have a direct affinity for the fiber, while adjective dyes require a mordant to fix the color to the textile fiber. Alum (potassium aluminium sulfate) is the most commonly used mordant and has been in use since ancient times (Wells, 1997). Aluminium is one of the most common metals on earth and is found in the majority of the earth's minerals. Recently, dyers have been using separate mordants for cellulose and protein fibers, aluminium acetate and potassium aluminium sulfate, respectively (Wipplinger, 2005). For this project, I followed these new guidelines and mordanted my fabrics according to their fiber content.

Vat dyes are much different than mordant and substantive; they are organic pigments, which are insoluble in water. During the dyeing process, they can only be fixed to the fibers after being transformed into a soluble substance via reduction. Natural vat dyes include indigo and woad. They are complex to use, requiring the establishment of an anaerobic (oxygen-free) fermentation (Balfour-Paul, 2000).

Some of the traditional plant and insect dyes include madder, weld, woad, cochineal, lac, indigo, brazilwood, and quercitron. For this research project, I focused on the three main plant dyes that are used in Turkey: madder, weld, and woad.

In 1856, William H. Perkin discovered a mauve “aniline” dye derived from coal tar and changed the use of natural dyes in practice for history. After the invention of synthetic colors by Perkin, natural dyes lost their importance due to the lengthy, laborious and tiresome processes involved in the application of the dye to textile material and their non-availability in ready-to-use form (Gahlot, Papnai, Fatima, & Singh, 2005). Naturally-sourced colors were a big business in the pre-synthetic era but within 40 years of the beginning of synthetic dyes the natural color industry was virtually dead. People preferred synthetic dyes because they were inexpensive, easy to find, and they have a basic dyeing procedure (Özgökçe & Yilmaz, 2003). The re-introduction of natural dyes has provided an opportunity for the textile industry to make use of these dyes for developing a niche market for naturally dyed/printed products. According to Shaw (1999), the market for natural textile products is huge and has not been fully tapped.

Currently, natural dyeing is done by artisans, craftsmen, and green-minded companies at three technological levels:

- handcraft level: one or two people use simple equipment (pots, gas cookers, etc.) and mainly dye wool and silk (as they can be more easily dyed than cellulose fibers);
- small business level: machines are used (similar to conventional dye houses) and up to 50kg (approximately 110lb) of yarn can be dyed per unit;
- industrial level: dyeing systems and machines are developed to build a consistent product (Hartl, 2003).

Madder. Madder is a mordant dye taken from the roots of the madder plant (Rubia tinctorum); Turkish name Kökboya (see Figure 1). Madder is one of the most ancient dyes and has excellent colorfastness. Madder came into use as an artist's pigment in the Middle Ages, however it was used as a dye from very early times (Thompson, 1956). The very best and most sought-after red from 1600 to 1930 was Turkey Red, the most complex dye known (Dean, 1999). The process is credited to the Persian, Turkish, and Greek dyers along the Mediterranean known as the Levant in about A.D. 1600 (Liles, 1990). Madder has great historical importance in the history of British costume as well as, their civil, sporting, and military dress (Thompson, 1956). After the collapse of the madder market following the introduction of synthetic dyes, Turkish farmers moved to the cultivation of cotton; however the root system was so established in the soil that madder grows wild in the fields and along roadways to this day (Böhmer, 2002).

Figure 2.1 From left, madder root and plant[1]

The madder plant should be three years old before the roots are dug up, washed and then dried in the air or in kilns (Weigle, 1974). There are more than twenty dyestuffs found in the reddish-orange roots, most important is alizarin, followed by pseudo-purpurine (Napier, 1875). The dyes are not present in free form because they are bonded to the sugars in the root and can only be released by drying the roots, storing them for a few weeks to months and finally heating them in a dye bath (Böhmer, 2000). According to old documents, the roots of the madder plant were harvested in the autumn (Dean, 1999).

Madder produces red, from deep red to orange-red in one direction and violet in the other (Böhmer, 2002). These three typical colors are often seen in Anatolian village rugs and kilims made before 1870. To obtain the red colors, traditional use of a mordant and heat (not to exceed

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[1] From website *http://www.dkimages.com*

70 °C) is required (Sandberg, 1997). I have only found one source indicating the result of violet from madder. Böhmer (2000) described the process as a heat-free mordant fermentation, even though it is not completely clear which bacterial processes are involved.

Madder is one of several plants whose cultivation will be vital in the future if the recent interest in natural dyes becomes more established, as it is one of the simplest plants to grow (Dean, 1999). During the revival of interest in natural dyeing, the advantages of madder have become known to a global market. Turkey took a lead role in this revitalization with the DOBAG project and the market for madder has grown in Anatolia as well as other various initiatives aimed at the revitalization of its cultivation. The acronym DOBAG stands for Dogal Boya Arastirma ve Gelistirme Projesi = Natural Dye Research and Developing Project. It has also gained precedence in Iran, Afghanistan, Pakistan and Morocco (Böhmer, 2000).

To have a thorough understanding of the plant the negative aspect of madder, the maturity of the plant, must be mentioned. Its roots must be well established (at least three years old) to obtain a sufficient amount of chemical dyestuff, mainly alizarin. The maximum alizarin content (2.5-4%) develops at about three to five years of age (Napier, 1875).

Weld. Dyers, historically, chose their yellow dyestuffs with regard to light and washing fastness and an important source of yellow dyes come from flavonoids (Cardon, 1996). The most widely cultivated and flavone-rich plant is weld (Reseda luteola L.); Turkish name Muhabbet çiçegi (see Figures 2 and 3). The coloring components of weld, a mordant dye, are luteolin and apigenin, both of which are flavones (Crews, 1987). The reason for the superior lightfastness of weld compared to other yellow natural dyes of flavonoid classes is unclear. However, Crews (1987) suggests that it related to the physical state of the fiber being dyed rather than the chemical state of the dyestuff.

Weld appears to have been in Europe since prehistoric times and it is considered one of the most important natural dyes due to its colorfastness (Liles, 1990). It is referred to as the oldest dyestuff known to man. The Romans regarded weld as a color symbolizing purity and used the dye for bridal clothes (Weigle, 1974). Weld was very popular with the dyers of the Ottoman Empire, primarily for silk and wool. Identified as the source of yellows and greens, it has been found in many pieces from sixteenth century silk made in Turkey (Cardon, 2007). It still grows wild in Europe, particularly in the areas where it was once cultivated for its dye. In Turkey, it extends through central Anatolia.

Weld, an annual or biennial herb, is a tall growing relative of the garden mignonette (Thompson, 1956). The first year plant produces a rosette shape while the second year plant has erect stems with small flowers. The coloring matter is concentrated mainly in the leaves, inflorescences and fruit (Cardon, 2007). Cardon (2007) defines inflorescences as the complete flower head of a plant including stems, stalks, bracts, and flowers. However, Buchanan (1995) found the leaves of the first-year rosettes and the whole flower stalks yield the most color.

While weld is the most lightfast pigment known and no synthetic dye has yet taken the place of weld as a means of producing certain yellows in silk dyeing (Thompson, 1956), there are some negative factors to consider. Similar to many plant based dyestuffs, large amounts of plant material are required for a strong color. Recipes call for two to three times the weight of dried dyestuff to that of fiber (Cardon, 2007; Weigle, 1974). Further, weld is a noxious weed and illegal to grow in some U.S. states (Buchanan, 1995).

Figure 2.2 Weld: botanist illustration[2]

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[2] From website *http://www.meemelink.com*

Figure 2.3 Weld, second year plant[3]

Woad. Woad (Istatis tinctoria L.); Turkish name Civit Out, a vat dye, is a biennial herb that begins as a rosette and matures with erect flowering stems that grow up to two meters tall (Cardon, 2007). See Figures 4 and 5. The broad green leaves contain the colorant. Leggett (1944) states that woad is classified in a group which derives its name from the Latin word isos, meaning equal, because it was thought that the family of plants possessed the virtue of removing skin roughness by applying its leaves to the affected parts . Linnaeus added the word “tinctoria” in 1753, to describe its dyeing qualities (Balfour-Paul, 2000). Woad is one of over 50 species that belong to the genus Isatis. In Turkey, botanists have identified over 36 species and

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[3] From website *http://www.wahlens.se*

subspecies and some are still being used to provide dye in modern, naturally dyed rugs (Böhmer, 2002).

Woad is one of the few dyes native to Europe and was heavily used due to a shortage of indigo caused by the Napoleonic wars (Mellor & Cardwell, 1963). It is said to have been used as early as 6,000 BC in the Near East because of suggested knowledge of dyes at the early Neolithic site of Catahoyuk in Southern Anatolia (Balfour-Paul, 2000). Babylonian texts of the second millennium mention ‘garments dyed in blue’ and it is supported by many fragments of wall paintings showing many shades of blue (Leggett, 1944). It has further historical importance as when Julius Caesar and his army invaded Britain in 55 BC; they were greeted by Picts, an ancient Celtic group whose bodies were said to have been painted blue with the indigoid from woad (Liles, 1990).

Figure 2.4 Woad detail[4]

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[4] From website *http://www.cassiacounty.org/weed/*

Figure 2.5 Woad (Istatis tinctoria  L.), second year plant[5]

A negative factor of woad is low indican content compared to other species of *Indigofera* (Liles, 1990). Most literature and recipes recommend three times as much woad per ounce of fiber compared to natural indigo.

### *Anatolia*

The Anatolian region of Turkey has a rich textile history. Its prosperous location along the famous Silk Road, which led to exchanges of ideas between countries and cultures influenced textile designs (Dean, 1999). Asiatic Turkey has long been a crossroad between East and West, due to its location between the Black and Mediterranean Seas and where Europe and Asia meet,

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[5] From website *http://www.cassiacounty.org/weed/*

and has resulted in cross-cultural influences seen in the historic textile designs. The Turkish culture is a unique mix of indigenous cultures that developed in this area, as well as being heavily influenced by the various people and cultures that flowed through the region (Wilson, 1979). Turks refer not just to the people living in Turkey, but rather signifies anyone who speaks a Turkic language. In the 1970s they numbered about 90 million people and live in areas reaching China and Russia to Greece and Afghanistan (Wilson, 1979).

The Ottoman Empire, famous for their silk dyeing and woven rugs, reigned for more than 600 years until 1922 when Turkey became a free democratic nation. The government controlled the production of silk and rugs creating a uniformity of designs and quality which led to their reputation of natural dyeing techniques (Doğan, Başlar, Mert, & Ay, 2003).

The oldest flat weave fragments were found in the Pazyryk tombs dating from the third century B.C. or earlier (Ziemba, Akatay, & Schwartz, 1979). Prior to the early twentieth century, there was very little interest in the preservation of old textiles in Asiatic Turkey and this has led to little literature and documented history of traditional Turkish textiles. Most of the Turkish textiles that survive date from the sixteenth and seventeenth centuries; the best source for information prior to these dates are European paintings from the fourteenth century (Wilson, 1979). According to Mackie (1973), Turkish carpets have appeared continuously in the paintings of Western masters, such as Leonardo da Vinci.

The Anatolian region has been using plant-originated natural dyes since ancient times and has supplied two-thirds of natural dyes in the world market (Özgökçe & Yilmaz, 2003). Woad is the oldest known indigoid vat dye and madder is the oldest mordant dye in the Anatolian region (Ziemba et al., 1979). Weld is also a very common plant in Turkey (Böhmer, 2002). In the eighteenth century, the Ottomans produced two-thirds of the world’s root dyes making way to the rich flora of this region. Turkey is one of the richest countries of Europe and the Middle East from the flora point of view (Doğan et al., 2003). In correlation to this floristic richness, the number of dye plants is relatively high in Turkey. According to Eyüboğlu (1983), the Turks successfully used the techniques of natural dyeing, which were about to fade because of migration in the Middle Ages, and introduced them to the world (as cited in Doğan et al., 2003).

It is important to encourage the use of natural dyeing in Anatolia because the naturally dyed products can make valuable contributions to the economy and help to restore the culture of the regions. It is also known that the authenticity and quality of fibers dyed with natural dyes are more valuable and that buyers pay a higher price. Turkey, because of its geographical position, has rich natural plant diversity as a natural dye source. Since their discovery, artificial dyes were preferred to natural dyes. However, it is found that the color of artificial dyes change over time, and the value of handcrafts decrease (Özgökçe & Yilmaz, 2003). On the other hand, when handcrafts are dyed with natural dyes, the bright colors last through time and the dyes are not harmful to the environment. For these reasons, the importance of natural dyes is increasing.

Turkish designs. Traditional Turkish textiles hold valued excellence in terms of their quality and elaborate designs. Floral and stem patterns, featuring carnations, tulips, artichokes, and pomegranates are very common (see Figures 6, 7 and 8). One characteristic Turkish pattern is the *Chintamani*, featuring two wavy lines with three balls (see Figure 8). According to Wilson (1979), the motif is probably Chinese in origin but it was a favorite with the Ottomans. Many designs of Turkish kilims, flat woven rugs made only in Turkey, were directly related to designs brought to Turkey by migrating Turkoman tribes as early as the eleventh century (Ziemba et al., 1979). Another influence on Turkish designs was their Islamic history. Islam is a major shared aspect of the Turkic culture, along with their history and language (Mackie, 1973).

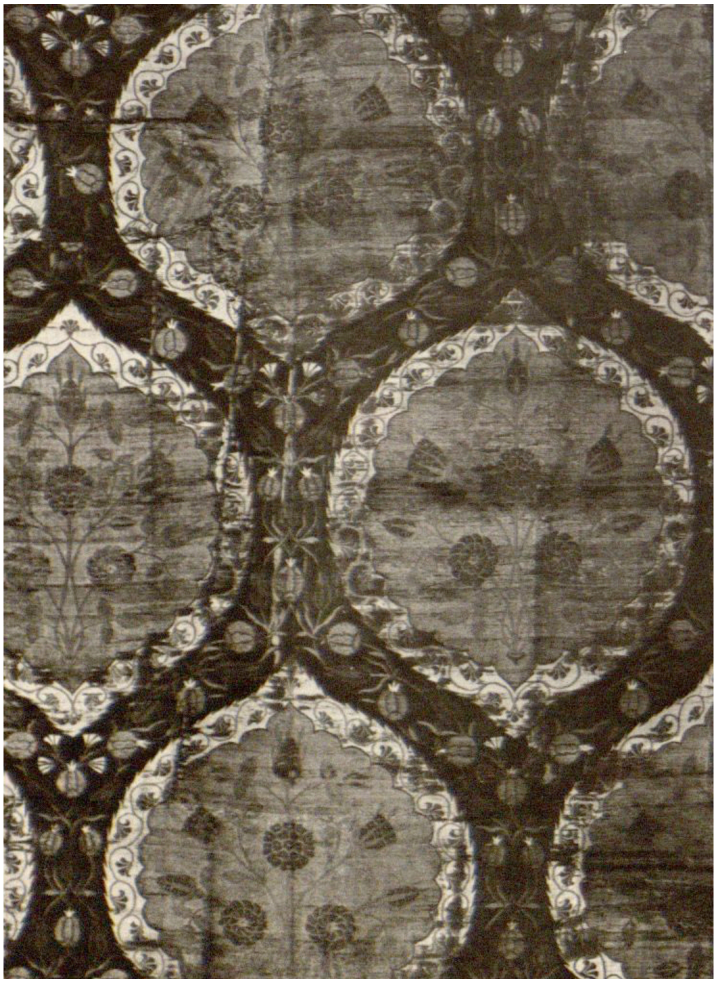

Figure 2.6 Sixteenth century Turkish fabric, pomegranate details[6]

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[6] From *The Splendor of Turkish Weaving* by L. Mackie, 1973, p. 48.

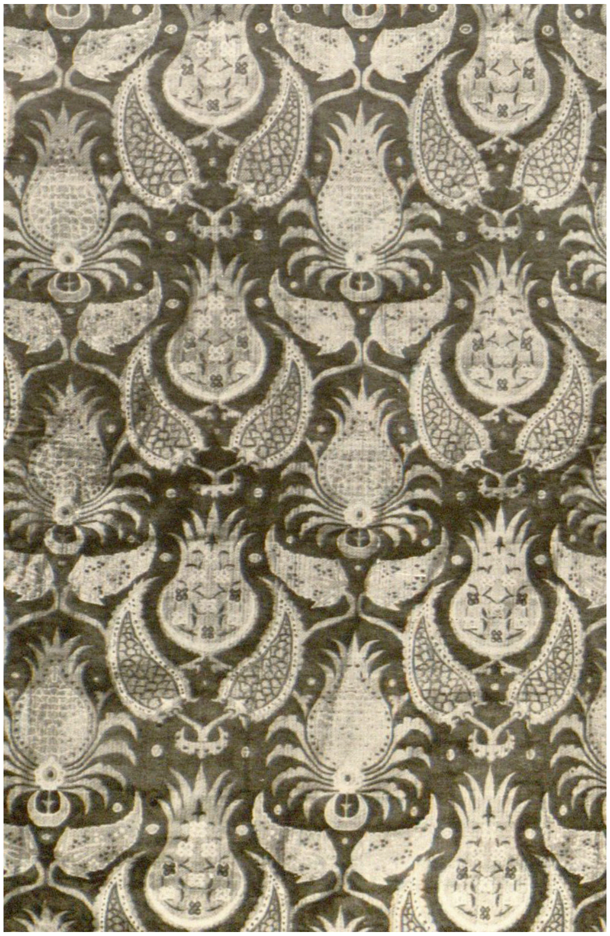

Figure 2.7 Fourteenth century Turkish fabric, artichoke detail[7]

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[7] From *Turkish textiles and velvets, XIV-XVI centuries* by T. Oz, 1950.

