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PERSIAN VELVETS OF THE 17TH CENTURY: SYMMETRY, CRAFT, AND TECHNOLOGY

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***Abstract**: Symmetry is the organizing principle that underlies patternmaking in compound woven textiles of 17th century Iran. Persian velvets are particularly noteworthy for their complicated weave structure. What defines compound weaves is the interlacing of more than one set of warps (longitudinal elements held under tension at the loom) with wefts (transverse elements). Velvets introduce an additional set of supplementary warps held under differential tension. The weaving of a compound textile requires both a pattern harness and a structure harness for the interaction of warps and wefts. A weaver on the bench manipulates the structure harness for each passage of the weft introduced while weaving; a drawboy, positioned above the loom, manipulates the warps that are dressed upon the loom prior to weaving. The drawboy's actions are guided by a* naqsh*, or maquette, affixed to the loom, which serves as the pattern harness. The role of the* naqshbandi *(literally, the one who ties the* naqsh*) cannot be underestimated in preparing the* naqsh *for Persian velvets and other compound weaves. The* naqsh *effectively programs the sequence of raising warps to create the shed for any given passage of the weft. The pattern repeat, established in the* naqsh*, is a technical unit that is technologically determined by the protocols of drawloom-weaving. Persian velvets of the 17th century typically represent three symmetry groups, reflecting the parameters of drawloom technology - periodicity (translation) of technical repeat units exhibit parallel glide reflections (pg) or reflections and parallel glide reflections across the warp axis (cm), or perpendicular reflections and glide reflections across both warp and weft axes (cmm).*

Keywords: Symmetry; Weaving; Velvet-Weaving; Drawloom; *Naqshband*

INTRODUCTION

Collaborative research in the 1980s (Bier, 1987) established a 'golden age' for Safavid textile arts of Iran in the 16th century, when compound weave structures – namely satin lampas and velvets (Sonday, 1987) – achieved the highest levels of technical and artistic achievement prior to the Industrial Age. The drawloom, which originated several centuries earlier, enabled the integration of

design and technology such that sophisticated designs could be repeated to form a pattern integral with the weave structure. In other textile technologies, such as printing and embroidery, patterning represents a process that is distinct from weaving. In the Safavid period the composition of designs, whether figural or floral, was often related to manuscript illustration and expressed a Safavid visual aesthetic that was also evident in ceramics and metalwork, but it was in textile technologies, particularly that of the drawloom, that the production of pattern based on symmetry was paramount. The potential of drawloom weaving technology seems to have been optimized by the turn of the 17th century. The largest corpus of Persian velvets (61 fragments including several complete loom widths with headers and footers) belongs to the Danish Royal Collections and resides at Rosenborg, a royal palace in Copenhagen (Bier, 1995). It derived from a gift offered by the Shah of Iran to Friedrich III, Duke of Gottorp (Holstein), whose embassy departed Iran in 1638. The velvets, both figural and floral, exhibit systems of pattern repeat that represent three symmetry groups (*pg*, *cm*, *cmm*). These symmetry groups rely upon a rectangular or rhombic grid, suggesting a heightened understanding of the relationship of symmetry to craft and technology, particularly crucial within the parameters of the drawloom weaving. For an appreciation of the complexity of the patterning of Persian velvets of the 17th century it will be helpful to develop a contextual understanding of weaving technology and the patterning mechanism of the drawloom, which is called *naqsh* (or *naqsha*) in Persian. The term *naqsh* is generally translated as image, picture, or design, but in weaving terminology, it assumes technical significance in its structuring of the pattern that is to be created by the interlacing of warps and wefts.

