EARLY COMPOUND WEAVE STRUCTURES
IN THEORY AND PRACTICE

M. M. El-Homossani

The emergence of compound weave structures marked an important event in the history of weaving technology. They played the major role in establishing the technical principles necessary to express design ideas in the medium of polychrome woven constructions. Their early techniques tried to overcome the mechanical limitations of the loom, and succeeded in simultaneously combining the designing and weaving into one continuous process. This technological breakthrough was a remarkable achievement as it founded the basis of draw-loom weaving techniques by which elaborate figured fabrics became attainable.

The earliest examples of compound woven fabrics were excavated in Egypt [1], [2] in the late nineteenth century, and in Central Asia [3], [4] and Siberia [5], [6] in the early decades of the present century. Other findings were also revealed later in Syria [7], [8]. The Central Asian fabrics – made of fine silk in warp-faced compound weave structures – could be dated to the Han dynasty (206 B.C. - 221 A.D.); the Egyptian ones – mostly made of wool in weft-faced compound weave structures – attributed to the late Roman period. These extant archaeological textiles provide historic materials of great importance and significance to the study of the flow of technical innovation and intercultural stimulations in Eastern Mediterranean and the Near East. In fact, the link between the appearance of compound weaves and the progress of weaving technology has been a subject of particular interest in recent years [9], [10], [11]; as explanation and understanding of technological development can be derived from detailed analytical studies of the surviving textiles. Theories and hypotheses in the literature indicated main streams which may be generally summed up as follows:

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The development of compound weaves was a progressive one starting with warp-faced compound tabby to warp-faced compound twill, both of Chinese origin, and continues to weft-faced compound weaves [12], [13].

Compound weaves were developed in the Near East as a result of the need to adapt the existing techniques to the new medium of silk [14], [15].

The early weft-faced compound fabrics produced in wool, of Egyptian or Syrian origin?, were the prototype for the fully developed figured-silk woven on drawlooms [16], [17], [18].

The main objectives of this paper are to discuss the concept of compound weaves, and to provide a comparative analysis of the characteristics of the early warp- and weft-faced compound weave structures. It is particularly concerned with the aspects of the structure and weaving techniques, and intend, by applying systematic analysis, to delineate the technical differences and similarities in an attempt to provide better understanding of the technological requirements of the weaving process.

I: Definitions.

Woven structures made up of two or more yarn elements vary in a number of ways [19]:

1. Different kinds of interlacing (that is, variety in the nature of the relationship between elements).
2. Different orders of interlacing (that is, variety in the numerical order of the grouping of elements).
3. Different degrees and kinds of complexity (that is, variety in the number and use of warp and/or weft sets in excess of the necessary two).

Weave structures may be divided according to Grosicki [20] into two main groups:

1. Simple structures, in which the ends and the picks intersect one another at right angles and in the cloth are respectively parallel with each other. In these constructions there is only one series of ends and one series of picks and all the constituent threads are
equally responsible for both the aspect of utility or performance in a fabric and the aspect of aesthetic appeal.

2. **Compound structures**, in which there may be more than one series of ends and picks, some of which may be responsible for the 'body' of the fabric, such as ground yarns, whilst some may be employed entirely for ornamental purpose such as 'figuring', or 'face' yarns. In these cloths some threads may be found not to be in parallel formation one to another in either plane, and indeed, there are many pile surface constructions in which some threads may project at right angles to the general plane of the fabric.

Compound structures may be categorized primarily according to the way component sets-of-elements or weaves are related in the fabric construction:

1. Compound structures which have a simple (one-warp/one-weft set) ground or foundation weave throughout, and any additional warp or weft sets are clearly *supplementary*.

2. Compound structures which have at least two sets of elements in either the warp or the weft direction, they are *complementary* to each other and co-equal in the fabric structure.

3. Compound structures which are composed of two or more complete and correlative weave structures, either separate or interconnected (as in double cloth).

The early compound woven structures belong to the second category.

As this study deals with early weave structures, the terminology used is based on the definitions recommended by CIETA[21]. Therefore, it may be appropriate to clarify and indicate the following basic terms:

**Warp (n):** The longitudinal threads of a textile; those that are arranged on the loom. A single thread of warp is called an end. Alone, the term warp denotes all the warp ends in a textile. Suitably qualified, it denotes all the warp ends engaged in a specific function.