Figure 2.8 Sixteenth century Turkish fabric, tulip and carnation designs[8]

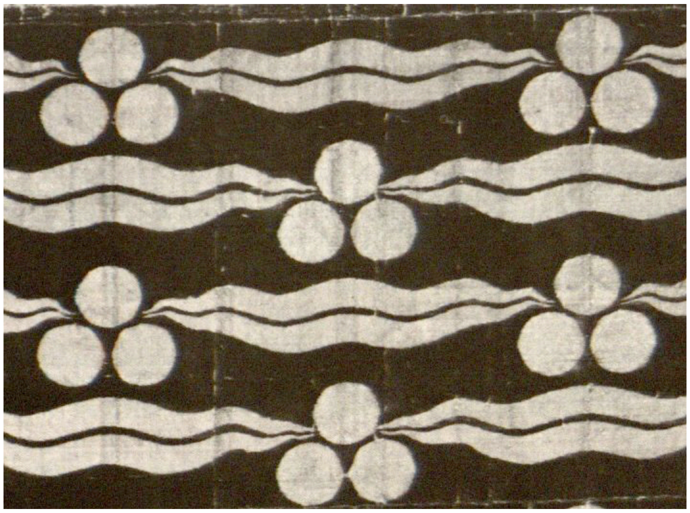

Figure 2.9 Fifteenth century Turkish fabric, Chintamani pattern[9]

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[8] From *The Splendor of Turkish Weaving* by L. Mackie, 1973, p. 21.
[9] From *The Splendor of Turkish Weaving* by L. Mackie, 1973, p. 43.

Central Asia is home to various cultures and peoples who gave rise to the beautiful tribal textiles and art. Within the Islamic culture, women are often restricted to their homes and textiles have become a place to express their feelings and dreams. Every motif, handed down over generations is carefully placed on the textiles. A part of the joy of looking at Turkish textiles is decoding the heartfelt messages on them (see Figure 10).

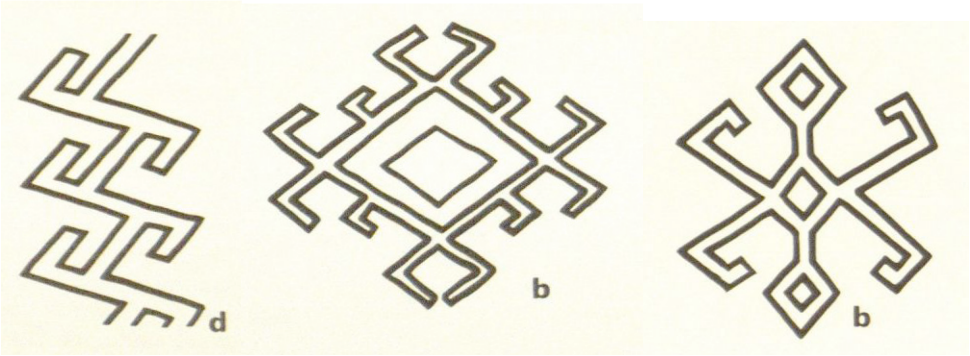

Figure 2.10 In order: border design, scorpion, and eye motif.[10]

The appreciation of Turkish textiles has not weakened. The bold patterns, vibrant colors, contrasting values, silk fibers and skillful stylizations still fit into the décor of modern homes just as they did in the houses of earlier periods. It is time to render homage to the cultural accomplishments of the people of Turkey as the West happily recognizes the artistic value of the textiles.

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[10] From *Turkish Flat Weaves: An Introduction to the Weaving and Culture of Anatolia* by W. T. Ziemba, A. Akatay, & S. L. Schwartz,1979.

Figure 2.11 Antique Herki Kurdish Rug;
100% hand spun wool; 90 years old; $900.[11]

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[11] From website *http://www.seeingisdreaming.com/*

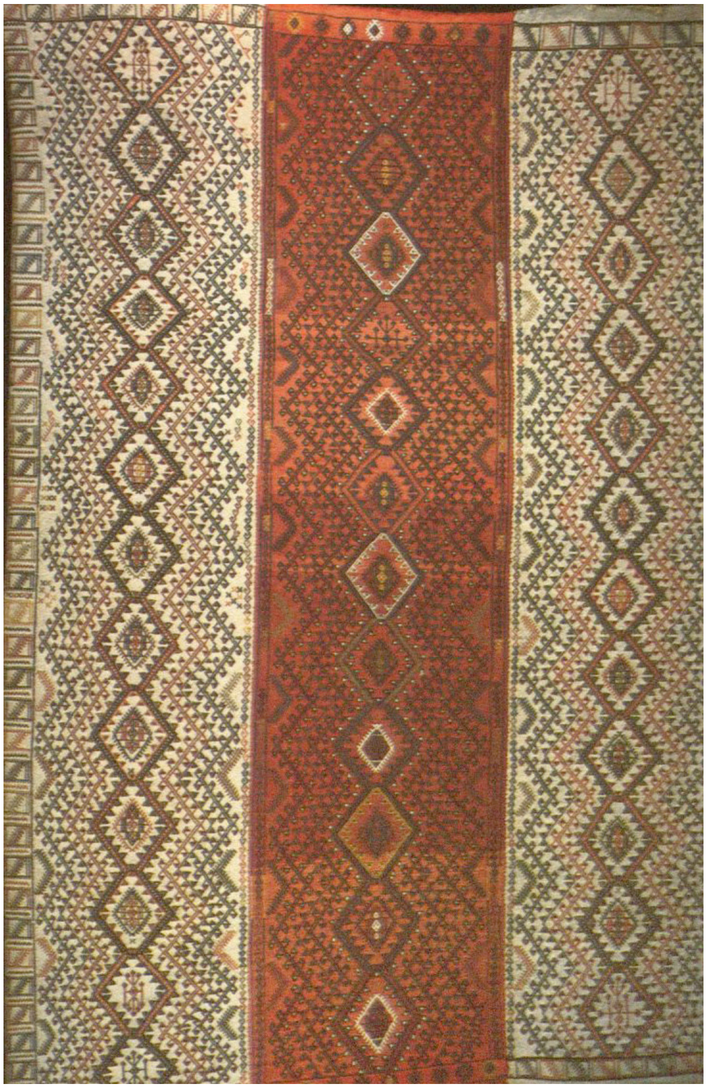

Figure 2.12 Central Anatolia;
madder red and natural white wool; circa 1910.[12]

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[12] From *Turkish Flat Weaves: An Introduction to the Weaving and Culture of Anatolia* by W. T. Ziemba, A. Akatay, & S. L. Schwartz,1979.

Figure 2.13 Sout of Turkey Aydin Nomadic Kilim;

100% hand spun wool; 100 years old; $1000.[13]

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[13] From website *http://www.seeingisdreaming.com/*

Figure 2.14 Semi Antique Anatolian Rug;

100% hand spun wool; 50 years old; $600.[14]

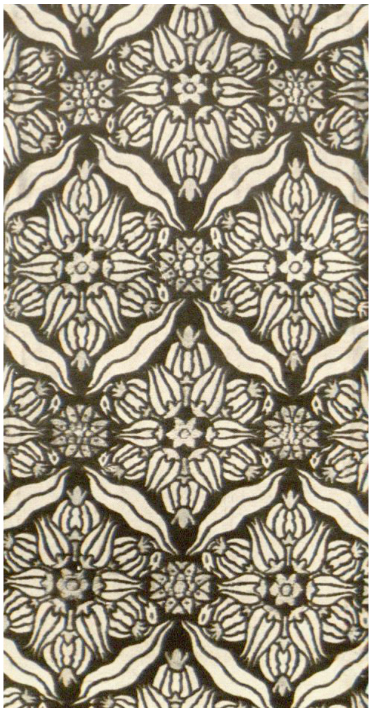

Figure 2.15 Fourteenth century Turkish fabric[15]

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[14] From website *http://www.seeingisdreaming.com/*

[15] From *Turkish textiles and velvets, XIV-XVI centuries* by T. Oz, 1950.

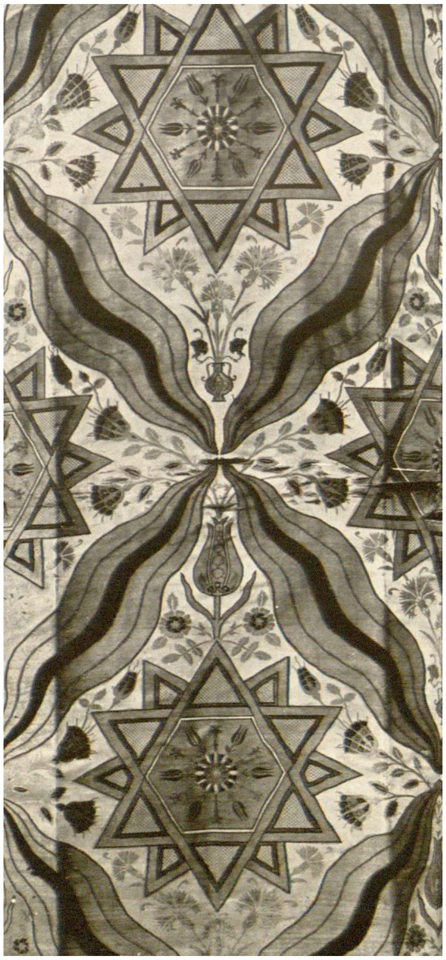

Figure 2.16 Fourteenth century Turkish fabric[16]

*Thickening Agents*

Little research is available on the preparation of natural dyestuffs for screen-printing. Today, textile screen printers continue to use a number of traditional thickeners, including rice starch, potato starch, locust bean and seaweed (sodium alginate) as well as gums arabic, karaya, and tragacanth. These can then be combined with vegetable oil, honey, glycerol, glucose, and molasses as retardants and plasticizers (Shaw, 1995). Based on my review, gums arabic and

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[16] From *Turkish textiles and velvets, XIV-XVI centuries* by T. Oz, 1950.

tragacanth (for use with fabric) have been most successful for researchers in this field (Wipplinger, 2005; Shaw, 1999; Gahlot et al., 2005).

Gum arabic. Gum arabic is the hardened sap from the *Acacia Senegal* tree (see Figure 17) and has been historically used for printing and paint production (Thompkins, 2007). It is found in the arid lands (Sahara Desert) extending from Senegal on the west coast of Africa to Pakistan and India (Cecil, 2005). The name is owed to Europe's early trading contacts with the Middle East where they learned of the gum from the Arabs. According to Sudanese sources, gum arabic was an article of commerce as early as the twelfth century B.C. (Cecil, 2005). By the Middle Ages, gum arabic was valued in Europe among scribes and illustrators for use as a binding medium in mixed pigment (Cecil, 2005). Gum arabic was also important to Turkish scribes for making lampblack ink. The organized trade of gum arabic started in Sudan in 1820 (Awouda, 1987).

Figure 2.17 Gum arabic as hardened sap on the Acacia Senegal tree[17]

Gum arabic is one of the purer gums, also known as Gum Senegal from the tree that produces it. Traditionally, it was particularly effective for printing on silk, as it has high solids content and achieves a sharp print and even color (Kinnersly-Taylor, 2003). The best grade of gum arabic is in the form of whole, round tears, orange-brown in color and with a matte surface texture (see Figure 18) (Coppen, 1995). Gum arabic has a diversity of uses, including lithography, binding color pigments in crayons, scratch-and-sniff perfume advertisements, laundry detergent and baking mixes. It is also used in the food industry as a thickener in many carbonated beverages (Cecil, 2005). The United States remains the largest single market for gum

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[17] From *Gum Arabic. Saudi Aramco World* by C. O. Cecil, 2005.

arabic annual consumption, accounting for 25% of the world market according to The Food and Agriculture Organization of the United Nations (Iqbal, 1993).

Figure 2.18 Gum arabic; pod, plant, and hardened round tears sap[18]

Gum production in the Sudan is a traditional skill handed down through many generations. It has always been an important part of life in the Sudanese gum belt; and continues to hold economic and social prominence (Rathgeb & Flowerman, 1991). The production is evolving from a primitive operation to a scientifically based agro-forestry operation providing higher and more reliable yields (Cecil, 2005). In addition to gum arabic, the gum tree provides many benefits, including the improvement of soil fertility through nitrogen-fixation, while less-productive trees are harvested for firewood and charcoal (Rathgeb & Flowerman, 1991). Despite these benefits, the use of gum arabic in textiles, paints, and adhesives has decreased to very low levels in recent years (Coppen, 1995).

The Gum Arabic Company and various Sudan government agencies have undertaken long-term projects to protect their invaluable gum resource. In close cooperation with international organizations, such as United Nations Sahelian Organization (UNSO), the Sudanese are planting *Acacia Senegal* trees in both traditional and new areas; they are teaching better

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[18] From website *http://www.fullmarkcommodities.com*

collection and cleaning techniques; and they are developing better-yielding and more drought-resistant varieties (Rathgeb & Flowerman, 1991). Other projects to protect and improve the gum resource include assisting the small farmer or villagers with local support services, trade credit, and more efficient marketing channels as well as subsidizing farmers with goods and other supplies in areas where the gum production projects are not yet self-sustaining (Cecil, 2005).

The preparation of gum arabic for screen-printing includes mixing it with water to create the desired consistency of gum (Wells, 1997). Cold water is preferred for the introduction of gum arabic and then the temperature is gradually raised to simmering (Kinnersly-Taylor, 2003). Flour has been suggested as an additive to gum arabic and water for hand painting, block and screen-printing (Wells, 1997). Gum arabic gives an even color on most textiles, although not as deep in shade as pastes made with gum tragacanth and other starch thickeners (Kinnersly-Taylor, 2003).

Gum tragacanth. Gum tragacanth has been used for hundreds of years for textile design. It is considered the second most important commercial gum, following gum arabic (Iqbal, 1993). It is obtained from the trunk of a thorny plant *Astragalus gummifer* (see Figure 19) from the Anatolian, Persian, and Turkistan mountains (FSTCLimited, 2006). In its original form, gum tragacanth was known as ‘gum dragon’ or ‘devil’s toenails’ due to its white to yellow scaly appearance (see Figure 20) (Kinnersly-Taylor, 2003). Like gum arabic, it is usually collected by hand and carried to a central processing area where it is sorted into several grades for export.

Figure 2.19 Astragalus gummifer[19]

Figure 2.20 Gum Tragacanth in detail[20]

Gum tragacanth is widely used because it fulfils the desired requirements of high viscosity with low solid content in the paste (Wells, 1997). To create a paste, powdered gum is

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[19] From website *http://waynesword.palomar.edu*
[20] From website *http://www.karawan.ir*

slowly added to warm water, mixed thoroughly with an electric blender, and left to stand for twenty-four hours to allow the paste to cure, stirring occasionally (Kinnersly-Taylor, 2003; Wells, 1997). Many thickeners need to be left to stand for a few hours or sometimes overnight before use, so it is recommended to mix enough for all the print paste that you will need in one session. The lifespan of the print paste is usually four weeks refrigerated (Kinnersly-Taylor, 2003).

### *Printing with Natural Dyes*

Earthues, a company founded by Michelle Wipplinger, has tested many thickeners and has found gum tragacanth to be the most effective with natural dyes. Wipplinger (2005) states that 'it [gum tragacanth] does not change the colors or the quality of the finished cloth' (p. 16). The company has tried gum arabic and locust bean paste as thickeners and found that they dull and alter the final colors (Wipplinger, 2005). Sodium alginate, the commonly recommended seaweed thickener for fiber reactive and acid dyes, curdles when added to the natural dye extracts according to Wipplinger (2005).

Beyond the thickening information presented in the gum sections, I have only found two research studies on the use of natural dyes for printing. Gahlot, Papnai, Fatima and Singh (2005) researched methods of printing with selected natural dye sources on cotton and silk.

The research was conducted in Pantnagar, India and they chose to use local flora (kilmora roots, walnut bark, hamelia leaves, and jatropha flowers) as their dyestuffs. They used gum tragacanth as the thickener and three mordanting options: potassium aluminum sulfate, copper sulphate, and ferrous sulphate (iron). See Table 1. Gahlot et al. (2005) created their paste by combining the dye concentrate, thickener and mordant in a beaker and left to cure for twelve hours. The printing technique was screen-printing and the samples where steamed upon completion. The screen-printed dyes were tested for colorfastness to light, washing, perspiration, and rubbing following the International Standards Organization (ISO) procedures: IS: 686-1957, IS: 3361-1979, IS: 971-1957, and IS: 766-1956, respectively. The results showed that the dye printed fabrics withstood the testing between fairly good to good on silk and cotton.