WEAVING AND TECHNOLOGY

Weaving is the process of interlacing warps (longitudinal elements) with wefts (transverse elements) to form a textile, usually implying the use of a loom. The loom serves to hold the set of warps under tension, both parallel and taut, with a means of opening sheds (e.g., alternate warps) for the insertion and passage of a succession of wefts. The ground weave thus created utilizes one of three basic binding systems: plain weave, twill, or satin, serving as the foundation for the fabric. Each binding system represents a regular ordered sequence of the interlacing of warp and weft. Plain weave exhibits the simplest of all possible bindings: Each weft interlaces with successive warps alternately over one and under one. Plain weave may be balanced, warp-faced or weft-faced, depending upon yarn dimension, density, and proportion of warp to weft. A twill binding system is based upon a unit of three or more warps interlacing with three or more wefts interlaces successively in either direction over two or three/under one; satin is over four/under one, which with long warp floats optimizes the sheen of silk. All utilitarian textiles rely upon one or another of these

basic binding systems, which could be embellished after weaving by such techniques as painting, printing, embroidery, applique, or quilting.

In the 17th century the patterns take on a new system of repeat, reflecting the application of drawloom technology that allowed for parallel glide reflections (Figure 1a-b). This became the favoured aesthetic for figural velvets in which the presence of two featured individuals creates a more complicated sense of design (Figure 1a) within a system of parallel glide reflections (Figure 1b). The flexibility in design and fabrication, based on symmetry, facilitated the weaving of complex imagery that was integral with fabric structure and executed during the process of weaving by means of a *naqsh* (Figure 2a-b).

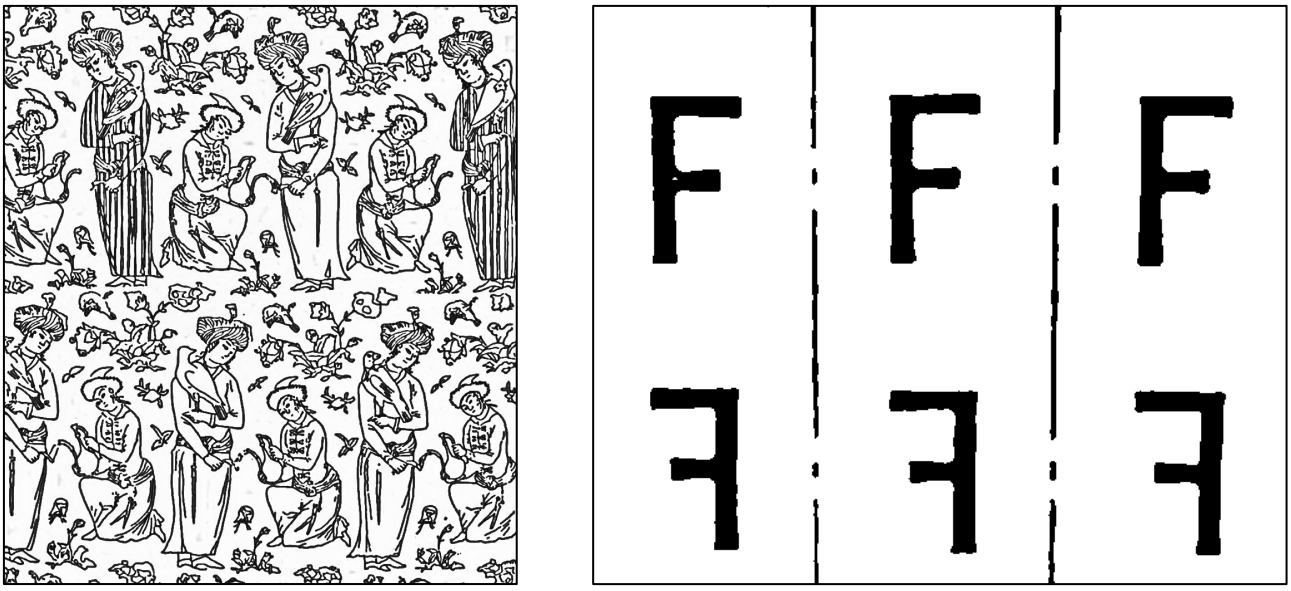

Figure 1a (left) Drawing of Falconer velvet (detail) at Rosenborg by K. Johansen and C. Bier.
Figure 1b right) Analysis of pattern repeat showing parallel glide reflections (symmetry group *pg*) by C. Bier.