**End:** In its most important use, an individual warp thread.

**Weft:** The transverse threads of a textile; those which are passed through the sheds. Also woof, filling, but those terms are not recommended by CIETA. Alone, the term weft denotes all the picks in a textile. Suitably qualified, it denotes all the picks engaged in a specific function.
Pick (n): A single passage of the shuttle through the shed, carrying one or more weft threads, cf. lat, Pass. By extension, it is the weft threads so carried.

Thread(n): A continuous strand, single or compound, made from any fibre or filament by reeling, spinning, twisting or throwing.

Yarn: A term used to designate thread when prepared for weaving or knitting.

**Warp-faced compound weaves:** Weaves employing a warp composed of two or more series, and one weft. Alternate picks serve to separate the series of warp ends so that only one appears on the face, while the other or others are kept to the reverse. The remaining picks bind the warp ends. The ground and pattern are formed simultaneously, and the entire surface is covered by warp floats which hide the weft. If the binding of the warp ends is tabby the construction is called warp-faced compound tabby, if in twill, warp-faced compound twill (Figure 1).

All the woven polychrome patterned silk from the Han dynasty that have been found are in this construction and the binding is invariably based on tabby weave. It is only at a later date, possibly not until the early T'ang dynasty, that a twill binding was employed [22].

**Weft-faced compound weaves:** Weaves employing two systems of warp each have a specific function: an “inner-warp” manipulates the design formation; and a “binding-warp” provides the fabric structure. Two wefts of different colours are usually used to form the pattern and its background. They cover the inner-warp and intersect with the binding warp in a tabby or twill weave order. The resultant fabric is reversible. The term “taquete” is used for the group with the tabby binding, while the term “Samit” refers to the group with the twill binding (Figure 2).

The earliest reliably dated example in the weft-faced technique is a specimen discovered at the site of Dura-Europos in eastern Syria [23]. The fall of the city in 256 AD furnishes an absolute limit for its chronology. It was executed in weft-faced compound tabby and made of Z-spun discontinuous silk yarn; a distinct characteristic from the Chinese practice of using silk yarns in the form of continu-
ous-filaments. The woollen compound textiles excavated from Egyptian graves have been generally dated cf. fourth - sixth century A.D. Some related archaeological findings, literary sources and textile representations on architectural remains and sculptures, however, suggested that the surviving textiles could be late examples of a long-existing tradition. On this assumption, an earlier date than is commonly supposed may be considered [24]. Nevertheless, concrete archaeological evidence is required for definite confirmation.

II: Comparison of construction and design aspects.

There has been a tendency to associate the appearance of weft-faced compound weaves in Eastern Mediterranean with the Westward movement of silk trading. Based on the fact that silk sericulture originated in China, it was assumed that the utilization of this exotic material in woven textiles made the Chinese weaving craft ahead of its counterparts in the West. Subsequently, any technological development in Eastern Mediterranean weaving of the early centuries A.D., has to be directly influenced by the introduction of Chinese silk fabrics. Silk trade must have a significant impact on the local textile industries, though, it is important to underline the fact that there are several hundreds of woollen specimens woven in weft-faced compound structures known to have survived from Egyptian burial grounds. There constructions and designs were in simpler forms than the specimens incorporating silk yarns and produced in the same technique, which may indicate an earlier stage in the evolution of this compound weave. For these reasons, it is felt that a comparative analysis of the construction and design aspects - based on the data resulting from previous studies - can be useful in verifying some of the technical differences and understanding the similarities as reflecting an evolving technological system.

II:1. Construction.