Table 2.1 Gahlot et al. recipe for printing

| | |
|---|---|
| Dye concentrate | 4.0ml |
| Gum Tragacanth | 5.0g |
| Fixer | 1.0ml |
| Alum | 10% |

*Note.* From “Printing with Natural Dyes,” by M. Gahlot, N. Papnai, N. Fatima, and S. Singh, 2005, *International Dyer*, *190* (10), 18-20.

They used these methods to develop a wide range of products, including household articles, apparel and handicraft items. With the assortment of end products, they argue that it represents a good opportunity for the production of value-added items for the export market.

Another researcher that has heavily informed my investigation is Phil Shaw of Middlesex University. Beginning in 1995, Shaw researched textile dye technology and developed a screen-printing system, called Phytochromography, describing the use of plant pigments in printing inks (Shaw, 1999). His research began because of an instinct that the water-based printing methods were not quite right. He decided to look into the possibility of using plants as a source of color. The initial research was to find the ‘process colors’, cyan, magenta, yellow, and black in plants (Shaw, 1995). Shaw tested nineteen species of plants and three thickeners; rice or potato starch, locust bean, and sodium alginate (Shaw, 1995). Of the test species, as few as four (buckthorn berries, elderberries, woad, and oak gall) would produce the color range. Therefore, Shaw developed an 'Ink Garden' to produce enough ink to print a limited edition book on the subject of vegetable colors (Shaw, 1995). Over 2000, four color screenprints were produced using the gardens vegetable inks.

An update on Shaw's research was published in *Printmaking Today* in 1997. He had replaced some of the process colors and had made changes to the production process. Yellow, originally from buckthorn berries, was replaced by weld. Magenta obtained from elderberries was now derived from madder root and cyan remained to be obtained from the indigoid plant, woad. A reason for the change in plant sources was the lack of fastness of the berries (Shaw, 1997).

With weld and madder, Shaw produced a 'lake' by precipitating the extract on potassium aluminum sulfate, which gave the properties of a pigment, rather than a dye (1997). He achieved this pigment by heating the source in water and filtering it to produce a color extract free of plant material. Then he precipitated the extract onto a metallic salt, such as alum. The exact process of precitating the extract is not provided in any of Shaw's articles and I have found little research on this process. There are great benefits of creating the lake pigment however. The vegetable colors can be easily stored in a dry powder form without the concern of decomposition. With the dry powder you can create inks and paints by combining them with vegetable oils or even acrylic printing media (Shaw, 1999). Artisit's watercolors can also be produced from the vegetable-based lake pigments by combing them with gum arabic .

Later research by Shaw (1999) tested rice and potato starch, locust bean, sodium alginate, as well as gums arabic, karaya, and tragacanth. Sodium alginate and potato starch were ideal agents for thickening for use with paper. Shaw also concluded that his choice of woad, madder root, and weld were correct as process colors and withstood the lightfastness testing.

### *Lightfastness of Natural Dyes*

Most natural dyes fade rapidly initially followed by a slower rate of fading (Crews, 1987). Only the most lightfast natural dyes fade at a constant rate over time (Crews, 1987). Padfield and Landi (1966) state that the most comprehensive tests of the lightfastness of natural dyes were made between 1890 and 1899 by a committee appointed by the British Association for the Advancement of Science. Since then, tests have been established by the ISO and American Association of Textile Chemists and Colorists (AATCC).

All lightfast natural dyes, with the exeption of indigo, are derivatives of anthraquinone (Padfield & Landi, 1966). This chemical additive in the properities of the dyes plays a role in its preservation and resistance against fading. There is no lightfast bright yellow natural dye, with the exeption of weld. This is evident by the predominant blue shade of the foliage and grass of old tapestries. Most of the yellow dyes become browner and duller as they fade (Padfield & Landi, 1966). Indigo and woad are the most lightfast natural dye. They exhibited a linear or constant fading rate. Crews (1987) suggested that the dye formed large aggregates inside the fiber which reduced the surface area of the dye accessible to oxygen, light and moisture.

Research indicates that there is no known way of preserving all dyes, both natural and synthetic, entirely from destruction by light. Dyes are substances of great chemical variety and that an immense amount of chemical research would be necessary to address such a problem. They do, however, suggest ways of reducing the fading by preventing the exposure of ultraviolet radiation and excessive exposure of any light variation.

### *Sustainable Fabrics*

This project used two different fibers, hemp and silk, in a variety of blends and fabrics. According to Böhmer (2002), hemp has become a choice fiber in Turkey because of its fast growth and heavy presence. Silk is a dominant fiber in Turkey as well because of the country's location in relation to the Silk Road. There were two hemp linens, a silk/hemp charmeuse and two varieties of peace silk, Eri and Ahimsa™. These fabrics are classified as sustainable and will be discussed in the following paragraphs.

Hemp grows very rapidly, naturally smothering weeds and controlling pests, and is thought to be suited to low-impact systems of agriculture (Fletcher, 2008). Growing hemp helps clear land for other crops; it improves the structure of the soil with its natural chemicals; its strong roots control erosion; and it has a high yield. Between 20-30% of the plant is fiber and its productivity is superior to other natural fibers according to Fletcher (2008).

Peace silk means that the lifecycle of the silk producing caterpillar is allowed to naturally complete itself. They are cultivated in open forest where there is an easy source of food, and no hazardous chemicals are used (Fletcher, 2008). The silkworm chrysalis is collected after the moth has emerged naturally (as compared with cultivated silk, where the silkworm grub is killed while in situ) (Fletcher, 2008). Eri is a type of wild silk found only in India (Kolander, 2007). The cocoons are small and the silk is very light in color. Wild silk is made from short lengths of fiber and is spun in a similar way to other staple fibers such as cotton because the moth damages the silk cocoon as it exits the chrysalis, breaking the single continuous filament. Ahimsa™ is a patented label by a producer in India. The high quality mulberry (cultivated Bombyx) silk fabric is exclusively imported and distributed by Aurora Silk (Kolander, 2007). Kolander (2007), the owner of Aurora Silk, pledges that

> all aspects of the operation are clean, healthy and honorable (absolutely no child labor, nor slavery; cocoons are raised in small family farm without the use of pesticides, herbicides, antibiotics, genetic engineering or any other practice of dis-repute).

### *Screen-Printing*

Printing, in general, is localized dyeing and one of the oldest means of surface decoration. Prior to the invention of synthetic dyes all the printing of fabric and paper was carried out using natural dyes. Dyes extracted from indigo and madder were extensively used for this purpose (Gahlot et al., 2005). Asian countries have a long and complex history of cloth printing using plant dyes (Flint, 2008). Printing with natural dyes is not yet explored to its full extent and the demand for natural dyed/printed products is increasing, especially in the export market (Böhmer, 2002). According to Böhmer (2002), modern silkscreen printing has replaced traditional block printing in many areas and almost completely in Turkey.

Screen-printing (or serigraphy, or ‘silk’ screening) is a printing process in which ink is pushed through a stencil image adhered to a tightly stretched mesh on a wooden or metal frame (MacDougall, 2005). The ink is transferred through this stencil onto a material or object using a squeegee.

One of the classic distinct print methods, screen-printing is also among the oldest. Evidence of repeat stencilling and graphic applications to walls, fabric, and paper have been found in Egypt, China, and Japan, predating Gutenburg’s ‘invention’ of printing by a few thousand years (MacDougall, 2005). Modern screen-printing dates its use as a formal print process from the early twentieth century, when patents and the emerging advertising industry were brought into a more public view (Hiett & Middleton, 1967). Automation of the process started in the 1920s, and today screen-printing has expanded into an approximately eighty billion dollar a year business in North America (MacDougall, 2005).

Adjective natural dyes, such as weld and madder, require a mordant to assist with the bond between dye and fiber. There are three sequences to apply the mordant: 1) mordant applied to fabric prior to the dye, 2) mordant and dye are mixed together and applied simultaneously, and 3) dye applied followed by the mordant (Thompson, 1956). The simultaneous method is the most commonly used. Once the dyestuff and warm water (called stock solution) has attained the required consistency (fully dissolved), it should be mixed with the binding medium (mordant). To prevent clogging of the screen; the dye extract should be finely ground and the solutions strained (Flint, 2008).

Advantages of screen-printing are that the printing process can carry more dye paste onto the surface compared to block printing. Compared to digital printing technologies, screen-printing has low capital costs with equipment return on investment measured in weeks and months, and machines staying productive for decades (MacDougall, 2005). This indicates that developing countries and regions of the world may be able to afford a natural dyeing and natural dye-printing establishment.

However, as screen-printing is labor intensive, it cannot compete with the large format inkjet printers used for the short-run full color market (MacDougall, 2005). The move toward digital printing of textiles in recent years can have a negative impact on the textile screen-printing industry in many countries where they do not have the capital for these new technologies (Ujiie, 2006).

### *Artisan Groups and Initiatives*

The primary example of an artisan group that is reviving the use of natural dyes is the DOBAG project organized by Harald Böhmer. Böhmer, a German chemist, has been working in Turkey since 1960 studying the traditional use of natural dyes in the Anatolian region. Begun in 1981, the project aimed at providing rural populations with a better source of income through the production of traditional textiles matching the quality standards of the ancient ones. This is a great model of the sustainable initiatives that can take place to help rural communities use the local resources they have and restore their traditional heritage. The people of these rural communities are developing a higher standard of living while revitalizing traditional skills and heritage.

The project began with the support of the German Ministry for Economic cooperation (within the structure of the Turkish-German economic cooperative) and is now in cooperation with the Faculty of Fine Arts at Marmara University Istanbul (Böhmer, 2002). Böhmer (2002) defines the goal of the project as ‘the weaving of naturally dyed pile carpets and flatweaves with traditional local Turkish designs for the international market and the strengthening of the social and economic situation of the women weavers in the villages’ (p. 259). See Figures 21 and 22.

Figure 2.21 DOBAG project: geometric pattern (woad and madder); circa 2004; $3395.00.[21]

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[21] From website *http://themagiccarpet.biz/*

Figure 2.22 DOBAG project: geometric pattern (woad, madder, & weld); circa 2005; $unknown.[22]

According to DOBAG standards, the following production principles are required: 'one hundred percent handspun Turkish wool for warp, weft, and pile; authentic Turkish designs; one hundred percent natural dyes (including natural indigo); no unhealthy mordants, no chemical wash, no atelier work, weaving in houses' (Böhmer, 2002, p. 259). The framework of the DOBAG project consist of two independent cooperatives with 350 member families total in 25 different villages. One of these cooperatives is the first women's cooperative in Turkey (Böhmer, 2002). The carpets are guarenteed and since 1981 about 30,000 carpets have been produced and sold (Böhmer, 2002).

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[22] From website *http://themagiccarpet.biz/*

There are also efforts to reintroduce the use of woad. A French company, *Bleu Pastel de lectoure*, produces woad for industrial use. They have developed products and usage for woad from dying fibers to painting cars and homes. The company not only researches the various usages for the plant but they also sell the product as a pigment or extract (Bleu Pastel de lectoure, nd.). There are a number of initiatives currently under way throughout the United States and Europe that are helping to either restore the use of natural dyes or research into plant-sourced alternatives in the dyeing and printing industries. Cardon (1996) discussed a European Union-funded project to investigate the agricultural and processing possibilities of natural dye plants, including woad, weld, and madder. The British ministry of Agriculture, Fisheries and Food have funded an investigation into the use of woad in the production of ink-jet printing inks (Shaw, 1999).

It is important that the skills and knowledge of natural dyeing are kept alive, not only because they are a valuable part of our heritage, but because it is possible that in the near future we may need to rely heavily on them again. My goal is not to offer a replacement for the entire color industry, but to offer alternatives for dyeing and printing that use a renewable source.

## *Justification and Contribution*

While research has been conducted on dyeing with natural dyes to improve the fastness properties of the dyed products, little research has been done on printing with natural dyes (Cardon, 2007; Flint, 2008; Böhmer, 2002; Shaw, 1999; and Padfield & Landi, 1966). My research contributes to the knowledge of thickening dyes, in particular plant-based dyes, for screen-printing. The research of thickening and printing with natural dyes is relevant in today's world for environmental aspects and restoration of a cultural art form.

Use of natural dye paste supports the sustainable practices already being undertaken by the apparel industry. It provides an alternative to petro-chemical dyes and pastes. Printing on eco-friendly fabrics contributes to understanding the properties of these relatively new fabrics, which in turn may increase demand. The information from this project may be valuable to artisans to further develop their techniques; to researchers to provide a foundation for testing additional dyes; and to industry professionals to modify their practices.

A further contribution of this project was advancing the scholarship of design through the use and documentation of mixed methodologies of scientific and practice-based. This process validates the research and brings increased depth, value and authenticity to the aesthetic outputs.

# Chapter 3. Methodology

The project aim of recommending an appropriate thickening agent for screen-printing natural dyes onto textiles was in consequence of practice-based research of combining multiple-methods to integrate 'external' factors with a personal 'internal' response informed by my printmaking and design process. The following sections provide background information on practice-based research and present methods used in the project.

## *Practice-Based Research*

Art and design is experiential and the most valuable way practitioners learn is by active participation and reflection on an experience; this is the fundamental nature of practice-based research. Synonymous with practice-based research is arts-based and practice- or arts-led research. Gray and Malins (2004) pose, that 'we learn through practice, through research, and through reflection on both; and this active and reflective learning makes a dynamic relationship between practice and research' (p. 1). Further, practice will raise questions that can be explored through further research, and in turn, this impacts the practice. This experiential learning is related directly to constructive learning. Constructivism has three principles:

- learning is constructed as a response to each individual's experiences and prior knowledge;
- learning occurs through active exploration;
- learning occurs within a social context – interaction between learners (Gray & Malins, 2004, p. 2)

The creative process within the context of educational research is important for the advancement of research (Leavy, 2009). It creates new and distinctive ways of understanding and representing data and meaning. Arts-based research, as defined by Leavy (2009), are

> a set of methodological tools used by qualitative researchers across the disciplines during all phases of social research, including data collection, analysis, interpretation, and representation. These emerging tools adapt the tenets of the creative arts in order to address social research questions in holistic and engaged ways in which theory and practice are intertwined (p. 3).

Naturalistic inquiry as described by Lincoln and Guba (1985) is a strategy where research happens in real situations rather than in laboratory controlled conditions. Gray and Malins (2004) explain this further: research takes place in a natural setting – that is a studio environment, where there is intuitive tacit knowledge for practitioners, methodologies are emergent (grow from interaction with question and context), and the research is grounded.

Eisner (1997) noted that ‘the capacity to wonder is stimulated’ by the kinds of methodological tools chosen, and forms of representation with which we are familiar (p. 8). Further, he suggests that we seek ‘what we know how to find’ and these tools will inevitably shape topic selection, research questions, and research design (p. 8). In the case of this project, my previous experience with natural dyeing, textile design, and printmaking and my desire to learn new practices, as well as my knowledge and interest in Turkish culture, led to the research conducted.

## *Methods*

In order to maximize the technical and aesthetic qualities of my work, a cross-disciplinary approach of using both quantitative and qualitative methods was used. Mixed methods or triangulation often requires a researcher to cross disciplinary boundaries, leave their comfort zones, and seek the knowledge of researchers in other areas (Hesse-Biber & Leavy, 2008). Triangulation can provide a balance of understanding and reveal the richness and complexity of an issue (Gray & Malins, 2004). By accessing multiple meanings and perspectives, I built depth into the design research; adding a dimension of validity to the work.

Further, the methods were categorized as internal or external. Internal methods are assimilated and evaluated through my practice and the knowledge and experiences I brought to the project. External methods are externally learnt acquired as a direct result of the research, and are evaluated externally.

### *Internal Methods*

Internal methods reflect my personal knowledge and experience that I brought to the project, as well as influencing decisions I made throughout the design process. The visual work produced as a consequence of this research can partly be considered subjective in nature, given that the art work is judged by myself to be visually 'successful' by a number of subjective criteria developed in my practice. These are:

- an independence of my experiences in determining the subject matter of the artwork;
- my evolving knowledge base, within the natural dyeing context and printmaking practice;
- an 'open' negotiation which will take place throughout the design process, based on the individual selection of subject matter, and my understanding and application of process.

Process documentation. Documenting the design process from ideas to physical outcomes allowed the research to be analyzed and move from subjective to objective. Recording the process offered a means of revealing information, often hidden or embedded in the final printed artwork(s). The design process was documented through journal entries and digital photographs. The journal (visual and text) was utilized throughout the entire research and design process in order to systematically engage in an 'internal' dialogue.

Inspiration. Understanding and respecting the cultural heritage of the Turks was also an important component of the design and research process as the information gathered will serve as inspiration to guide the designs. Visual art can serve as a significant source of information about the social world (Leavy, 2009).

### *External Methods*

External methods aided in the objective evaluation of the design process and outcomes. The methods included the quantitative evaluation of the thickening agents and qualitative evaluation of the process and project through observer analysis and review.

Thickener testing. Thickening agents and application methods were tested on several fabrics to identify best procedures. Tests of fabric hand and colorfastness to light were conducted according to AATCC standards.