NAQSH AND *NAQSHBANDI*

At first glance, a *naqsh* (or *naqsha*) may look like a messy bundle of strings wrapped around a pole (Figure 2a). But it is really a bundle of compressed logic that controls the symmetry of a pattern made by weaving on a drawloom (Figure 2b). Prepared by a *naqshbandi*, literally, tier of the *naqsh*, it bears a woven mock-up of the design that is to be repeated across the width of the fabric being woven; it is strung with cords that enable the manipulation of the pattern warps in sets for each sequential passage of the weft. Each set reproduces by translation one woven line of the design, repeated. But by counting in an ascending or descending order, the design can be reproduced right-to-left or left-to-right in weft direction, effecting a mirror reflection, and the design sequence may be repeated again in warp direction either in alignment or offset. Once the design sequence is accomplished, in the next sequence, the orientation may again be reversed. The *naqsh* is an ingenious device serving as a patterning harness, which when set up on the loom with all the strings attached to

the appropriate lashes, works in tandem with the structural harness to control the sheds for the interlacing of the structural wefts of the ground weave. The presence of both structural warps and wefts for the foundation, and supplementary warps and wefts for the patterning is what characterizes a compound weave. The technique of preparing the *naqsh* is highly specialized and reflects intimate knowledge of drawloom technology and the possibilities for producing a pattern based on symmetry. The task of preparing the *naqsh* is undertaken by the *naqshbandi*, which is often translated as 'master weaver,' but this term does not adequately convey the mastery and mystery of the work involved. The term, *naqshbandi*, literally means the one who ties the *naqsh*. (Note: the relationship between *naqshbandi* and the Sufi order has not been conclusively established and warrants further study).


Figure 2a (left) Naqsh, Varanasi, India.
Figure 2b (right) Drawloom with *naqsh*, Cholapur, Varanasi, India. Photographs: C. Bier, 2020.

While in India in 2020 I witnessed the ingenuity of the drawloom in action at Cholapur, a weaving village near Varanasi (Barrett *et al.*, 2020; Pickett, 2018; Jain, 1993-94; Jayakar, 1967). The *naqsh* seemed like an enigmatic device but clearly critical to what it could accomplish in the way of pattern-weaving. Historically it was used to implement the repeat of a pattern by lifting sets of pattern warps with each successive passage of the weft. Seemingly like magic, it programs the warps during weaving, which through raising and lowering, enables the weaving of a repeated design across the width of the fabric. Controlling the pattern warps ensures that the pattern is integral with the ground weave, forming a pattern that is based upon symmetry and the mechanical iteration of the design set up in the *naqsh*. Accompanying my epiphany regarding this messy form of logic is its

inherent portability when removed intact from the loom, which conceivably contributed to the yet not fully understood transmission of this advanced textile technology across Asia (Bier, 2004).

SATIN LAMPAS AND VELVET

Satin lampas refers to a compound weave structure often used for textiles woven in Iran during the Safavid period (1501-1736). Typically, figural or floral designs are repeated across the width of a fabric from selvedge to selvedge and header to footer. What characterizes a lampas is the interaction of two distinct woven structures created by multiple sets of warp and weft; in a satin lampas one of the weave structures is satin. Many of the most important figural Safavid textiles, with pictorial compositions related to literary and historical episodes, were executed in satin lampas woven on a drawloom (Sonday, 1987; Munroe 2023). While satin lampas textiles reached the highest levels of technological and aesthetic achievement in the 16th century, velvet weaving in the 17th century seems to have pushed these heights to even higher extremes (Figure 3a-c). Velvets, as distinct from lampas and satin lampas, are characterized by their surface pile that results from the introduction of supplementary warp yarns pulled to the front of the fabric forming loops during the process of weaving. The raised loops created by the supplementary warp yarns, held with differential tension, could be cut after weaving, or left uncut. Areas of the textile left plain, i.e., without raised loops, are referred to as 'voided' (Figure 3b).