It is apparent from the data accumulated in Table I and Table II that there are intrinsic characteristics related to each group which can be realized in the following areas:

Material: Continuous-filament silk slightly twisted or mainly without apparent twist was employed in the manufacture of the early
warp-faced compound fabrics; this was not the case with the fabrics executed in weft-faced compound weaves. A number of the early examples of the latter group were woven in wool, and sometimes a wool weft on a linen warp. The warp ends are hardly twisted, while the weft picks have appreciably lesser twist. In Egypt, where most of these textiles were found, fine woollen yarns were first met with in the Ptolemic period. Wool and linen were used together in tapestry-weaving, as it was economical to employ the more costly dyed wool for the design motives and the undyed linen for its background. By analogy, it seems that the weavers had, at the beginning, to continue the traditional procedure of tapestry-weaving, although the consumption of the two wefts becomes proportionally equal due to the reversible nature of the compound weave. It is evident from the data in Table I that the combination of different materials in one construction is of frequent occurrence in the weft-faced compound fabrics. The existence of wool/linen, wool/cotton and wool/silk constructions in this group can provide the basis for useful technical studies which may be utilized for explaining cultural influences and technology transfer between regions. This point is being investigated, by the author, as part of an ongoing research project in cooperation with the Textile Department of R.O.M., and the Collegium Archaeometricum of the University of Toronto. It is intended to expand the technical analysis to include larger number of samples, in an attempt to provide better interpretations and understanding of textile history.

Set: In warp-faced compound fabrics, the warp density is high. About 100 to 200 ends per cm. or 5,000 to 10,000 ends on the loom, assuming a width of approximately 50 cm., as in certain specimens in the Hermitage, Leningrad, and the National Museum, New Delhi. This is in sharp contrast with the low warp density of the weft-faced compound fabrics. A preliminary analysis shows that the woollen specimens have 10 to 15 ends per cm. This figure would be increased up to 30 to 36 ends in the silk specimens, as indicated in Table I. The situation is reversed when the weft density is considered.

These technical factors point out two different approaches to the weaving technique. They must be analyzed within a historic context
recognizing the long established weaving traditions prior to the evolution of compound weaves, both in China and the Eastern Mediterranean region.

In practice, a weaver who is accustomed to handling a few ends per unit length, would find it difficult to deal with the complexity of weaving a warp consisting of several thousand ends across its width. In addition to the frustration which could result from the slow and sensitive preparation and threading of a fine and dense warp; the actual difficulties are fundamentally technical. To overcome these difficulties, specific solutions are required to maintain a trouble-free operation. The high friction generated between adjacent warp ends is one of the main causes of the problems encountered during the weaving process. An increased end-breakage would be an immediate result. Entanglement of warp ends and misplacing the broken ones are typical consequences. Take, for example, a tabby weave which is by far the simplest and most used structure. If a warp of low to medium set should be woven in this particular weave, only two shafts or the equivalent would be required. When the warp becomes highly dense, threading has to be spread over four and sometimes six shafts, depending on the degree of warp density. The spreading of ends is necessary because of the limited number of heddles or loops that can be placed on a shaft. An appreciable reduction in friction between ends is the additional benefit. Employing a high set warp in early woven constructions demanded certain adjustments:

1. Threading of more than one end in each heddle to keep the permissible number of heddles per shaft unchanged. This may explain the grouping of warp series in the heddles of the front harness (a method developed for weaving early Chinese silks produced in warp-faced compound tabby weave), as will be seen later when dealing with the technical analysis of this compound structure.

2. Changing the weave structure to another structure which requires more shafts for its weaving. For example, a twill instead of tabby weave, to allow practical distribution of the warp ends.

3. Modifying the weaving device (Loom) to accommodate more shafts, and to enable the formation of a clear shed. Thus, satisfactory conditions for weaving can be accomplished.
The solutions provided by these adjustments can only be achieved through extensive experience and innovative thinking. A process requiring time and development of special skills.

Weave structure: In both groups there is evidence that tabby was used as the binding weave in the early specimens. In a later stage a 1/2 twill weave was employed. This trend does also technically agree with the changes that took place in material and design. In the group of weft-faced compound fabrics, it will be noted that the change from wool to silk favours a weave structure which provides a looser binding. A tabby weave affords more interlacing points resulting in a firmer structure which limits the number of ends and picks per unit length. A weave of this nature is appropriate for a woollen construction with a low density set. On the other hand, a twill weave increases the float length on the fabric surface, and enables the weaving of higher density set. These factors enhance the inherent properties of silk yarns related to fineness and luster.