Committee review. Cho and Trent (2005) have recommended getting feedback during all phases of the research project. In addition to the routine feedback provided by my major professor, I built in 'external review' periods into my design research for committee members to review and provide feedback. The goal of this process was to gain input and understanding from a variety of perspectives and adjust my design process after evaluation and reflection of the feedback given.

University exhibit. Visual imagery does not represent a window onto the world, but rather a created perspective (Leavy, 2009). The visual art naturally opens up multiple meanings that are determined by the artist as well as the viewer and within the context of the viewing (Leavy, 2009). When a researcher provides imagery it is most important to provide context, and Holm (2008) suggests using artist's statements as a means to accomplish this. As part of my university exhibition, I developed a written justification or artist statement of the design research project holistically (see Appendix C). The physical university exhibition promotes practice in the fields of textile design, printmaking, and sustainability.

Juried review. A final means of external review will be submitting the process and the outcomes to juried venues. External juried review validates the significance, contribution, and originality of the project.

## *Summary*

A practice-based methodology was used as a means of making art while responding to the potential conflict presented by the 'internal rationale' – which may be seen as subjective, and 'external rationale' – which may be seen as objective. The methods adopted therefore supported the criteria below, that they should:

- be led by my creative practice and experience within printmaking and surface design on sustainable fabrics, and inspired by the Turkish cultural heritage;
- be documented and analyzed through visual and text records;
- test thickening agents for most appropriate methods;
- ensure outcomes be reviewed through external review of the committee, university exhibition, and juried review.

# Chapter 4. Thickener Research

As limited research was available on thickening agents for screen-printing on textiles, I conducted research experiments to establish appropriate formulas and procedures for gums tragacanth and arabic and then tested those amounts for fabric hand and colorfastness to light. This chapter presents the procedures for establishing viscosity or thickness of the agents and evaluating the agents for fabric hand. Based on these findings, two thickening formulas are recommended and continued through the research process. Dye extract amounts were established and added to the two thickening formulas, and screen-printed on selected fabrics. The printed specimens were evaluated for colorfastness to light and those results are presented. The chapter ends by presenting the procedures used to mordant, dye, and screen-printed fabrics.

## *Thickening Agent Procedures*

### *Viscosity*

Viscosity is a measure that describes a fluid's resistance to flow. To establish similar levels of viscosity between agents gum tragacanth and gum arabic, formulas of water and agent were evaluated using a Brookfield DV-II+ Programmable Viscometer, spindle number 6. Viscosity is independent of pressure (except at very high pressure) and it tends to fall as temperature increases. Keeping these attributes in mind, the formulas were measured at a constant temperature of 25 °C (77 °F) and at a constant speed of 60 rpm.

Comparing the natural gum thickeners to a known acrylic textile ink's viscosity was used to establish appropriate viscometer reading. The viscosity reading for the Speedball brand textile screen-printing ink was 1425cP. Researchers (Gahlot et al., 2005; Shaw, 1999; Wipplinger, 2005) have recommended a ratio of 1 g of thickener to 25 ml water; therefore that was the initial ratio used. The 1:25 ratio was appropriate for the tragacanth and had a viscometer reading of 1380.6 cP. However, the gum arabic was too liquid, with a viscometer reading of 81 cP, after being thickened at a 23:25 ratio. As the high amounts of gum arabic became unfeasible to work with and the consistency was poor, it was decided to focus on the gum tragacanth for further thickening analysis.

The amounts of gum tracaganth that moved forward for fabric hand analysis diverged from the established 10 g thickener to 250 ml water at .125 g increments starting at 9.75 and ending at 10.25 g. The five gum tracaganth formulas and the final gum arabic formula (234.5 gm agent and 250 ml water) were screened onto the following four fabrics:

100% silk Ahimsa™ peace, woven, 101.718 g/m² (3 oz/yd²);

100% organic hemp plainweave, 196.655 g/m² (5.8 oz/yd²);

65% hemp/ 35% silk charmeuse, 176.311 g/m² (5.2 oz/yd²);

60% hemp/ 40% silk linen, 88.156 g/m² (2.6 oz/yd²).

Thus, 24 specimens, sized 12.7 cm x 17.78 cm (5 in x 7 in) were made for evaluation of fabric hand.

### *Fabric Hand*

Evaluation of fabric hand was performed following AATCC Evaluation Procedure 5-2006 (AATCC, 2009). The 24 screen-printed thickening agent samples were conditioned at 21°C (70 °F) and 65% RH prior to the evaluation. Three evaluators handled and ranked the specimens by comparative assessment for two physical attributes of hand, surface (smooth to rough) and shearing (pliable to stiff). The view of the specimens was blocked from the evaluators by placing the specimens behind an opening in a box. The evaluators handled the randomly placed samples by 1) holding down the specimen with one hand and stroking or touching with the other hand, 2) rubbing the specimen between the thumb and fingers, and 3) squeezing the specimen gently between the thumb, fingers and palm making a fist. The specimens were then placed in rank order by the evaluator according to the assessment values pliable to stiff or smooth to rough. The evaluation procedure was repeated by each evaluator two days later.

### *Fabric Hand Results*

Spearman's rank correlation coefficients were used to determine the correlation of rankings within each evaluator and across evaluators (Table 4.1 and Table 4.2). The overall correlation between the raters for surface was .65 and for shearing .62 and across evaluator correlation ranged from .47 to .73. Explanation for the variance could be that the evaluators required further training. However, the correlation was high enough to show significant differences in the concentrations of thickeners.

Table 4.1 Spearman's rank correlation coefficient for evaluator ranking within themselves

| Evaluator | Surface (n=48) $r_2$ | Shearing (n=48) $r_2$ |
|---|---|---|
| 1 | .47 | .79 |
| 2 | .75 | .47 |
| 3 | .71 | .61 |
| overall | .65 | .62 |

Table 4.2 Spearman's rank correlation coefficient for evaluator ranking across evaluators

| Evaluator Pairs | Surface (n=48) $r_2$ | Shearing (n=48) $r_2$ |
|---|---|---|
| 1 vs 2 | .69 | .69 |
| 1 vs 3 | .47 | .73 |
| 2 vs 3 | .66 | .59 |

Friedman's two-way analysis of variance (ANOVA) by ranks to compare the rankings of the five concentrations of gum tragacanth on the two hand tests was conducted. The ranking for gum arabic was removed as all evaluators ranked it as most rough and most stiff. To protect against Type I error rate, Bonferroni correction for multiple tests was also conducted. Table 4.3 presents the mean scores for each concentration. The mean for the 9.875 g concentration was the highest, indicating that the evaluators ranked those specimens on average nearer to the pliable and smooth assessments. The concentration that ranked closest on average to rough was 10.25 g and the concentration that ranked nearest to stiff was 10.125 g.

Table 4.3 Mean rankings of gum tragacanth concentration on fabric hand assessment of surface and shearing

| Concentration *(g)* | Surface (*n*=6) *M(SD)* | Shearing (*n*=6) *M(SD)* |
|---|---|---|
| 9.75 | 3.17(1.20) | 3.50(1.32) |
| 9.875 | 3.92(1.25) | 4.29(1.00) |
| 10 | 2.67(1.27) | 2.29(1.16) |
| 10.125 | 2.75(1.54) | 2.04(1.00) |
| 10.25 | 2.50(1.44) | 2.88(1.36) |

The Friedman two-way ANOVA by ranks provided evidence for significant differences among the rankings for surface assessment and shearing assessment (Table 4.4). There were pairwise significant differences for surface between concentrations 9.875 versus 10, 10.125, and 10.25 (.0043, $p$<.05; .0412, $p$<.05; .0143, $p$<.05) and significant experimentwise differences between .9875 and 10. For the shearing assessment there were both pairwise and experimentwise significant differences between 9.875 versus 10, 10.125, and 10.25 (.0002, $p$<.05; .0001, $p$<.05; .0043, $p$<.05), and between 9.75 versus 10 and 10.125 (.0043, $p$<.05; .0043, $p$<.05). Therefore, concentrations of 10 gm of tragacanth with 250 ml (or ratios of 1:25) and above are least preferred when assessing the surface smoothness of screened gum tragacanth on selected fabrics; while the concentration of 9.875 gm gum tragacanth to 250 ml is most preferred. For assessing gum tragacanth for shearing pliability, concentration 9.875 emerges along with 9.75 as most preferred.

Table 4.4 Concentrations of gum tragacanth compared for differences in rank on hand assessment of surface and shearing

| Concentration *(g)* | Surface *p* | Shearing *p* |
|---|---|---|
| 9.75 vs 9.875 | .1025 | .1025 |
| 9.75 vs 10 | .2207 | .0043* ** |
| 9.75 vs 10.125 | .2207 | .0043* ** |
| 9.75 vs 10.25 | .4142 | .4142 |
| 9.875 vs 10 | .0043* ** | .0002* ** |
| 9.875 vs 10.125 | .0412* | .0001* ** |
| 9.875 vs 10.25 | .0143* | .0043* ** |
| 10 vs 10.125 | 1.000 | .4142 |
| 10 vs 10.25 | .4142 | .2207 |
| 10.125 vs 10.25 | .4142 | .2207 |

*Note:* $p < 0.05$; * = pairwise significance without correction; ** = experimentwise significance with Boneferroni correction; *df* = 1.

These findings indicate that the recommended ratio of 1:25 (agent:water) is slightly higher than necessary for a smooth and pliable fabric hand. Instead, a ratio of .975-.9875:25 is recommended for thickening gum tragacanth with water. Gum arabic is not recommended as a thickening agent. The large amounts of gum arabic needed (23:25) was unfeasible and the screen specimens consistently ranked as most rough and most stiff.

## *Colorfastness to Light*

The next stage of the research was to test for colorfastness to light of thickened dyes (weld, madder, and woad) on fabric. Concentration ratios of gum tragacanth and water used were

.9875:25 and 1:25. These ratios were selected to determine if there was a difference between a preferred concentration and the previously recommended concentration (1:25) when exposed to light.

### *Depth of Shade*

Dye concentrations were determined following AATCC Evaluation Procedure 4-2007 (AATCC, 2009). Colorfastness evaluations require dyes to be of visually equal depth. Dye concentrations were adjusted until the color depth of each dye was rated as 1/12. The resulting powdered extract amounts were madder 5 g, weld 12.5 g, and woad 10 g per weight of fabric (WOF).

### *Specimens and Testing*

The three dyes in two concentrations of gum tragacanth were screen printed onto two fabrics: 100% organic hemp plainweave 196.655 $g/m^2$ (5.8 $oz/yd^2$) and 65% hemp/ 35% silk charmeuse 176.311 $g/m^2$ (5.2 $oz/yd^2$). Even though four fabrics were used in the study, two fabrics were selected for colorfastness testing in order to reduce the overall cost of testing. Since the hemp plainweave and hemp/silk charmeuse were favored during sample making, those fabrics were selected.

Seventy-two samples (3 dyes x 2 thickening concentrations x 2 fabrics x 6 [3 replicate specimens + 3 standards of comparison]) were printed and tested for colorfastness to light according to AATCC Test Method 16-2004 (AATCC, 2009). Since the final screen-printed fabrics were framed behind plexi-glass, Option 6 Daylight Behind Glass was specified at 20 fading units. The procedure involved exposing the specimens to controlled levels of radiant energy under specified conditions of temperature and relative humidity. The testing was performed by Professional Testing Lab in Dalton, GA.

### *Colorfastness to Light Results*

After each specimen has been exposed at 20 fading units, the samples were evaluated using AATCC Evaluation Procedure 1, Gray Scale for Color Change (AATCC, 2009). The original, or control, fabric and the exposed specimen were visually compared for color difference or contrast with the differences represented by the colorfastness scale with grades between 5 and 1. A grade of 5 represents no change, 4 being a slight change in color; 3 is a noticeable change; 2 a considerable change; and 1 severe change in color. Colorfastness ratings of less than grade 3 indicate considerable alteration in color after exposure to light.

Table 4.5 lists the colorfastness to light ratings for each of the thickened dye concentrations on two fabrics. Little or no difference was found between the two thickening concentrations of gum tragacanth. Only a slight difference was displayed on the 100% organic hemp linen between concentrations, with the .9875:25 ratio rating slightly better.

Madder displayed no change in color. This can be due in part to its chemical structure and bond with the fibers. Weld had noticeable to considerable color change. Prior research on the colorfastness of weld resulted in slight to noticeable color change and a rating of 3.0 - 4.0 (Angelini, Bertoli, Rolandelli, & Pistelli, 2003; Cardon, 2007). Based upon the known results, it was expected that weld would perform in a similar manner during this test of colorfastness. Considerations for the poor performance could be due to the particular batch of dyestuff or the interaction with the thickener. Further testing of weld in future studies is recommended. Woad resulted in slight change which was expected and similar to other indigoid dyes.

Table 4.5 Lightfastness mean gray scale ratings for color change of fabrics screened with gum tragacanth thickened natural dye.

| Gum:Water | Woad | | Weld | | Madder | |
|---|---|---|---|---|---|---|
| | Hemp | Hemp/Silk | Hemp | Hemp/Silk | Hemp | Hemp/Silk |
| .9875:25 | 3.8 | 4.0 | 2.5 | 2.0 | 5.0 | 5.0 |
| 1:25 | 3.5 | 4.0 | 2.0 | 2.0 | 5.0 | 5.0 |

*Note:* 5 = no change, 4 = slight change, 3 = noticeable change, 2 = considerable change, 1 = severe change.

## *Fabric Mordanting and Dyeing Procedures*

### *Fabric Mordanting*

Fabrics were pre-mordanted following Wipplinger's (2005) procedures and formulas for immersion mordanting for protein fibers and for cellulose fibers. The 100% silk Ahimsa™ was mordanted following the protein fiber procedures, while the remaining fabrics (100% organic hemp plainweave, 65% hemp/ 35% silk charmeuse, and 60% hemp/ 40% silk linen) followed the cellulose procedures.

The primary nontoxic mordant used for protein fibers was potassium aluminum sulfate (alum). The fabric was first washed and soaked for 30 minutes with Orvus® WA paste, a gentle detergent to clean the fibers. Alum at 12% WOF was dissolved in boiling water and then added to a large pot of warm water. Cream of tartar at 6% WOF was dissolved and added to the alum bath. Cream of tartar works to soften the fibers, brighten shades, and to change the color of some dyes (Wipplinger, 2005). The fabric was added to the pot and slowly brought to 85 ºC (185 ºF) over 45 minutes. Once the temperature was reached and held for one hour, the fabrics were left to cool overnight. The next day, the fabrics were rinsed with warm water and either hung to dry or bagged and stored damp in a refrigerator until needed for dyeing. However, mordanted protein fiber cannot be stored damp in the refrigerator for more than a few weeks. I found that longer periods of time allowed mold to develop.

For cellulose fibers there were two separate steps in the mordanting process: scour followed by the application of aluminum acetate (scour bath and mordant bath). According to Wipplinger (2005), this method insures maximum dye absorption, which will, in turn, improve the lightfastness and color depth obtained by natural dyes.

Liquid scour, produced by Wipplinger and sold by various retailers, and soda ash were the two additives used in the first bath or scour bath. Water was brought to 38 ºC (100 ºF) in a large pot and liquid scour at 5.5% WOF was added. Next, soda ash, at 2% WOF, was dissolved in boiling water and added to the scour bath. Fabrics were added and held at 82 ºC (180 ºF) over 30 minutes. The fabrics were then rinsed quickly in warm water and added to the second bath.

Aluminum acetate at 5% WOF was dissolved in boiling water and added to a pot of fresh water. The scoured fabrics were added to the mordant bath and held at 38 ºC (100 ºF) over an hour. The fabrics were then left to cool overnight and rinsed the next day with warm water. They were either hung to dry or bagged and stored damp in a refrigerator until needed for dyeing.

### *Fabric Dyeing*

Fabrics were dyed with weld, madder, and woad following the dyestuff supplier's (Earthues and Bleu de Lectoure) immersion method. Weld extract amounts were calculated at .5% WOF weight of fabric and dissolved in a small amount of tepid distilled water. The dissolved extract was then poured into a stainless steel container of distilled water. The wetted fabric was then introduced to the dyebath and rotated well. The dyebath temperature was slowly raised from 49 °C (120 °F) to 85 °C (185 °F) over 60 minutes. The fabric was rotated occasionally and the temperature was held at 85 °C (185 °F) for an additional 30-45 minutes.

The dyebath was removed from the heat source (electric hot plate) and allowed to cool for 30 minutes prior to rinsing the fabric under warm water until the water ran clear. The fabric was air dried, ironed, and set aside until printing.

Madder extract amounts were calculated at 3% WOF. Fabrics dyed with madder extract followed the same basic procedures as for dyeing fabric with weld. However, as madder yields color based on heat and time, fabrics were removed throughout the dyeing process. Fabrics dyed in room temperature distilled water, approximately 32 °C (90 °F), yielded variations of orange; heated distilled water, 46 °C (115 °F) through 82 °C (180 °F), yielded orange-red to brick red; and purple shades were achieved by allowing the fabric to cool overnight in the dyebath.