Figure 3a (left) Persian velvet (detail), 17th century (Rosenborg, Copenhagen) showing the following structural elements: silk warps (vertical), silk wefts (horizontal), metallic strips (supplementary wefts, horizontal), metallic-wrapped wefts (horizontal), and tufts of cut velvet pile (supplementary warps, vertical). Microphotograph: C. Bier 1993. *Figure 3b* (middle) Falconer silk (detail) showing several now faded colours of velvet pile, and voided ground (Rosenborg, Copenhagen). Photo: C. Bier, 1993. *Figure 3c* Diplomatic pouch that contained letter from Shah of Iran, 17th century. Falconer velvet (The Danish Museum of Decorative Art, Copenhagen). Photo: Ole Woldbye (reproduced in Bier, 1995: fig. 14).

The 17th century velvets preserved at Rosenborg are characterized by several features that lend further extravagance in the use of metallic wefts and in technical complexity. The number of colours of the surface pile were increased by means of warp substitution, while the entire surface of figural velvets was enriched by the presence of metallic strips inserted as wefts on the front face (Figure 3a). Their original colors were bright, even garish by our standards, dazzling with gold and brightly shining silk in many colors. A diplomatic pouch, preserved in the Danish Museum of Decorative Art, retains an extraordinary range of colors that suggest the original palette (Figure 3c). Under the reign of Shah Abbas I, who reigned from 1588 to 1629, Iran established important economic ties with emerging European powers, and with the Mughal empire in India, and artistic styles were shared (Jain, 2011; Jain, 2017: 66-70). Textiles figured prominently in diplomacy and trade (Mackie, 2015; Skelton, 2000: 251), and silk was the major item of export from Iran (Bier, 1987). The numerous velvet textiles, which comprised the diplomatic gift proffered by Shah Safi, successor to Shah Abbas, in 1638 to the embassy from the court of Friedrich III in Holstein, were cut up and sewn together into a series of pelmets, short panels with fringe, and long panels that were used for wall coverings (Figure 4).