Another observation drawn from the data appears in Table I, which connects the weave structure to the number of colours used in the design. When tabby weave is employed for binding, the design is mainly bi-colour. If a third colour is introduced, it is only to replace or to alternate with one of the basic two colours of the design. In the case of polychrome designs, there are three or more different colours of weft which are picked in a consecutive order. Consequently, the change to a binding weave with less intersecting points becomes preferable. A twill weave allows an adequate coverage of a particular weft colour on the fabric surface, permitting the other wefts to be hidden and squeezed on the reverse side.

However, these changes in materials, number of design colours and weave structures did not occur abruptly, but they were developed gradually. There are indications of experimental and transition stages in the mode of fabrication that can be depicted by detailed technical analyses of the extant textiles. The literature clearly points out a shortage and lack of technical information – particularly related to the early “non-silk” compound woven fabrics.
II:2. Design.

*Dimension and distribution:* Amongst all the surviving examples of warp-faced compound fabrics, the height of the repeat is seldom known to exceed 9 cm. A unique piece in the Hermitage collection has an unusual height of 54 cm [25]. The pattern unit width where determined, is greater than its height, but generally undetermined since it exceeds the width of the fragment examined. In some cases it may have extended from one selvage to another, a width of about 50 cm [26].

The early woollen weft-faced compound fabrics from Egypt have two distinguished features: repetition of a design motif; and a design repeat unit that can be enclosed within an imaginary squared or elongated rectangular frame. The shorter sides are controlled by the warp and the longer ones are formed by the weft. Repetition is an important part in the formation and production of woven patterns. Aesthetically, it creates a rhythmic flow and provides aspects of design uniformity and balance. Technically, it is advantageous to have a pattern unit repeated in some order sequence due to the great number of elements that make up a useful piece of fabric; because of the constraint applied by the mechanical principles and the orthogonal features of the loom. The economic value of the repetitive arrangement can not be ignored in respect to weaving production.

Most of the extant textiles from antiquity were essentially plain or with very little embellishment, though, textiles represented on wall-painting and other artifacts prove that patterned materials were also produced, (Figure 3), (Figure 3a). In retrospect, creating designs by building from components is deep-rooted in the ancient civilizations of Eastern Mediterranean and the Near East. It may be presumed that these patterns were directly painted or stamped on the fabric; or were either embroidered or appliquéd. The only means of producing such patterns in a woven construction was by tapestry-weaving, which is a discontinuous process and laborious. The introduction of compound weaving techniques as manifested in the early weft-faced fabrics was the primary attempt for the repetitive mechanization of the designing process of a woven fabric.
Implementation: The high density of the warp and the low number of pattern sheds – which are typical characteristics of the Han dynasty warp-faced compound fabrics – support the opinion expressed by Burnham [22], that equipment simpler than a draw-loom was used. King [26] also agreed and explained that the short, wide pattern unit of the Han silks, suggests a figure-harness of quite different type than the drawloom figure-harness familiar in the West. The Chinese adaptation lacks any provision for automatic repetition in the width, and hardly ever repeats more than a few dozen pattern sheds in the length; presumably because of the limitation of the device, or the laboriousness of the procedures involved. Vial [27], in his technical analysis of a Han silk, suggested that it may have been executed on a loom equipped with two shafts for the production of the foundation structure on the odd-numbered picks, and a number of shed-rods for the even-numbered picks to produce the pattern. He noticed significant variations in the vertical repeat of the pattern. Based on these findings two types of looms were identified: the first equipped with shed-rods with attached loops, retaining the original order of sheds in each repeat; the second had shed-rods which were placed and withdrawn pick by pick. Hence, inexact repetition of the pattern inevitably occurred [28]. Replication experiments carried out by de Jonghe & Tavernier [29], and Becker & Wagner [30] support these propositions.

Inspite of the limited technical information relating to the early weft-faced compound fabrics, there features indicate that a horizontal loom may have been used, and some mechanical adaption of the loom devised to achieve the type of repetition apparent in the woven patterns. To be able to determine the degree of complexity of the device and to reconstruct the past technology, further technical studies dealing with fabric construction and design, as well as the more complex aspects of weave structure and mode of fabrication are required.

III: Analysis of the weave structure.

A weave structure possesses inherent properties which control the technical procedure suitable for its production. It is important to understand the interaction between each element and the function of
all the constituents incorporated in the structure. In developing a new effect to achieve a certain criterion either performance and/or design of a woven fabric, a new element might be introduced, or the function of the existing elements could be altered. These changes directly influence the weaving process and require modification of the conventional device (Loom) to overcome any technological limitations.