Woad, being a vat dye, had a different dyeing procedure. A stock solution was made by dissolving 28 g woad extract in 237 ml distilled water; adding 14 g thiourea dioxide and standing for 10 minutes; dissolving 21 g lye in 59 ml water and adding to solution. The solution was covered tightly to allow the chemicals to react. A dye vat of warm distilled water was prepared and 30 ml of woad stock solution was lowered into the water being careful not to introduce air. A scant amount (5 g) of thiourea dioxide was added to the vat keeping the temperature at 43 °C (110°F) for 15 minutes. Lye was then added to the vat at 1.25 g increments until the pH changed from 7 to 10. Wetted fabrics were slowing moved into the dye vat for various periods of time to gain different depth of color. Fabrics were carefully removed from the vat and allowed to oxidize for a minimum of 15 minutes. Once finished, the fabrics were rinsed in distilled water and vinegar to counter-act the alkaline effects of the vat.

## *Screen-Printing*

### *Direct Emulsion*

This project used the direct emulsion method to create the screen images. Direct emulsion is a light sensitive coating, usually of silver halide grains in a thin gelatin layer, on photographic film, paper, or glass (MacDougall, 2005). The process of emulsion-based screen making was to coat the screen with direct emulsion and allow to dry for three hours in an area below 50% RH (MacDougall, 2005). The three hours allow the emulsion to cure and the water resistance to lock in.

The next step was to 'burn' the image into the screen. The image was placed against the screen and exposed to light for one minute using a light-box with UV bulbs. After the image was 'burned' into the screen, the unexposed areas (image) were washed out with a power washer. After washout, to ensure that the screen was completely hardened, it was re-exposed. For water-based screen-printing, it is very important to ensure that the screen is completely hardened, as this will affect the fineness of the patterned lines. The screen was then taped out around the pattern to control and create wells for the paste.

With the preparations of the screen completed, the next step was to position it on a padded table in accordance with the pattern. The natural dye paste was poured into the reservoir space at either end of the screen and the color drawn across the screen. If the same screen was used on the fabric, the skip-and-repeat system was used to eliminate the possibility of smearing, blurring, or feathering (Hiett & Middleton, 1967). Printed fabrics were left in position to dry or cure from 12 to 24 hours. All dye colors must receive a heating-in treatment (Hiett & Middleton, 1967). This not only sets the color permanently in the fibers, but in many instances acts as a developer to clarify them and bring out their full brilliance (MacDougall, 2005). The most efficient means for yard goods is forced steaming, recommended by Wipplinger (2005) and Flint (2008). Forced steaming takes place in purpose-built equipment, which does not allow the steam to escape, therefore enabling steam pressure to build up, increasing the temperature and reducing the time. The length of time the printed fabric is steamed depends on the weight and the nature of the fabric, as well as the type of dye. Cotton, wool, and hemp require longer times than silk and rayon (Hiett & Middleton, 1967). Regardless of the heat source care must be exercised not to over-heat (too high or too long) silk, as it can be easily scorched.

Using a SteamFast digital fabric steam press model no. SF-680, I heat-set all of the prints at the appropriate temperature determined by the manufacturer's guidelines. The cotton setting was used for the 100% organic hemp linen and the silk setting was chosen for the 65%hemp/35%silk charmeuse. The fabrics were pressed with forced steam for 8 seconds and shifted as the steam plate was smaller than the fabric pieces.

# Chapter 5. Designs

## *Design Process*

### *Tradition and Modernity*

Within the limits of Turkish culture and art, there are some topics which remain constantly significant to various periods. Among them is that of tradition and modernity, the theme of my present collection of prints. A long-standing topic indeed, but one that continues to preoccupy modern day artists and to provide ever-new avenues for expression (Glassie, 1993; Mufti, 2009).

However, the word "tradition" which once implied a desirable linkage with one's ancestors has come to carry negative connotations. According to supporters of modernization (Reisman, 2006; Weston, 2001; Wilk, 2008), tradition has associations with what is tired, withered with use, repetitive and stripped of meaning, which what is unfashionable and embarrassing. Modernization, for them, should be a rebellion against all aspects of an almost totally rejected artistic past. This provides implications that the production of this past was inferior and should be removed from our modern culture.

There is no doubt that the modern art revolution broke loose from those remaining traditions which had limited the growth of Turkish art (Bozdogan, 2002; Kinzer, 2008). One must search out a modern means of expression that reflects present-day experience and uses present-day design and imagery.

While exploring the essence of an early period, the designer has simulated its style and adopted its emphasis. This has resorted to apparent traditions of design, line and imagery, giving the modern viewer a feeling of strange congruity, of an incompatibility with his or her own experience. There is an impression of unreality, of something being dislocated and totally out of proportion.

However, there are some basic traditions which are subtle and not easily recognized or differentiated. Complex florals, geometric shapes, and calligraphy are commonly found in designs. These form the backbone of Turkish design, the very foundation that supports its structure.

It is important, in the history of art, to go back to tradition, as it is to renovate and renew. Danger naturally arises when one adopts uniform traditions to the design, re-entering as artist or visionary, to the mind-set of a different period and assuming its particular style. But never to return to tradition would imply that everything in the old artwork is to be thought of as defective, that it contained nothing which was permanently and universally viable; that it was a mere deformity, able to teach us nothing.

### *Inspiration*

Taking the inspiration of traditional and modern Turkish imagery, I formed collages of visually impactful imagery. These sources of inspiration guided the process of creation and production. Overall inspiration themes were line and shape, architecture and interior design, and color.

Strong lines and shapes played a key role in the creation of motifs and imagery (see Figures 5.11, 5.12, 5.21 and 5.23). The idea of a dominate shape or silhouette on the fabric was inspired by the scale of traditional Turkish designs. Within the flatweaves created by the DOBAG project, large motifs are woven into the rug surrounded by solid color or small repeats. Classic Ottoman textiles also incorporated large scale objects contrasted by solid color. The creation of designs that are off-center and have a strong positive/negative space were explored (see Figures 5.11, 5.15, 5.23, 5.27, 5.30 and 5.34). The tulip shape (see Figures 5.1 and 5.7), commonly found in classic Turkish designs, has been redesigned into a bold vine of tulips (see Figure 5.13).

The ornate detail of architecture and interior design of Istanbul inspires the sense of the Ottoman Empire being present in modern-day Turkey (see Figures 5.1-5.5). Working with the thought of old and new living amongst themselves as a new artform was explored (see Figures 5.11, 5.16, 5.20, 5.22, 5.27 and 5.28). The lines and delicate lattice and wrought-iron work can be found in the design products from this project (see Figures 5.16, 5.20 and 5.22). Moving from the Ottoman Empire to traditional flatweaves of the countryside (see Figure 5.8) influenced the direction of some shapes and motifs (Ottoman Empire see Figures 5.15, 5.20 and 5.35; Flatweaves see Figures 5.23, 5.25, 5.26 and 5.33). Historic botanist drawings were imitated into new modern designs (see Figures 5.19, 5.24, 5.30 and 5.35).

A colorstory was also formed from the inspirational imagery. The soft colors of Figure 5.6 embody much of what can be found in the prints. The strong hues and patterns shown in Figures 5.2 and 5.7 can be directly related to the designs. The contrast of soft colors with bold shapes and vivid colors with delicate lines creates a new look for Turkish design.

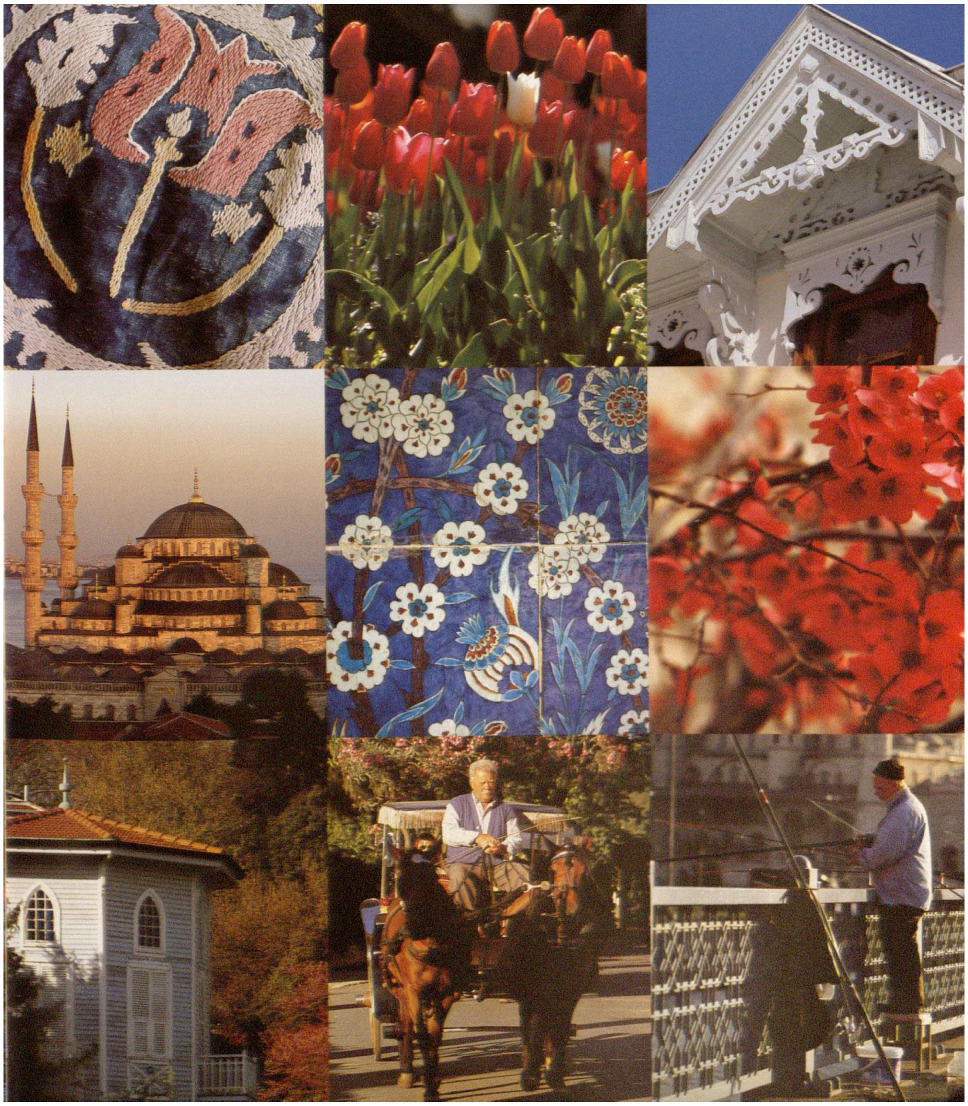

Figure 5.1 Turkish imagery.[23]

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[23] From Santos, S. & Torolsan, B. (2008). *At Home in Turkey*. London, England: Thames & Hudson.

Figure 5.2 Turkish imagery.[24]

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[24] From Santos, S. & Torolsan, B. (2008). *At Home in Turkey*. London, England: Thames & Hudson.

Figure 5.3 Turkish architecture.[25]

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[25] From Santos, S. & Torolsan, B. (2008). *At Home in Turkey*. London, England: Thames & Hudson.

Figure 5.4 Turkish architecture and interiors.[26]

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[26] From Santos, S. & Torolsan, B. (2008). *At Home in Turkey*. London, England: Thames & Hudson.


Okula ad
yonu geçti
birlikte yanacağız

Figure 5.5 Istanbul.[27]

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[27] From Mourad, K. (1994). *Living in Istanbul*. Paris, France: Flammarion.

Figure 5.6 Color story inspiration.[28]

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[28] From Mourad, K. (1994). *Living in Istanbul*. Paris, France: Flammarion.

Figure 5.7 Turkish patterns and inspiration found in fashion.[29]

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[29] From Scott, P. (2001). *Turkish Delights.* London, England: Thames & Hudson.

Figure 5.8 Turkish flatweaves.[30]

## *Print Development*

Imagery was first hand-drawn and then imported into Adobe® software and manipulated and edited (see Figure 5.9). The use of CAD textile print design and hand-drawn motifs was important to reflect the theme of the artwork: tradition and modernity. The modernity of CAD allowed for experimentation with composition and the ability to present and discuss imagery with committee members prior to being physically created.

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[30] From Michell, G. (2007). *The Majesty of Mughal Decoration: The Art and Architecture of Islamic India.* London, England: Thames & Hudson.

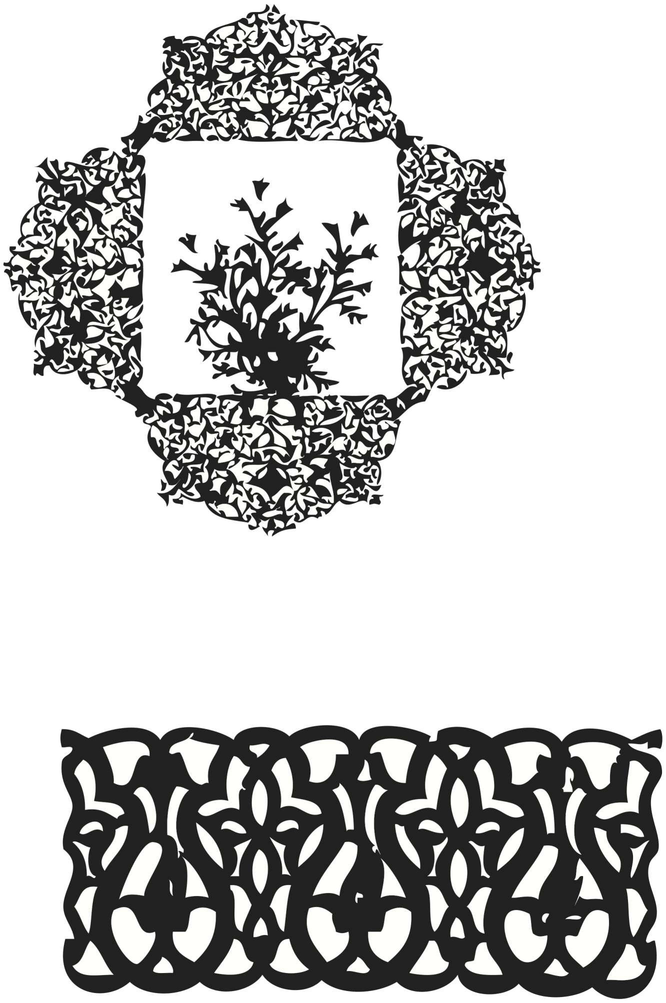

Figure 5.9 CAD textile print design composition

Compositions and imagery selected to move forward were printed onto 45.7 cm x 61 cm (18 in x 24 in) mylar sheets using a plotter printer. The images were burned onto emulsion-coated screens in a light-sensitive room. The screens were then washed out and set to dry. See chapter four for detailed information regarding the screen making process.

### *Fabric Prints*

Initially, I screen-printed natural dye paste onto naturally dyed pieces of fabric. The color and chemistry of the natural dyes and the variation of the dye across the fabric impacted the overall composition of the design. Unlike inks that sit on the surface of the fabrics, dyes bond to the fibers and colors interact as they are layered on top of each other. When reviewing the early pieces, the dyed backgrounds competed with the strategically placed prints. In addition, exploration of layering imagery on the dyed fabrics was unsuccessful as the dyes became muddy from the multiple dye interactions.

While I did not find the layered color appealing on the already dyed fabrics, I did find it interesting on undyed fabric. This process was much more successful as the dye print colors were not darkening as they did on the dyed fabrics and the changes in value created interesting colors in themselves (see Figure 5.10). A visual sense of depth was also created by the, now pronounced, foreground and background.

Figure 5.10 Layering of dyes onto undyed fabrics

## *Design Products*

### *Design pieces*

Figure 5.11 A Sunset in Turkey, 15.25 in. x 17.5 in.

Natural dyes used: weld, woad, brazilwood/logwood grey

Fabric: 100% organic hemp plainweave

This print is inspired by the cross-cultural influence seen in historic textile design resulting from the prosperous location of Turkey along the famous Silk Road.