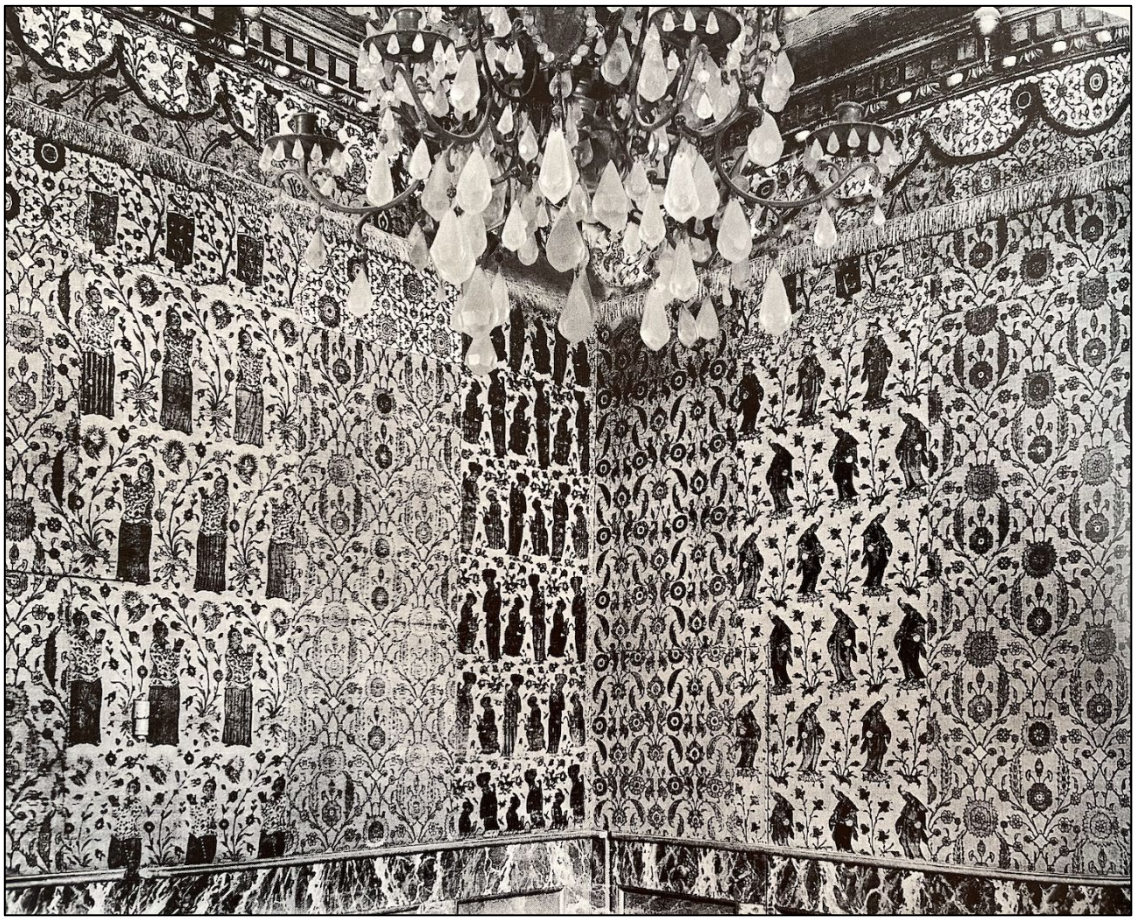

Figure 4 Persian velvets used as wall coverings at Rosenborg. Note that all figural patterns show symmetry group with parallel glide reflections in a rectangular grid (*pg*). Floral patterns show symmetry groups of parallel and perpendicular reflections (upper right pelmets), and parallel mirror reflections in a rhombic grid (*pm*, *cmm*). Photo: F. Martin, 1901 (reproduced in Bier, 1995: fig. 7).

Based on the evidence of Persian painting of this period, these fabrics were more likely produced to be tailored for garments. No matter their intended use, this group of velvets of attests to a pinnacle of textile manufacture at weaving centres in Iran.

Figural velvets produced during this period of Safavid art often represented themes familiar from Persian poetry and painting (Munroe, 2023). Falconers with falcons, and other pastimes of the court are illustrated, along with naturalistic and fanciful landscapes with trees and flowers, birds and butterflies, and stones beside streams and ponds with fish. The intricate arrangement of winding branches, sinuous stems, and colorful blossoms express both the rapturous concerns of skilled artists and artisans, but also an exceptional playfulness with symmetry limited by the technology of weaving that results in the orthogonal interlacing of warp and weft.

SYMMETRY AND PATTERN-MAKING

The tying up of the *naqsh* on a drawloom, with its leashes, lashes, and cross-cords (Figure 5a) serves as a pattern harness to program the sequential drawing forth of selected supplementary warps form shed openings for the passage of wefts that interlace with the warps to create the design repeated to form the pattern (Becker and Wagner, 2014; Wulff, 1966: 205-210).