In the study of archaeological textiles, when the technology becomes obscure due to the lack of records or insufficient documentation, the extant product presents the most reliable source to extract technical information and reconstruct the past technology. A systematic analysis as indicated in the flow chart, appearing in Figure 4, recognizes the elements involved in the execution of a weave structure, and is applicable to the study of early textiles. The analysis follows a methodology which builds technical data of great use in identifying groups that can be classified, not only on the basis of style and design elements, but also by attributes and particulars of construction and mode of fabrication.

It is important to start with the determination of warp and weft directions. The fragmentary condition and the absence of selvages in many of the archaeological textiles make this identification not easy to be accomplished. However, data related to yarn properties and twist, coupled with an indepth knowledge of weave structures and the analyzer's experience, can be utilized to resolve this problem. In case of compound weaves, the analysis becomes more complex; each additional set of elements in the warp and/or the weft assembly should be isolated, and the number of warp(s) and weft(s) in the fabric construction must be denoted. Subsequently, the function of each set of elements (for example, supplementary, complementary, structural, ornamental...) can be established. The interaction among the different sets of elements is expressed in a numerical order of interlacing, and consequently, the basic weave repeat unit can be set up. This unit is the building component of the fabric construction which indicates the smallest area, expressed in the number of ends and picks, on which a weave interlacing can be represented. Based on this information, planning of the weaving procedures may be
reconstructed. Two plans are required: a draft plan which determines the number of shafts and the arrangement of warp threading; and a lifting plan which considers the tie-up and the sequence of the up and down movements of the shafts to create consecutive sheds corresponding to each pick in the repeat.

The weaving technique and possible type of equipment must be explained, evaluated and reconstructed within a framework which realizes the archaeological findings belonging to earlier or later dates, and utilizes literary sources and other relevant media for analogy and inference. Studies of ethnographic evidence related to traditional weaving technology can also be a useful tool for explanation and reconstruction of early techniques. However, the technology of ethnic textiles should be carefully analyzed and understood on its merits in a proper environmental context without the enforcement or imposition of foreign standards and models.

As can be seen, the outlined analytical scheme deals with the three basic factors comprising the foundation of weaving a fabric: the weave repeat unit; the draft plan; and the lifting plan. Very few studies – notably by Vial in collaboration with Riboud; and de Jonghe and Tavernier (see references) – have dealt with these interdependent complex aspects of the structure and technique. Important information can be obtained through detailed analytical studies, and effectively applied in clarifying some conflicting interpretations. For example, in most of the studies related to early compound woven fabrics, the weave structure was invariably presented idealistically in a plane view of an interlacing diagram (Figure 5 and Figure 6), or in a cross-section either in the warp or in the weft direction (Figure 7). These presentations can be useful explanatory tools, but if applied in their abstract forms to explain and define the technical aspects of a weave structure, an incomplete or somewhat misleading interpretation may result.

In this regard, weft-faced compound tabby weave was referred to as:

"... structure of 3-over-1 compound cloth. Four sheds only are required for the simplest compound cloth. The shots of weft lie alternately under 3 and over 1 warp-thread and under 1 and over 3. Odd-numbered weft-
threads (shot 3/1) are of one colour, the even-numbered ones (shot 1/3) of another. As a result, one colour predominates on one face of the cloth, the other on the opposite face...” [31].

Although this definition is descriptively correct, it is not technically accurate. It does not realize the fundamental technical principles of the weft-faced compound tabby weave which initiates the employment of two different sets of warp controlled by a double-harness setup [32]. One warp “the inner-warp” controlled by the figure-harness, is responsible for the design composition, while the other “the binding-warp” controlled by the front (binding)-harness, is responsible for the fabric structure. The wefts do not interact structurally with the inner-warp in any respect, but in effect they interlace with the binding-warp in a tabby order, over 1/under 1. Hence, the definition compound tabby weave is implied.