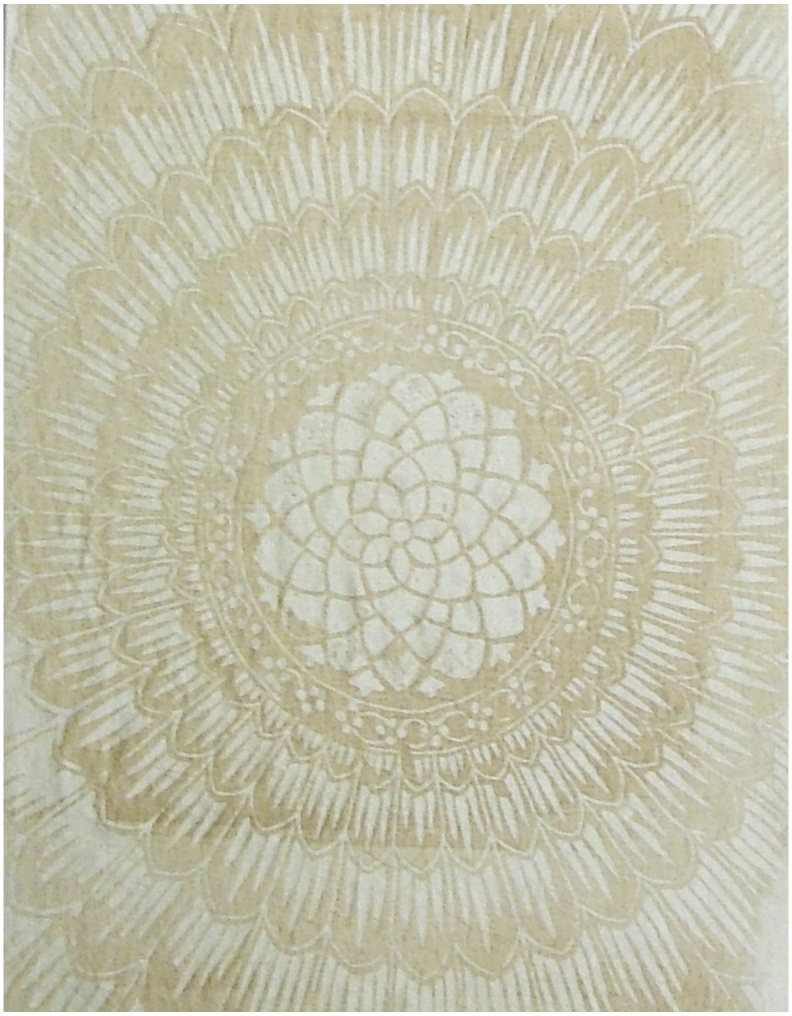

Figure 5.12 Istanbul, 19 in. x 24.5 in.

Natural dyes used: cutch (print), weld (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

Entitled after the largest city in Turkey, Istanbul represents the modern view of a global empire. The movement and layers display the essence of a large city's activity, while the image bleeds off the canvas giving the feeling of no boundaries.

Figure 5.13 Tulips 16.5 in. x 10.5 in.

Natural dyes used: logwood grey (print), madder (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

A modern view of a classic motif; the tulip, among other iconic Turkish images, represents a cultural heritage. The evolution results in an endlessly growing tulip vine.

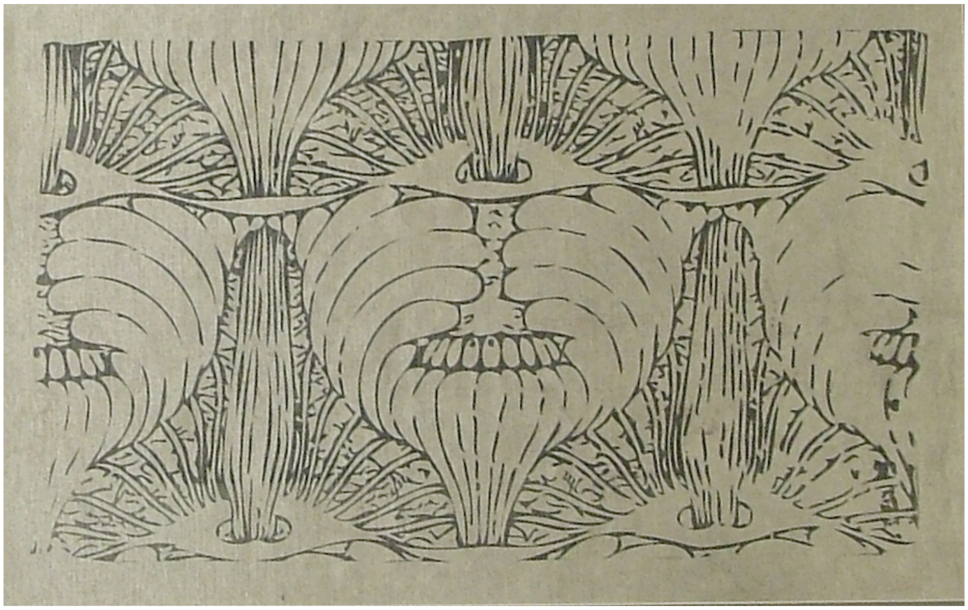

Figure 5.14 The Progression of Tradition 17.5 in. x 11 in.

Natural dyes used: logwood grey (print), madder (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

Tradition moves throughout a culture at a rapid pace. Its meaning is often misunderstood but it continues to grow and evolve into a new representation. The fluid movement of this print encompasses the many routes and resting places of traditions.

Figure 5.15 The Ottoman Empire 19 in. x 29.5 in.

Natural dyes used: logwood purple

Fabric: 100% organic hemp plainweave

The Ottoman Empire, which reigned for more than 600 years, created a uniformity of design and quality. The progression of design has built upon those established reputations and has created a new empire for textiles.

Figure 5.16 Katmanları 18 in. x 23 in.

Natural dyes used: logwood grey, brazilwood, weld

Fabric: 100% organic hemp plainweave

Katmanları (layers) represents the textile heritage of Turkey. The complex flatweave designs to the ever intricate Ottoman designs blend together to create a new era of Turkish design.

Figure 5.17 Abstract Flora 22 in. x 16 in.

Natural dyes used: madder (print), madder (fabric)

Fabric: 100% organic hemp plainweave

Floral designs have been associated with Turkish art for centuries. The progression of that tradition is displaying an abstract representation of Turkish florals.

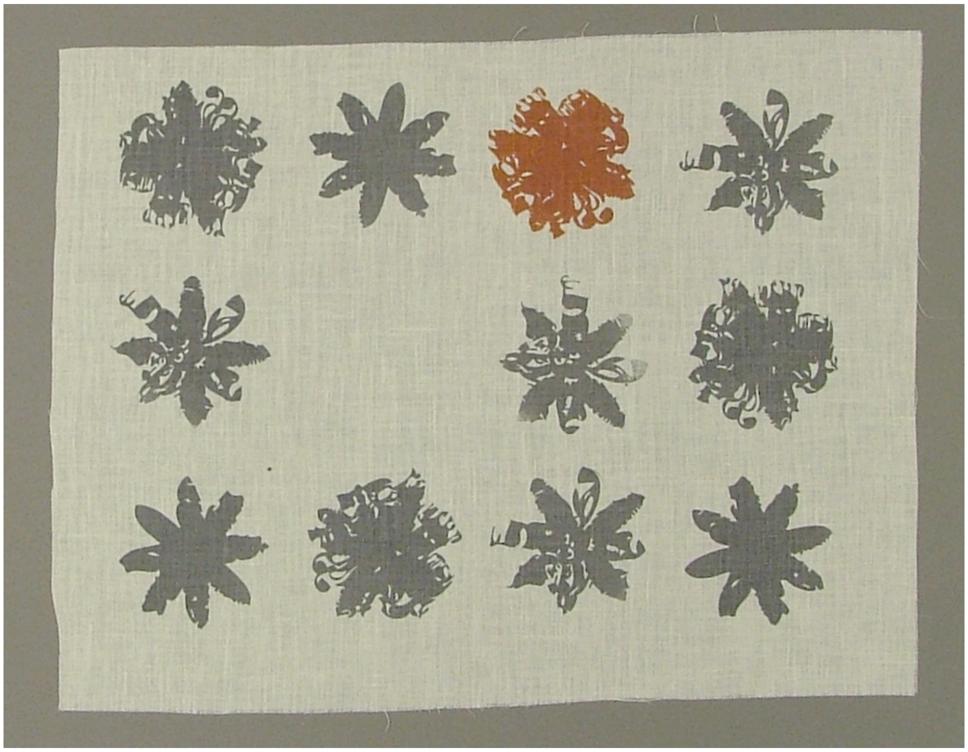

Figure 5.18 Ankara 24 in. x 18 in.

Natural dyes used: logwood grey, brazilwood

Fabric: 100% organic hemp plainweave

Named after the capital city of Turkey, Ankara represents the pride of a complex country.

Figure 5.19 Weld. Woad. Madder. 22 in. x 23 in.

Natural dyes used: woad, brazilwood, weld

Fabric: 100% organic hemp plainweave

Inspired by botanist drawings, the three main plants used in this exhibit, native to Turkey, are represented.

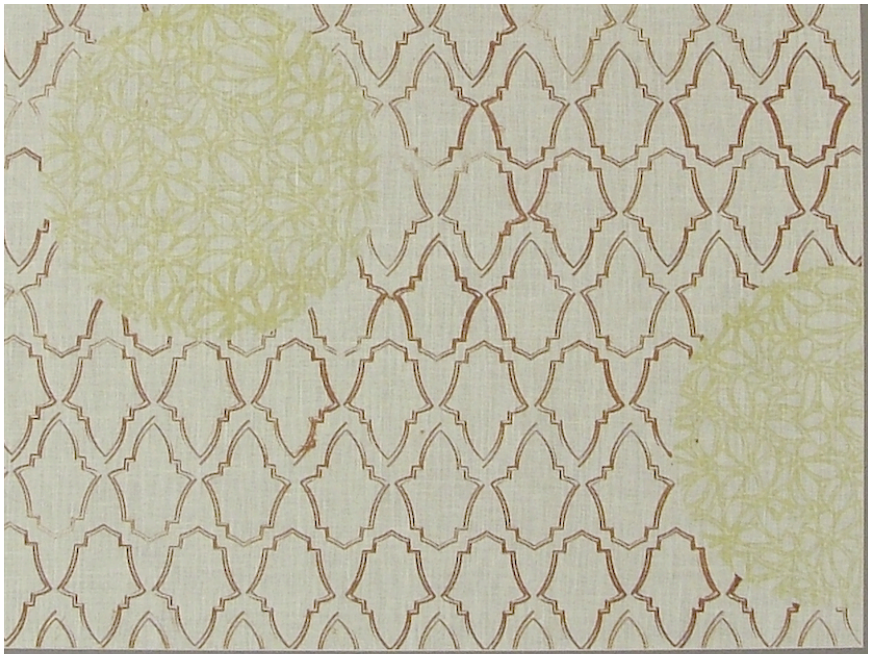

Figure 5.20 Brazilwood-Weld Motif 23.5 in. x 17.5 in.

Natural dyes used: weld, brazilwood/logwood grey

Fabric: 100% organic hemp plainweave

The ornate repeat printed in a dark red symbolize the union of the Turkish culture and pay homage to its historic architecture of the cities. The floral medallion is placed at the foreground giving the sense of a new growth of modernism.

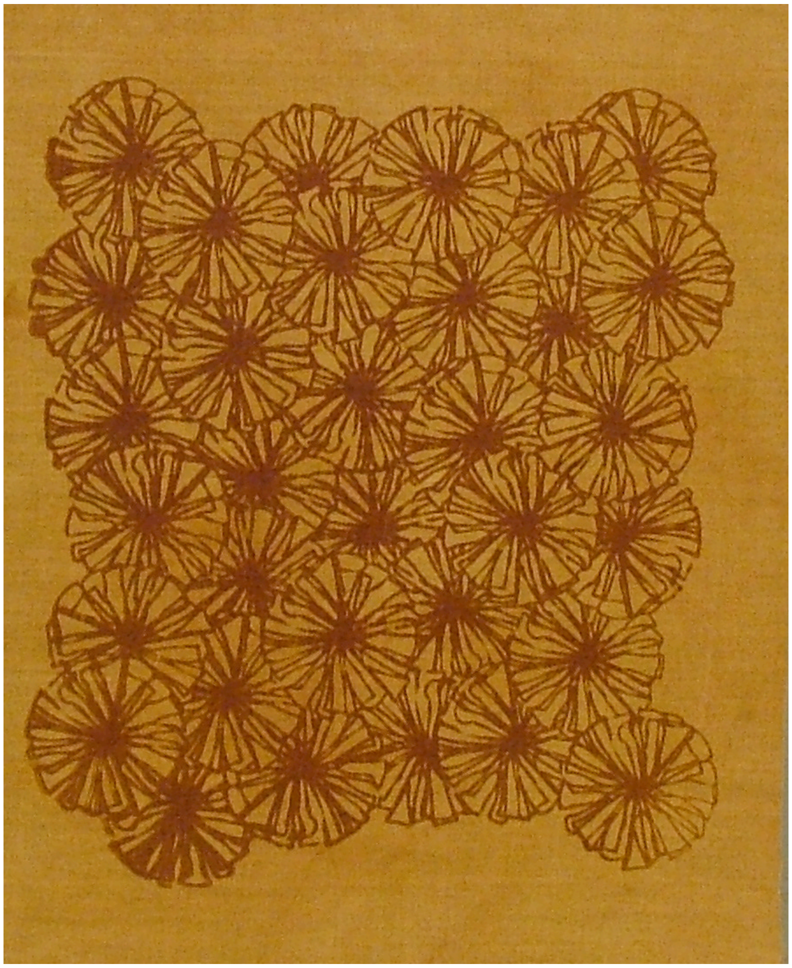

Figure 5.21 Turuncu 15.5 in. x 18.5 in.

Natural dyes used: brazilwood (print), madder (fabric)

Fabric: 100% organic hemp plainweave

Turuncu (orange) represents the product of using two red-orange dyes layered. The abstract layered flowers create a new floral look for Turkish art.

Figure 5.22 Whirling Dervish 15 in. x 19 in.

Natural dyes used: logwood grey, cutch

Fabric: 100% organic hemp plainweave

In the Turkish city Konya, lies the center of Mevlevi, or Whirling Dervishes. Now as a cultural organization in the Turkish Republic, the Whirling Dervish dances as part of a ceremony in a precise rhythm. He represents the earth revolving on its axis while orbiting the sun. The purpose of the dance is to empty yourself of all distractions, being placed in a trance. The layering of the drawn Dervish over the fluid movement of the background embodies the essence of that trance.

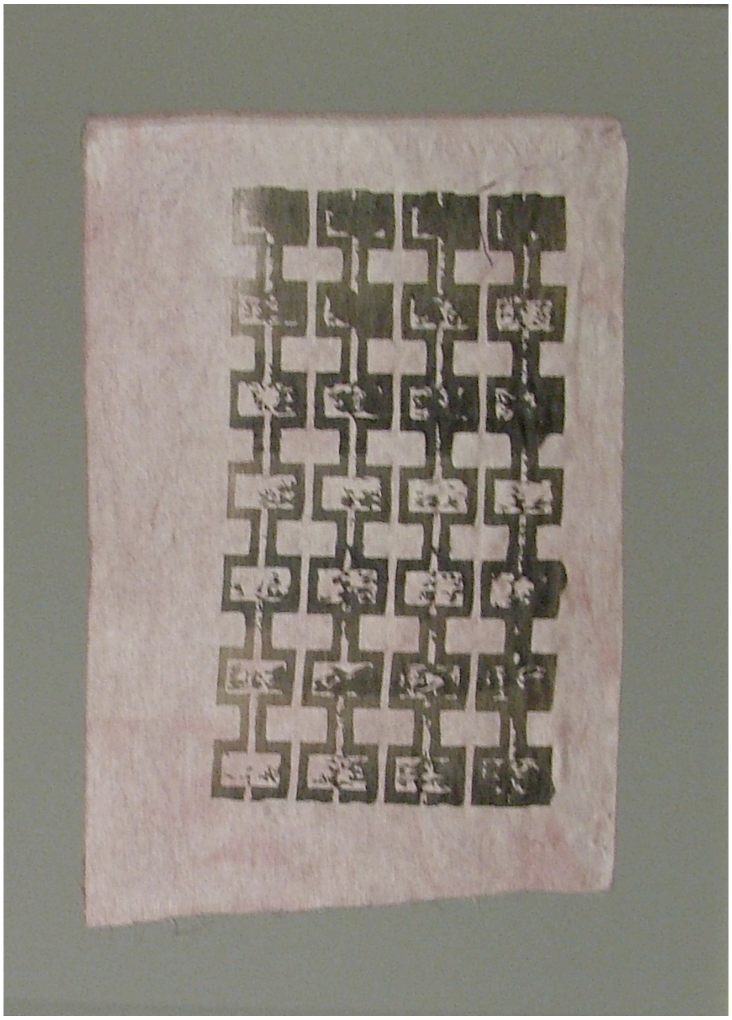

Figure 5.23 Blocked Mor 17.5 in. x 26 in.

Natural dyes used: logwood grey (print), madder (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

Off-center and slightly faded, the blocked mor represents a modern view of the bold lines and shapes found in Turkish flatweaves.

Figure 5.24 Patch of Woad 14.25 in. x 16.5 in.

Natural dyes used: woad, brazilwood

Fabric: 100% organic hemp plainweave

The patch of woad shows the nature of the dye and its chemistry that changes when it is layered.

Figure 5.25 Past Expressions 21.375 in. x 30.5 in.

Natural dyes used: woad, weld, brazilwood

Fabric: 100% organic hemp plainweave

Blending the historic designs of the Ottoman Empire with the native print of traditional flatweaves creates a new genre of Turkish textile design.

