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Integrating the Evidence: Historic Silk Production in Context

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Consistent with the theme of this conference, my work involves a new direction in the study of weft-faced compound weave figured silks attributed to the Mediterranean region c. AD 600-1300. Known as samite and taqueté according to the binding structure, woven figured silks represent a highly recognizable, but poorly understood body of material. Figured silks are often described in terms of their association with the Byzantine Empire, based on representational and textual evidence.[1]

The implement necessary to weave sophisticated repeating patterns was the drawloom.[2] These devices were equipped with a figure harness for repetitive production of woven patterns. Although the origin and development of these looms is obscure, they were important labor-saving devices. Patterns tied-up in a figure harness provided a means of recording and storing work for later mechanical reproduction. Without a means to replicate memorized patterns, weaving designs in silk was slow and tedious. From a modern point of view, the capability to store sequences of mechanically recorded work steps means that pattern tie-ups were, in effect, an early form of software (Fig. 1).

Figure 1. Lashes tied on a drawloom simple at the Maison des Canuts, Lyon. This device permits successive groups of warp ends to be selected to form a pattern.

Research problem

Thousands of weft-faced compound weave figured silk fragments are held in museums, private collections, and religious institutions, mainly in Europe and North America. Most figured silks

[1] Galliker 2014, 1-31.

[2] CIETA 1987, 16-24; 2006, 15.

were found in one of two contexts: reliquaries and shrines in European churches, and non-scientific excavations of cemeteries in the Near East.

The research problem associated with these fragments is that no archaeological evidence survives to provide evidence about how, when and where these textiles were manufactured.[3] In the Byzantine world, tenth-century textual sources such as the *Book of the Eparch*[4] and the *Book of Ceremonies*[5] demonstrate the ways that silk was employed by the state in various ceremonial, diplomatic, and economic roles. However, ancient texts contain few technical or production details. Written descriptive information is rarely sufficient to form a reconstructive view of particular textile types.[6]

Some surviving silks have been extensively studied from an art historical perspective with attention devoted to the interpretation of pattern motifs.[7] The advantage of a representational approach is that textile evidence can be compared to dated media including coins, seals, and illuminated manuscripts. The problem for textiles is that designs were widely transferred among production centers with extensive sharing of common themes and technical attributes. Moreover, few museum collections have been comprehensively published, resulting in a research bias toward the most impressive and intact pieces.

For a variety of reasons, research progress for this category of textiles has slowed in recent years with few scholars now active in the field. While essential to protect fragile textiles from damage, the practical consequence of strict museum conservation standards has been reduced collections access for textile scholars. Resource constraints and structural changes in museum practices mean that many institutions now focus on exhibitions rather than research. At some institutions, large textile collections established in the early 1900s now languish. Even at well-resourced institutions, there is little opportunity for incomplete or antiquated collections documentation to be updated.

In the face of these challenges, computer-based tools provide new research opportunities to examine surviving textual and material evidence more intensively and comprehensively than was previously possible. To aid data collection and analysis, information technology tools involving relational database methods and digital imaging were devised. Data from these complementary sources were integrated according to a common framework based on production stage. The four stages applied to my research are material, textile characteristics, pattern, and finished goods. Each of these categories also includes evidence for quality decisions and planning.

Textile mention database

A review of middle Byzantine historical, ceremonial and testamentary sources reveals a large number of textual 'mentions' concerning textiles.[8] These are typically incidental in nature with

[3] For a synthesis of primary source references to silk, see Jacoby 1991-1992; 2004.

[4] *BOE*, Koder, Chapters 4-8.

[5] *BOC,* Reiske, especially II.15.581-588.

[6] Schmitter 1937, 201.

[7] For example, see Grabar 1936; 1956; Beckwith 1974; Starensier 1982; and Muthesius 1982; 1997; 2004.

[8] For a complete list of sources included in the textile mention database, see Galliker 2014, chapters 3 and 4.

only partial descriptive information included. To analyze written works, prosopography provided a relevant model for developing a textile mention database.[9] Considered collectively in the form of a consolidated corpus, these 'mentions' are very revealing and include specific details about textiles including materials, weave type, decoration, end use, quality, and usage context.