In accordance with the analytical approach, it is recommended that the weave repeat unit should be expressed schematically on point (squared) paper, using marks to denote interlacing type (A) – warp over weft – and blanks to denote interlacing type (B) – warp under weft – as shown in Figure 8. On this basis, a more comprehensive diagram can be developed which includes the weave (design) repeat, the draft and lifting plans. The application of this systematic method on a group of early textiles would enable establishing data to indicate the minimum and maximum limits of the weaving device capacity. Consequently, possible types of equipment, techniques, and the degree of technological complexity may be explained and evaluated. The data can provide sensitive indicators for changes in weaving technology, and hence, cultural influences, date and origin may be assessed.

The technical principles of the warp- and weft-faced compound weaves are shown schematically in Figure 9 and Figure 10, respectively. It will be noticed that in all the diagrams two colour effects are considered, and tabby weave is used as the binding structure. This is for simplicity, but, on the same basis more colour effects can be added and a twill weave can be used for binding purposes. In Figure 11, it can be realized that the colour arrangement of the warp ends in the order of 1:2:2:1, and repeat. This is the standard order
of colours in the polychrome compound silks of Han dynasty, and the same system is followed where other numbers of warp series are found (for example, 1:2:3:3:2:1, and repeat) [26], [33]. A similar phenomenon was noticed in the change in shuttles due to colour order of later examples of weft-faced compound fabrics made of silk in a 1/2 twill binding weave [12], [34]. The procedure consists of making the colour alternate by two picks of each weft during weaving in the order of 1:2:2:1. This type of picking order accelerates the rate of production, particularly when a draw-loom is considered. It is also a method for scaling up the design repeat to achieve appropriate proportion in the warp and weft directions. However, attention should be paid to the changes in the numerical order of the weave repeat unit. The picking order of weft colours repeats on 4 picks, which does not correspond with the 1/2 twill weave, repeating on 3 picks. Therefore, a complete weave repeat unit requires 9 ends arranged in one end of the binding-warp followed by two ends of the inner-warp; and 12 picks arranged in one pick of the first colour followed by 2 picks of the second colour, and 1 pick of the first colour.

It is evident from the analytical approach as presented in this study, that the two main groups of early compound weaves, the warp-faced and the weft-faced, are intrinsically distinguished. Characteristics related to material, construction and design do not substantiate the supposition that the development of weft-faced compound weaves was directly influenced by Chinese silk-weaving techniques. Archaeologically, among the enormous quantities of textiles that have been preserved in the burial grounds of Egypt, there was not one example, possessing specifications similar to the Chinese warp-faced compound silks, known to have been discovered. The existence of many woollen weft-faced compound fabrics – with varying degrees of design complexity – cannot be pushed aside when dealing with the question of the evolution of compound weave structures. The fact that these textiles are made of fibres other than silk does not make it less important, at least from a technical viewpoint. The postulation that the appearance of compound weaves was sequential, starting with warp-faced weaves, seems to be not clear. It also connects the Chinese silk with the weft-faced silk of the Near East, as-
assuming they were chronologically consecutive, without considering
the earlier examples of weft-faced effect executed in other materials.

There are technical aspects which would suggest re-evaluation. For
a weaver who inherited the tapestry tradition of creating a design
with the weft, it would be rather difficult to convert his weaving
technique to achieve a warp-patterned effect. It would be necessary
to change from highly tensioned warps to comparatively loose ones;
in addition to the difficulty of managing a significant increase in the
number of much finer warp ends. These factors support the idea of
an independent beginning of the two compound weaves, but do not
necessarily mean that no adaptation or technical exchange happened
at a later stage. However, until conclusive archaeological evidence is
to be found, extensive research and detailed analytical studies of the
extant textiles are needed to illuminate remaining areas of
uncertainty.