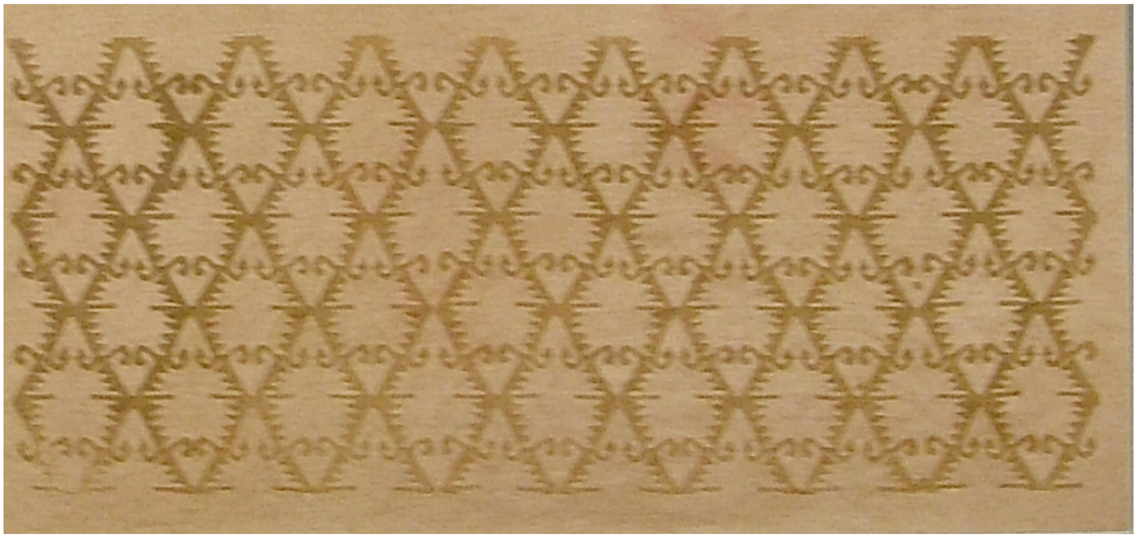

Figure 5.26 Flatweave 21.75 in. x 9 in.

Natural dyes used: cutch (print), madder (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

A modern representation of traditional flatweaves.

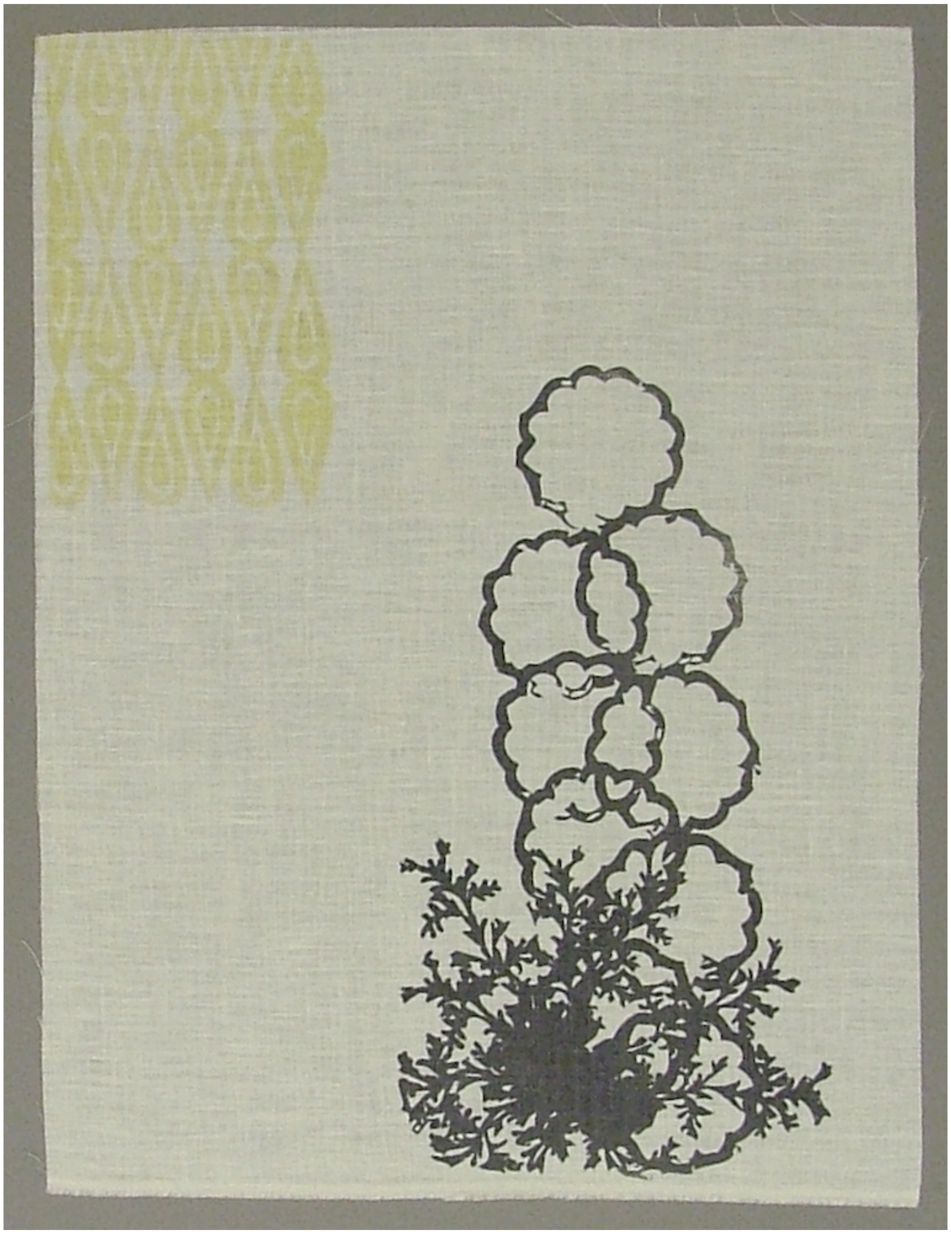

Figure 5.27 Konya No. 1 18 in. x 24 in.

Natural dyes used: weld, logwood grey

Fabric: 100% organic hemp plainweave

Konya is a city of great antiquity now mixed with a thriving modern metropolis. A visual representation of this city is shown by blending a traditional flatweave motif, classic Ottoman medallion shape and a modern view on plantlife.

Figure 5.28 Konya No. 2 12.5 in. x 19.125 in.

Natural dyes used: weld, brazilwood/logwood grey

Fabric: 100% organic hemp plainweave

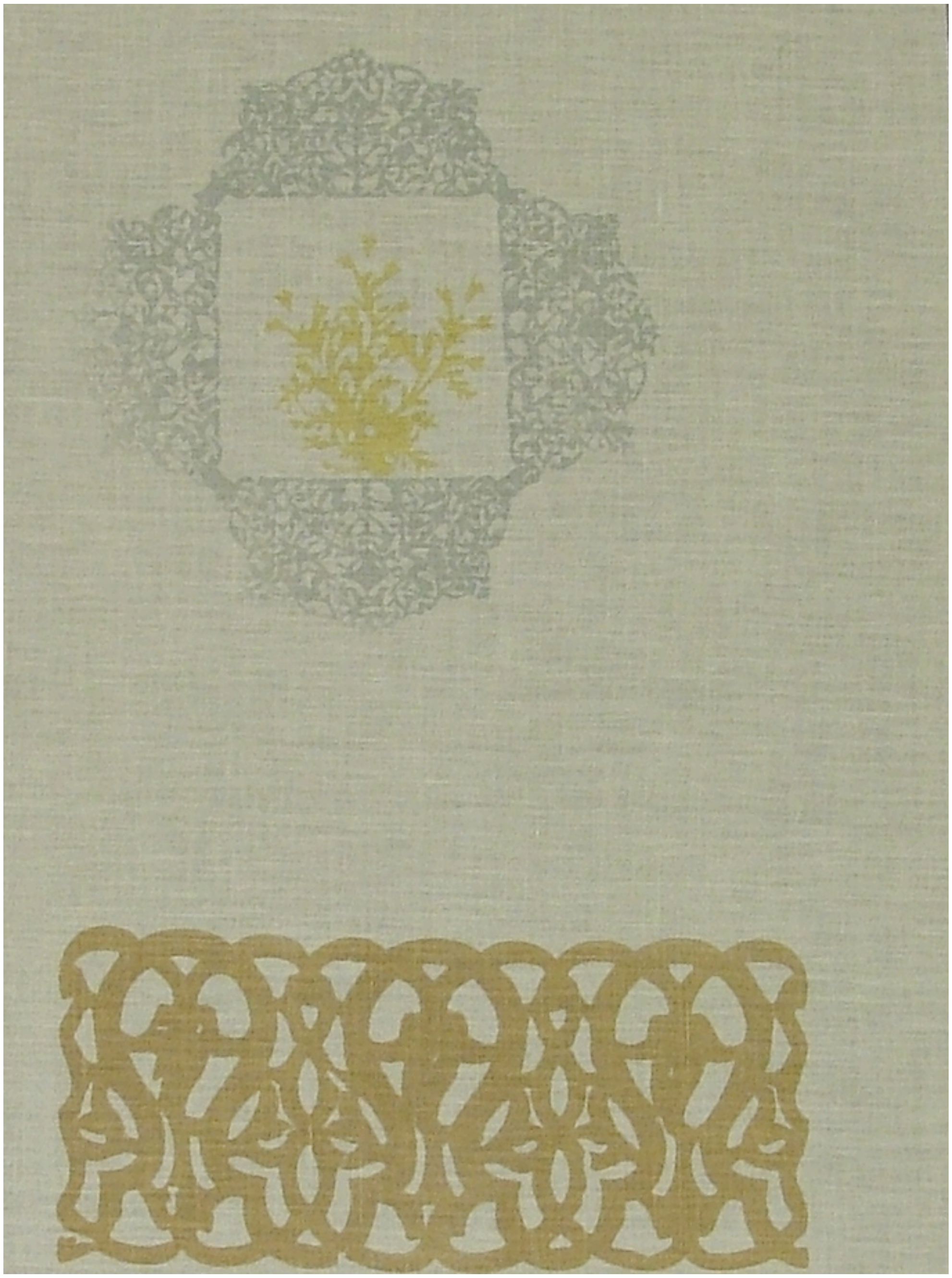

Figure 5.29 Sarı Çiçek 13 in. x 20.75 in.

Natural dyes used: woad, weld, cutch

Fabric: 100% organic hemp plainweave

With the contrast of color, emphasis is shown to the sarı çiçek (yellow flower), weld.

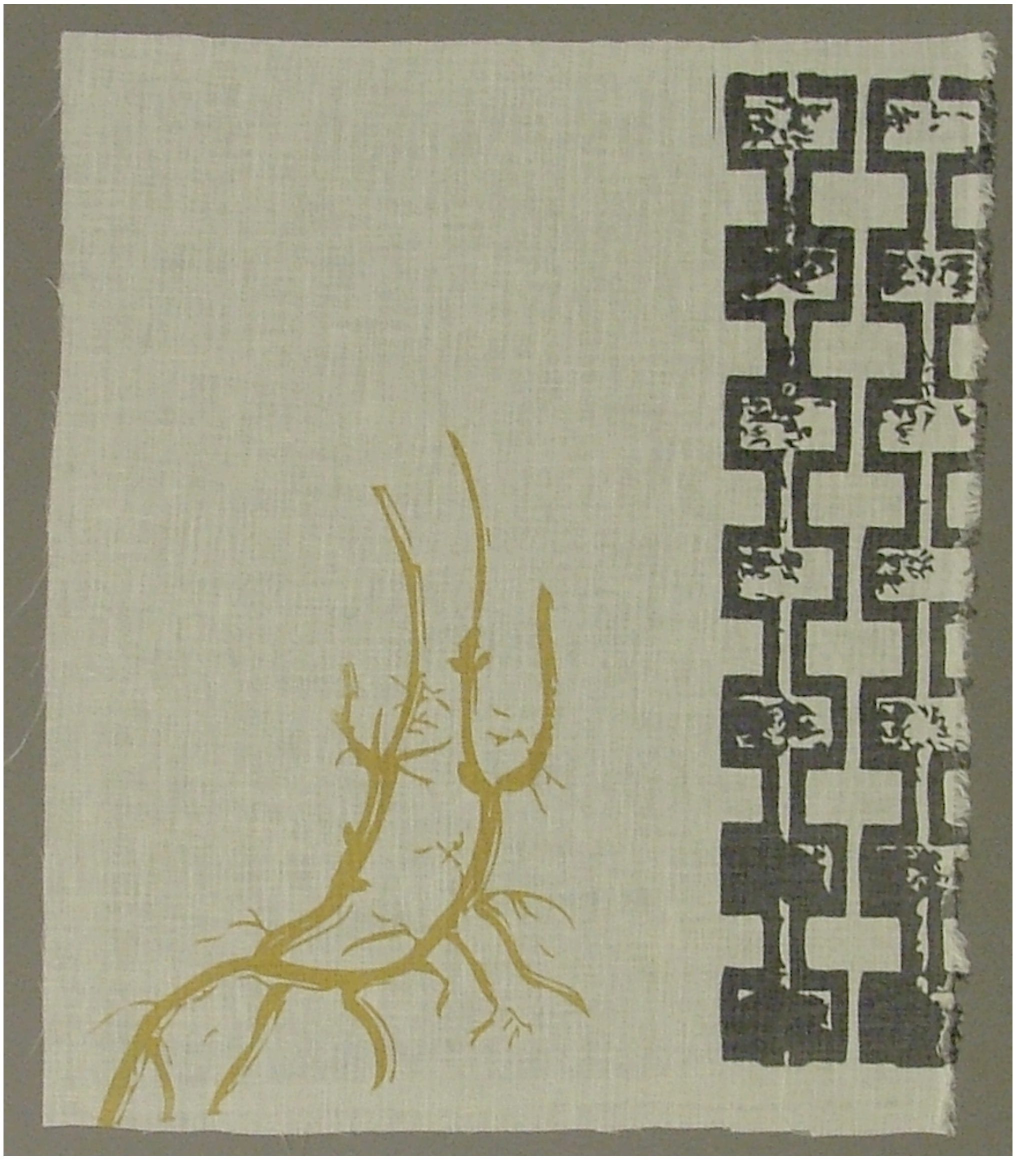

Figure 5.30 Madder Root 18.5 in. x 21.75 in.

Natural dyes used: madder, logwood grey

Fabric: 100% organic hemp plainweave

The root system of madder is so established in the soil of Turkish fields that it grows wild to this day. The strong bold lines emphasize the power and strength that this plant has.

Figure 5.31 Güzel Tanrıça 15.75 in. x 15.75 in.

Natural dyes used: logwood grey (print), weld/woad (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

The fluid movement of the dyes on fabric is emphasized by the movement of the floral medallion print. The image pushes beyond its borders and truly encompasses its title of beautiful goddess.

Figure 5.32 Woad Tree 20 in. x 26 in.

Natural dyes used: woad, brazilwood/logwood grey

Fabric: 100% organic hemp plainweave

The woad tree symbolizes strength and the history of growth for Turkey while the falling brazilwood flowers represent the change of this country.

Figure 5.33 Izmir 29.5 in. x 16.5 in.

Natural dyes used: cutch (print), woad (fabric)

Fabric: 60% hemp/ 40% silk linen

Inspired by the city on the Aegean Sea, the movement in the fabric dye represents the fluidity of the water. The print layered over the dyed fabric shows the relationship between culture and sea.

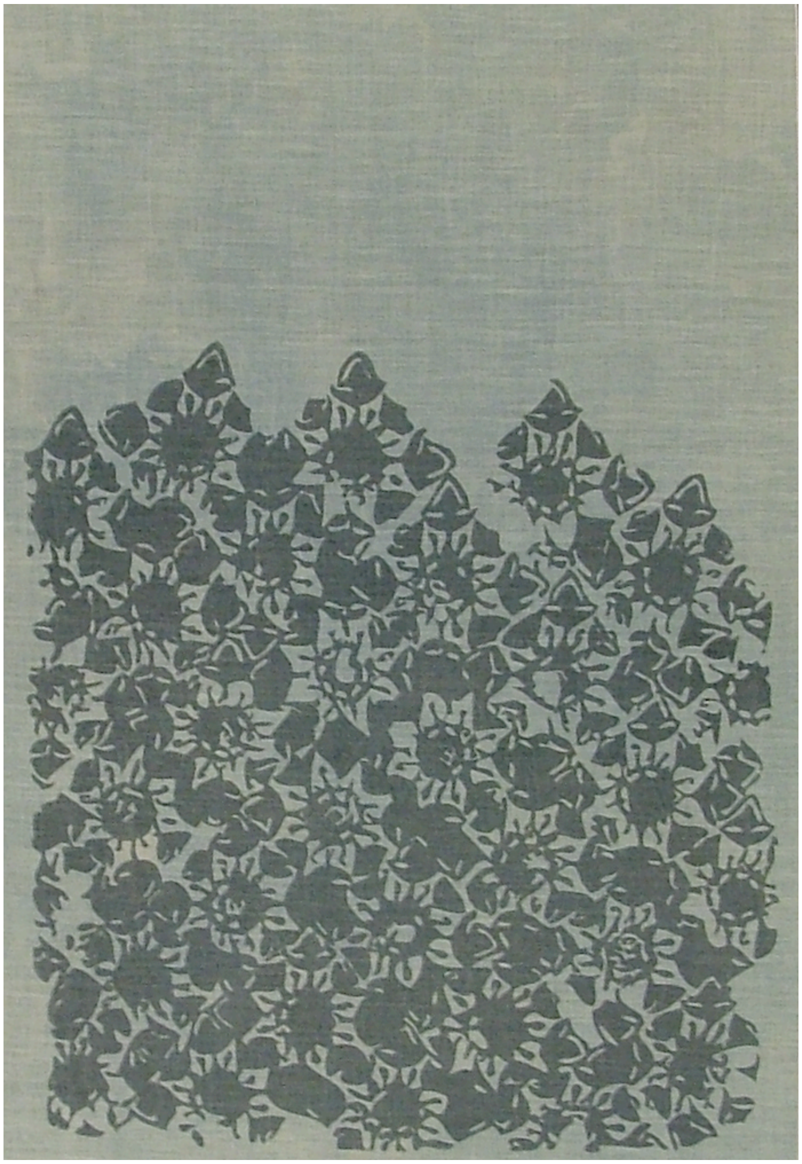

Figure 5.34 Çiçek Alan 18 in. x 26.5 in.