Significant findings include more precise definition of Byzantine terminology associated with silk. Although *metaxa*, *serika* and *blattia* are generally considered to be nearly synonymous terms for silk, close analysis indicates distinctive meaning associated with each word. *Metaxa* was often used with reference to raw silk fiber. *Serika* was the principal term for finished silk goods employed by all historians from Nikephoros (c. 750-828) to Choniates (c. 1155-1217). Over time, the meaning of *blattia* evolved from the name of a purple dyestuff to silk with high status designs or embellishments.

Figure 2a. © Example of diblattion, AN34973001, Trustees of the British Museum

Figure 2b. © Example of triblattion, BZ.1934.1, Dumbarton Oaks, Byzantine Collection, Washington, DC

Scholars have long puzzled over the meaning of *triblattion* and *diblattion,* which appeared only in association with imperial or high prestige silks. Conventional interpretations follow Du Cange who suggested the terms refer to either the number of times a textile was placed in a dye bath or to mean colored strips applied to designate hierarchy.[10] Close textual analysis shows that *triblattion* and *diblattion* were the middle Byzantine terms for imperial quality weft-faced compound weave figured silks. *Diblattion* referred to a bi-colored silk, while *triblattion* described a figured weave with three or more colors (Figs. 2a and b). This explanation is

[9] For application of database methods to prosopography see Bradley and Short 2002; Short and Bradley 2005; Verboven, Carlier, et al. 2007.

[10] Du Cange and Carpentier 1733, VI, 1277; Guilland 1949, 339-348.

consistent with descriptions of aesthetic and symbolic preferences as related through a variety of written sources. This analysis also agrees with accounts of pattern use and color terminology.[11]

Computer vision analysis

Analysis of textile fragments requires a different set of tools to extract meaningful information in a way that can be analyzed and compared with written evidence. The advantage of textiles is that they are composite structures created through a series of processes. Woven line by line, fabrics provide a sequential record of production. A consistent methodology is required to discern technical details from extant fragments and to define relationships among sets of distinguishing characteristics.

During the past decade, dramatic advances in imaging technologies have made digital photographs the medium of choice for recording technical textile attributes. However, the fine resolution of silk textiles requires specialized microscopy equipment to capture consistent, high quality images at a scale appropriate for objective characterization. My equipment set-up for *in situ* recording of textile attributes is shown in fig 3.

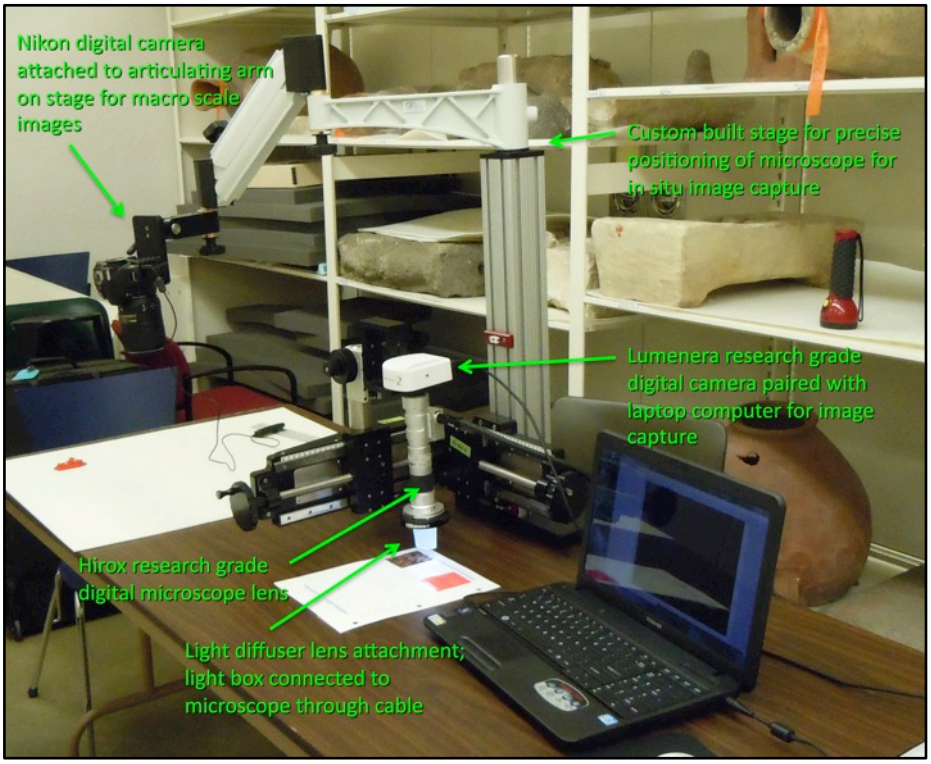

Figure 3. Portable equipment setup for conservation-safe, cross-collection photographic documentation of weft-faced compound weave figured silks