An important result obtained from the analysis of the weave struc­
ture: The differences in weaving procedure in respect of loom setup
and operation, as indicated by the draft and lifting plans, established
two inventive technical principles. The first, related to weft-faced
compound weave, is the introduction of an additional patterning
warp-set controlled by a separate special harness which lifts the warp
ends in a pre-determined sequence to form repetitive pattern
motives. The second, related to warp-faced compound weave, is the
dual control of the warp ends by passing them through two sets of
shafts (harness) which requires the employment of a form of “long­
eyed” or “clasped” heddles in the front set; thus allowing a free
movement of the selected ends in the pattern shed. It is reasonable to
conclude that the latter technique could be attributed to China, while
the former one would probably originate in Eastern Mediterranean
region, in a place where tapestry weaving was the paramount
 technique, to satisfy increasing demands for patterned woven fabrics.
These two developments are of prime importance in the history of
figure-weaving technology. They continued to be practiced, pro­
viding the technical basis for the development of other weave
structures suited for draw-loom weaving.
The study of early compound weave structures can provide materials of great importance to the history of weaving technology, and viable information for cultural influences and comparison. It is also hoped that understanding the concept and technology of compound weaves will draw attention and revive the interest of the contemporary weavers to explore new possibilities in design and performance of woven fabrics.

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References


Department of Metallurgy and Material Science
University of Toronto
Toronto, Ontario
M5S 1A4
Figure 1
Warp-faced compound fabric – Han dynasty, ca 206 B.C.-221 A.D.
Philadelphia Museum of Art, No. 34.2.2

Source:

Weible A.C., “Two thousand years of textiles”, The Detroit Institute of Arts, 1952, Figure 39.

Figure 2
Weft-faced compound fabric Egypt or Syria?, ca third century A.D.
Philadelphia Museum of Art, No. 33.50.1

Source (Early Woollen Compound Fabrics with Hunting Scenes):

Von Falke O., “Kunstgeschichte der Seidenweberei”, Berlin, 1913, I, Figure 30, 31.


Weible A.C., “Two Thousand Years of Textiles”, The Detroit Institute of Arts, 1952, Figure 37.

Figure 3

The concept of motive repetition in textile design examples from ancient Egypt

L: Painted wooden statue, 11 dynasty (ca. 2040 B.C.), found in Der El-Bahri, now in Cairo Museum.

M: The God Re Harakhti and Amentit Goddess of the West seated side by side, 19 dynasty (ca. 1100 B.C.), tomb of Queen Nefertari.

R: Painting on the coffin of Sennutem, 20 dynasty (ca. 1000 B.C.), found in Der El-Medine, now in Cairo Museum.
Figure 3a

The concept of motive repetition in textile design examples from Mesopotamia


R: Ubal daughter of Jabal, second century A.D., found in Hatra, now in Baghdad Museum.
Figure 4
Flow chart of systematic weave structure analysis
Figure 5
Plan view of warp-faced compound tabby fabric

A: first warp series  
   (first warp colour)  
B: second warp series  
   (second warp colour)  
C: binding-weft  
D: inner-weft
Figure 6
Plan view of weft-faced compound tabby fabric

A: binding-warp
B: inner-warp
C: first weft colour
D: second weft colour
Figure 7
Cross-section in the warp direction

A: warp-faced compound tabby weave
B: weft-faced compound tabby weave
Marked squares denote interlacing type (A) warp over weft

Blanked squares denote interlacing type (B) weft over warp

Figure 8
Weave repeat unit

Weft-faced compound tabby weave
A: first colour effect
B: second colour effect

Warp-faced compound tabby weave
C: first colour effect
D: second colour effect

0 = binding weave
X = warp end up to provide the desired colour (design) effect

b: binding-ends or picks  i: inner-ends or picks  f: face-ends or picks
r: reverse (back)-ends or picks  c: colour order
Figure 9
Warp-faced compound weave
Principles of warp-ends dual control weaving technique

A: design effect
b: binding-weft
i: inner-weft
c: warp colour order c₁: c₂
d: drafts plan
L: lifting plan
Figure 10
Weft-faced compound weave

Principles of employing two warps with separate functions
A binding-warp for structural purpose, and an inner-warp for design formation

A: design effect
b: binding-warp
i: inner-warp
c: weft colour order c₁ : c₂
d: drafts plan
L: lifting plan
Figure 11
Warp-faced compound tabby weave
with \(c_1: c_2: c_2: c_1\) warp colour order

N.B.: Due to the high density of the warp, 4 shafts are used in addition to the essential 2 front shafts.