Natural dyes used: woad (print), woad (fabric)

Fabric: 100% organic hemp plainweave

Working only with woad dye, this print represents the unity of the plant. The harmony created with the singular color story gives a feeling of calmness.

Figure 5.35 Koekboya 17.875 in. x 23.375 in.

Natural dyes used: cutch, brazilwood, woad, madder, weld (print), weld (fabric)

Fabric: 65% hemp/ 35% silk charmeuse

Known in Turkey for natural dyes, Koekboya, displays the colors used throughout this exhibit. It is an expression of a modern view on two traditions, classic Ottoman design and the preservation of natural dyes.

### *Exhibition*

Compositions and motifs, inspired by Turkish art and culture, were created by screen-printing thickened natural dyes onto naturally fibered fabrics. The artwork was exhibited in the William T. Kemper Art Gallery at Kansas State University from April 28 through May17, 2010. All pieces were mounted and framed behind plexi-glass in a natural wood frame created by the designer or a purchased black frame. Prints were either mounted within a matboard frame or mounted onto a piece of matboard allowing the raw edge of the fabric to be shown. This created a sense of antiquity to the artwork while the framed matboard created a sense of a clean, modern presentation.

Twenty-five pieces, of varying sizes, were displayed in the gallery hanging at eye level on three of the four walls (see Figures 5.36 and 5.37). Artist statement and biography (see Appendix C) were placed on a pedestal at the entrance of the gallery (see Figures 5.38 and 5.39). The exhibit title, *Modernity with Tradition*, and the artist's name were placed on the remaining wall in the gallery. A display label was created for each piece to include its title, size, natural dyes used, fabric name and fiber content, and a brief explanation which could include inspiration or other contextual content.

Figure 5.36 Gallery exhibition

Figure 5.37 Gallery exhibition

Figure 5.38 Gallery exhibition and artists statement

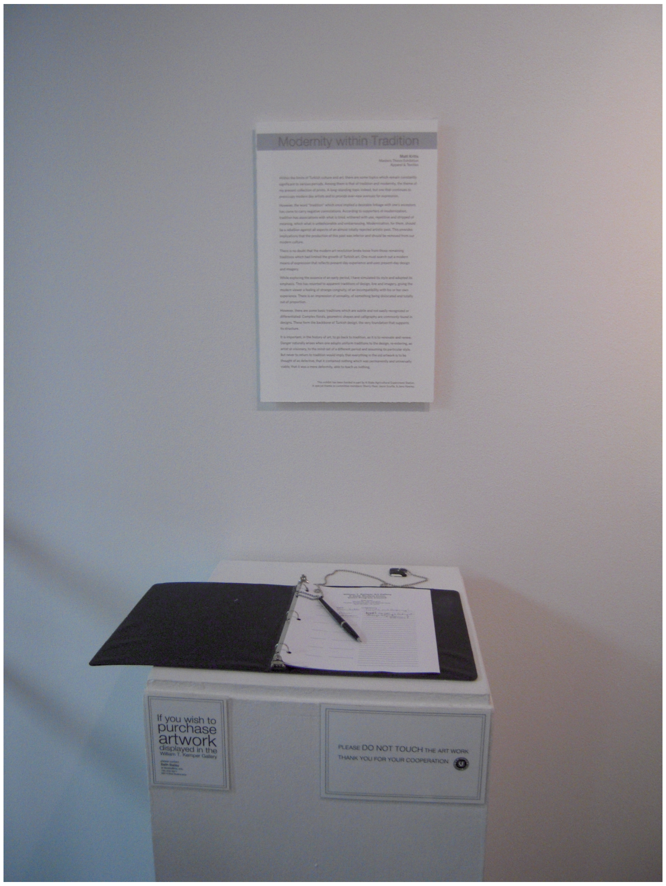

Figure 5.39 Artist statement in gallery

## *Evaluation*

The goals set at the initiation of this design process and research project were to acknowledge and preserve traditional cultures, inform designers and researchers, and advance the developing practices of sustainable design. The success of these three goals can be found in the research process, as well as, in the design products themselves.

The research of traditional Turkish art and culture led to the inspirational concepts and brought the design products to fruition. Understanding the dyeing practices, regional traditions and political rule of this nation informed the design process and directly influenced the composition and imagery of the designs. The historical importance of natural dyes in the

Anatolian region of Turkey strengthened the thought process for using the Turkish culture as inspiration.

By providing the viewer with an artist statement (Appendix C) as Holm (2008) suggested, the context of my design process is universally known. Fellow artists and researchers are informed from my processes through the visual output of my research and the written documentation. To further disseminate the knowledge developed from this project, submission for publication and national/international exhibition will be pursued.

The developing practices of sustainable design were advanced as I used sustainable products (natural dyes, natural gums, naturally fibered fabrics) and methods (hand screen-printing) throughout the project. I determined the most effective thickener for natural dyes for use with screen-printing onto sustainable fabrics. The results of this research show that gum tragacanth is most preferred based on fabric hand testing at the ratio of .9875 g to 25 ml of water. Colorfastness to light was excellent for madder, good for woad, while weld had considerable color change. As weld typically has good lightfastness it is recommended to experiment further. The use of natural products and methods may be further developed and thus increase their use in research and design products. Current support of natural dyes in sustainable design is growing and awareness to consumers is becoming more prevalent in the marketplace.

### *Recommendations*

Throughout the project, areas for future research and design were discovered. Even though reflection is a component of practice-based research, I was not consistent in documenting my process or recording my thoughts. Therefore, I recommend designating set times or stages for documentation and reflection. A standardized reflection form could be developed to facilitate or initiate the reflection.

Building upon the same principles of the thickener testing, evaluation of colorfastness to washing of fabrics printed with thickened natural dyes could be conducted. Continuing with the two set ratios of .9875:25 and 1:25 the researcher could print samples to be tested according to the AATCC Test Method 61 (AATCC, 2009). In addition, an extension of the fabric hand testing could be conducted to rank fabrics against each other. Using the preferred ratios, the researcher would print on various sustainable fabrics and have evaluators rank the printed fabrics against each other based on the two elements of hand: shearing (pliable to stiff) and surface (smooth to rough).

As noted, the thickened weld had considerable color change when tested for lightfastness. The powdered extract used in the study was not very refined and difficult to dissolve, which may have influenced the fastness results. Further study is recommended.

An area for future design would be a continuance of layering dyes through printing on undyed fabrics. Developing techniques that would display the color theory and practice would inform designers about specific natural dye chemistry with fabrics.

## *Reflection*

Overall the research and design process of this project was an informative journey. It was quite interesting to explore a culture rather different than my own. Discovering the ancient dyeing practices and reading of stories in the Anatolian region strengthened my desire to learn more about natural dyes and their history. As the fundamental process of practice-based research, learning through active participation and reflection on an experience was an effective way to create and conduct research in this field. Meeting with committee members to discuss my design thought process and research created a social context, an interaction between learners’ that pushed the exploration further. During the initial stages of the design process, I placed patterns together and blocked colors to create layers and overlap. Upon advisement from my committee, it was suggested to explore layers as single colors and not entire prints at the start. This proved to be successful and led to the creation of new prints and the discovery of the change in color and chemistry of the dyes. Questioning practices and being guided to investigate techniques further strengthened the design process and brought validity to the final design output.

This project was very enlightening and educational for me on an academic level, as well as on a personal level. The research conducted will inform the field of textile design while presenting areas for further advancement and study. It can be hoped that the design products from this project may bring inspiration and knowledge to others and further create future practice-based research projects.

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# Appendix A - Timeline

| **Date** | **Event** |
|---|---|
| 2/3/09 | Proposal Outline Due |
| 2/17/09 | All Contextual Review reading 95% complete<br>First draft of Proposal due |
| 2/19/09 | ATID – Agriculture Experiment Station (AES) Meeting – Budget proposed |
| 3/3/09 | Second draft of Proposal due |
| 3/24/09 | All revision made – Fourth draft of proposal due |
| 3/31/09 | Finalize Proposal |
| 4/29/09 | **Written Proposal distributed to committee members** |
| 5/13/09 | **Proposal presentation with committee members** (Justin 227 / 1:00 PM) |
| Summer 09 | Research methods and materials; Begin design research |
| 8/24/09 | Fall 2009 classes begin |
| Fall 09 | Test thickeners viscosity, hand, and determine appropriate recipe; continue on design research |
| 12/18/09 | Fall 2009 semester close |
| 1/14/10 | Spring 2010 semester begins |
| 2/26/10 | Discuss designs with committee |
| 4/6/10 | Last day: *Schedule Final Examination & Diploma Information submitted to Graduate School* |
| 4/16/10 | **Final Thesis given to committee members for review** |

| | |
|---|---|
| 4/27 & 28 | Exhibition set-up (K-State Student Union Gallery, 10:00 AM-6:00 PM) |
| 4/28/10 | **Exhibition opens** |
| 4/30/10 | **Oral Defense given to committee members (K-State Student Union Gallery & Stateroom 1, 1:00-3:00 PM)** |
| 5/3/10 | *Thesis finalized; converted to PDF and submitted to K-Rex; pay submission fees; complete ETDR survey; complete exit survey* |
| 5/4/10 | Last day: Final Examination ballot, Final copy of electronic report submitted to Graduate School |
| 5/13/10 | **Exhibit closing reception (K-State Student Union Gallery, 4:00-6:00 PM)** |
| 5/14/10 | Graduate School Commencement (Bramlage Coliseum, 1:00 PM) |
| 5/17/10 | Exhibition clean-up |

# Appendix B - Budget

| **Cost** | **Item** |
|---|---|
| $100.00 | ETDR Submission Fee |
| $65.00 | Copyright Fee |
| $varies | Additional fabric & supplies, if needed |
| $100 max | Printing expenses |

*Items needed for research techniques. Proposed to Agriculture Experiment Station*

| **Category** | **Item** | **Description** | **Source** | **Price** | **Quantity** | **Total Estimate** |
|---|---|---|---|---|---|---|
| Aid | Aluminum Acetate | 16oz | HillCreek Fiber Studio | $31.50 | 1 | $31.50 |
| Aid | Cream of Tartar | 8oz | HillCreek Fiber Studio | $10.40 | 1 | $10.40 |
| Aid | Earthues Liquid Scour | 8oz | HillCreek Fiber Studio | $10.35 | 2 | $20.70 |
| Aid | Emulsion | Ulano Fotocoat TZ Diazo Emulsion, 28oz | Dick Blick | $28.18 | 1 | $28.18 |
| Aid | Emulsion Coater | 11” | Dick Blick | $18.60 | 1 | $18.60 |
| Aid | Gum Arabic (liquid) | pint, premium | Daniel Smith | $13.46 | 1 | $13.46 |
| Aid | Gum Arabic (powder) | 8oz | Daniel Smith | $14.85 | 1 | $14.85 |
| Aid | Gum Tragacanth | 1oz | LongRidge Farm | $4.40 | 8 | $35.20 |
| Aid | Mylar | 11”x17” | Varney’s | $1.05 | 25 | $26.25 |
| Aid | Potassium Aluminum Sulfate | 16oz | HillCreek Fiber Studio | $6.40 | 1 | $6.40 |
| Aid | Tannin | 1oz | LongRidge Farm | $2.90 | 5 | $14.50 |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Aid | Thiourea Dioxide | 1oz | LongRidge Farm | $2.30 | 8 | $18.40 |
| Aid | UV Light Blocking Sleeve | 48", T-12, Item No. SPSSUVS | Screenprintingsupplies.com | $16.00 | 1 | $16.00 |
| Aid | Screen Cleaning Kit | Kit contains all chemicals needed & brushes, Item No. CCRS | Screenprintingsupplies.com | $44.99 | 1 | $44.99 |
| Aid | Screen Tape | 2", 60 yards, Item No. HRST | Screenprintingsupplies.com | $8.99 | 1 | $8.99 |
| Dye | Black Walnut (powder) | 1oz | LongRidge Farm | $1.25 | 6 | $7.50 |
| Dye | Madder Root (extract) | 1oz, Earthues | LongRidge Farm | $8.50 | 6 | $51.00 |
| Dye | Weld (extract) | 1oz, Earthues | LongRidge Farm | $36.00 | 2 | $72.00 |
| Dye | Woad – Bleu de Lectoure (powder) | 4oz | HillCreek Fiber Studio | $41.60 | 1 | $41.60 |
| Fabric | Hemp | Organic, 57" | Aurora Silk | $23.00 | 6 | $138.00 |
| Fabric | Silk | Eri, Peace, 2.7oz, 45" | Aurora Silk | $23.00 | 5 | $115.00 |
| Fabric | Silk | Ahimsa™, Peace, 3oz, 46" | Aurora Silk | $22.00 | 5 | $110.00 |
| Fabric | Silk/Hemp Charmeuse | 65/35, 5.2oz, 56" | Pickering International | $10.50 | 10 | $105.00 |

# Appendix C - Exhibition

Location: William T. Kemper Art Gallery – Kansas State University
Dates: 4/28/10 – 5/17/10

## *Juried Exhibition of Products*

Print designs will be submitted to Specialty Graphics & Imaging Association annual conference (Tom Frecska Student Printing Competition) in Las Vegas, Nevada, October 13-15, 2010. Submission due date is July 6, 2010.

## *Publication of Research*

The research and selected print design images will be submitted to *Printmaking Today*.

## *Artist Biography*

Matt Kritis is currently a graduate student at Kansas State University majoring in Apparel and Textiles, set to complete his degree in May 2010. His work and research focus on screen-printing using natural dyes inspired by Turkish design and culture. During his time at K-State he served as the President of the Apparel Textiles Graduate Student Organization, and has been recognized in his field of study by receiving the Oris Glisson International Fellowship. His work will be exhibited at the William T. Kemper Gallery in the K-State Union from April 28 through May 17. Upon graduation he plans on continuing research of natural dyes, working in the industry, and designing.

# *Artist Statement*

Within the limits of Turkish culture and art, there are some topics which remain constantly significant to various periods. Among them is that of tradition and modernity, the theme of my present collection of prints. A long-standing topic indeed, but one that continues to preoccupy modern day artists and to provide ever-new avenues for expression.

However, the word "tradition" which once implied a desirable linkage with one's ancestors has come to carry negative connotations. According to supporters of modernization, tradition has associations with what is tired, withered with use, repetitive and stripped of meaning, which what is unfashionable and embarrassing. Modernization, for them, should be a rebellion against all aspects of an almost totally rejected artistic past. This provides implications that the production of this past was inferior and should be removed from our modern culture.

There is no doubt that the modern art revolution broke loose from those remaining traditions which had limited the growth of Turkish art. One must search out a modern means of expression that reflects present-day experience and uses present-day design and imagery.

While exploring the essence of an early period, I have simulated its style and adopted its emphasis. This has resorted to apparent traditions of design, line and imagery, giving the modern viewer a feeling of strange congruity, of an incompatibility with his or her own experience. There is an impression of unreality, of something being dislocated and totally out of proportion.

However, there are some basic traditions which are subtle and not easily recognized or differentiated. Complex florals, geometric shapes and calligraphy are commonly found in designs. These form the backbone of Turkish design, the very foundation that supports its structure.

It is important, in the history of art, to go back to tradition, as it is to renovate and renew. Danger naturally arises when one adopts uniform traditions to the design, re-entering, as artist or visionary, to the mind-set of a different period and assuming its particular style. But never to return to tradition would imply that everything in the old artwork is to be thought of as defective, that it contained nothing which was permanently and universally viable; that it was a mere deformity, able to teach us nothing.

# Appendix D - Publication

| **Journal Title** |
|---|
| Printmaking Today |
| Appropriate Technology |
| Economic Botany |
| Leonardo |
| Journal of Sustainable Agriculture |
| Fiber Arts |
| International Dyer |
| Turkey Red Journal |
| Screen Process |
| International Journal of Agricultural Sustainability |
| Surface Design Journal |
| Clothing & Textiles Research Journal |
| Environmental Education Research |
| Sustainability (Magazine) |
| Journal of Sustainable Product Design |
| Alternatives Journal |
| Clourage |
| Colour: Design & Creativity |
| Dyes and Pigments |