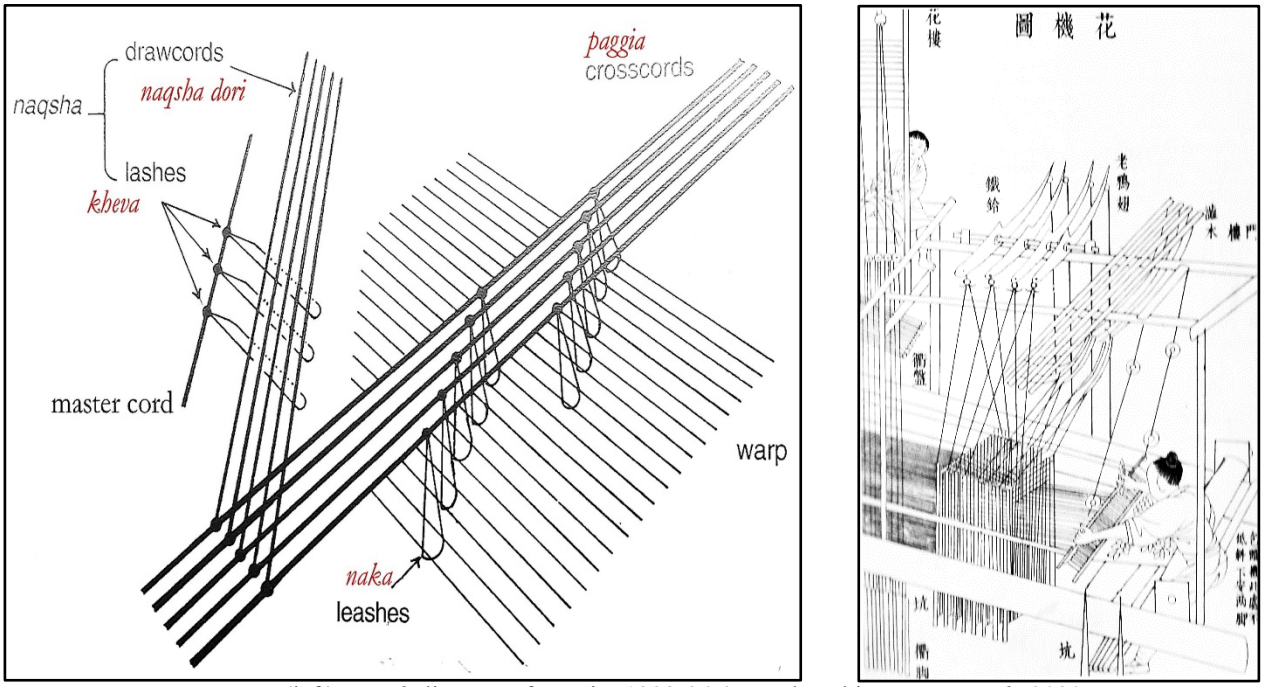

Figure 5a (left) *Naqsh* diagram after Jain, 1993-94 (reproduced in Barrett *et al.*, 2020.
Figure 5b (right) Chinese drawloom, 17th century (reproduced in Bier, 1995: fig. 5).

The *naqsh* and pattern harness are controlled by a drawboy working from above (Figure 5b). The pattern warps and wefts work in tandem with the structural interlacing of structural warps and wefts, which are controlled by the weaver, who is seated at the front of the loom while operating the

structural harness (usually a set of heddles and treadles). The structural warps and wefts interlace to form the structural foundation of the fabric. The arrangement of the pattern is thus affected by the drawboy manipulating the warps as determined by the *naqsh*. The *naqsh* is critically important both to retain the design as a moquette in the interlacing of the warps and wefts secured by lashes and leashes that correspond and connect to pattern warps dressed on the loom. The arrangement of the pattern, likewise, results from the sequence of warps drawn forth in repeated fashion across the width of the fabric according to the *naqsh*. Depending upon the sequence selected, the design may be repeated symmetrically by translation, reflection, or glide reflection. The possibilities for error are infinite. The knowledge and intimate familiarity with the technology of weaving, and – in particular – the tying of the *naqsh* and its set up at the loom, are vital to achieve an artistically pleasing woven product that is consistent with the aesthetics of the time. The masterful skill and expertise of the *naqshbandi* must not be underestimated. For it is he who understands the magic of tying up *naqsh* and securing its leashes, lashes, and cross-cords to control the pattern warps as a harness mechanism such that the design can be repeated to form the pattern by means of symmetry.

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