A: design effect
b: binding-weft
i: inner-weft
c: warp colour order
  \(c_1: c_2: c_2: c_1\)
d: drafts plan
L: lifting plan
Figure 12
Weft-faced compound twill weave
with c1: c2: c1 picking order

A: design effect  B: binding weave 1/2 twill  C: weft colour-order
D: weft guide  E: warp guide  G: weave repeat unit, first colour on face
H: weave repeat unit, second colour on face
b: binding-warp  i: inner-warp  f: face weft  r: reverse (back) weft
Technical analysis published:

I: Weft-faced Compound Woven Fabrics

<table>
<thead>
<tr>
<th>Designation</th>
<th>Chronology</th>
<th>Source</th>
<th>Material</th>
<th>Colours</th>
<th>Set</th>
<th>Warp proportion</th>
<th>Binding Weave</th>
<th>Pattern Repeat Unit Width (cm)</th>
<th>Pattern Repeat Unit Height (cm)</th>
<th>Required No. of shafts or equivalent</th>
<th>Fabric Width (cm)</th>
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<td>Petrie Coll.</td>
<td>2-3 Cent. A.D.</td>
<td>Crowfoot &amp; Griffiths,1</td>
<td>Wool S-spun</td>
<td>Light?</td>
<td>9.4</td>
<td>37.8</td>
<td>Tabby</td>
<td>‡</td>
<td>‡</td>
<td>4 shafts</td>
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<tr>
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<td>4-5 Cent. A.D.</td>
<td>Lamens &amp; Charl.2</td>
<td>Linen</td>
<td>Undyed Purple</td>
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<td>7.5</td>
<td>‡</td>
<td>45 cords</td>
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<td>Maenad silk at Sens</td>
<td>4-5 Cent. A.D.</td>
<td>Falke, 3 King. 5</td>
<td>Silk</td>
<td>Light?</td>
<td>‡</td>
<td>‡</td>
<td>Tabby</td>
<td>9.8</td>
<td>‡</td>
<td>220 cords</td>
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<td>S. Guilianis aiRimini</td>
<td>4-5 Cent. A.D.</td>
<td>Gerola, 4 King. 5</td>
<td>Silk</td>
<td>Light?</td>
<td>‡</td>
<td>‡</td>
<td>Tabby</td>
<td>4.8</td>
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<td>144 cords</td>
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<td>The Keir Coll.</td>
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<td>King, 5 Figure 2</td>
<td>Silk/Z</td>
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<td>126</td>
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<td>4.5</td>
<td>18.0</td>
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<td>King, 5 Figure 4</td>
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<td>150</td>
<td>1/2 twill</td>
<td>13.0</td>
<td>25.5</td>
<td>240 cords</td>
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<td>Colors</td>
<td>Set</td>
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<tr>
<td>V.A.A. Museum 2189.1900</td>
<td>6-7 Cent. A.D.</td>
<td>Mackie,6</td>
<td>Silk</td>
<td><em>Blue t</em></td>
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<td>1/2 twill</td>
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<td>Mackie,6</td>
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<td>Undyed</td>
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<td></td>
<td>1/2 twill</td>
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<td>40.0 Dia. of roundel reconst.</td>
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<td>8-9 Cent. A.D.</td>
<td>Vial,7</td>
<td>Silk/Z WAT.</td>
<td>Dark-green Green/yellow Red</td>
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<td>23.75</td>
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<td>1/2 twill</td>
<td></td>
<td>17.0</td>
<td>20.0</td>
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3) O. von Falke, “Kunstgeschichte der Seidenweberei. I.” Figure 30, 31. Berlin, 1913
4) G. Gerola, Bolletino d’Arte, Vol. 5, 1911, p. 111-112
6) “The Royal Hunter, Art of the Sasanian Empire”, Ed. P.O. Harper, Asia House Gallery, New York, 1978, Figure 54, 57

Note: WAT. = without apparent twist
† = information is not available
## II: Warp-faced Compound Woven Fabrics

<table>
<thead>
<tr>
<th>Designation</th>
<th>Chronology</th>
<th>Source</th>
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<th>Colour</th>
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<th>No. of pattern sheds in pattern unit</th>
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2) D. King, "Some Notes on Warp-faced Compound Weaves", Bulletin de Liaison, CIETA
4) K. Riboud, "Quelques Problemes Techniques Concernant une Celebre Soierie Faconne Polychrome Han (Lou-Lan)", Bulletin de Liaison, CIETA 49, 1977-1, p. 51-64