An additional technical problem is that much of the production data embedded in textiles exists at a level that is too diffuse to be captured reliably by conventional measurement methods.

[11] Dawson 2002, 25-26 concluded that *tri-* and *diblattion* filled a terminology gap in the *BOC* as a technical term for figured pattern weaves.

Information technologies can aid in developing low-level data into meaningful information according to scientific research standards. Within the field of computer engineering, computer vision refers to technologies associated with acquiring and using information from digital images.[12] My research program combines macro and micro scale digital imaging with use of a specialized computer vision software tools developed for this project.[13] The computer vision application aids in error detection, providing a basic form of industrial inspection for ancient textiles. The outcome is a set of objective and reproducible measurements enabling specific comparison of attributes across different collections.

During 2012 and 2013, I studied 125 textiles in ten collections including the Boston Museum of Fine Arts, British Museum, Cleveland Museum of Art, Cooper Hewitt Museum, Detroit Institute of Art, Dumbarton Oaks, Katoen Natie, Kelsey Archaeology Museum, Textile Museum of American, and Yale University Art Gallery. To document each textile according to my research protocol, I took a total of 10,635 photographic images. Based on maximum width and height measurements, the total area of the textile fragments analyzed is more than 780 meters. I applied my defined research protocol to record all measurements and observations in a relational database.

From a production point of view, surviving textiles contain information about the work environment and methods of production. Close analysis reveals characteristics associated with workplace organization, processing steps, demonstrated skills, division of labor, and work habits. Evidence indicates distinctive specialized roles for the designer, weaver, and assistant.

The textile evidence shows that a body of conventions existed that provided a means of standardizing work. The high degree of consistency of certain practices over hundreds of years in widely separated workshops is a surprising finding from this analysis. The uniformity of Z-twist direction and surface helix angle suggest that technologies associated with silk were transmitted with the material and adopted by specialized producers at various locations throughout the region. While patterns varied among textiles, particular design conventions were applied to the majority of silks in the collection.

In terms of structure, 1/2 samite was overwhelmingly the dominant method of patterning silks. Pairing a twisted warp with an untwisted weft meant that each component had a specific function that was adopted by producers with variation only in instances when a particular effect was desired. Differences occurred in incidental decisions such as the choice of either twill direction or in color insertion order. The highly repetitive nature of weaving lends itself to formation of craft habits that were presumably shared by weavers within a given workshop.

Economic motivations are evident in surviving fragments. The widespread adoption of the work savings method of returning weft insertion demonstrates an efficiency innovation that reduced the labor involved in weaving complex silks. The use of lesser quality dyes in warps was a means of economizing on materials while disguising visible warps. Substitution of lower quality

[12] Nalwa 1993, 3-29.

[13] Patel, Gallikar (Galliker), et al. 2013.

or spun silk implies either economy or fraud. Discontinuous use of color provided the appearance of a more expensive polychrome silk without the associated costs.

Among various attributes, it is the errors that provide the most intimate perspective on the working lives of weavers. The work was evidently exacting, especially the process of preparing the loom. While we can only judge from surviving finished textiles, the incidence of tie-up faults shows that minor and major errors were allowed to continue throughout a textile length. Some weavers faced equipment-related problems with uneven warp tension on their looms. The task of maintaining an even warp distance and weft density was on-going. The difficulty of coordinating work between a weaver and an assistant is also obvious. Based on the study group, the overall impression is one of tedious and difficult work under time pressure with constant adjustments required to maintain the weaving process.

Conclusion

From a regional Mediterranean perspective, the transformation of silk production and consumption patterns from East to West during the first millennium represented a social and technological process of adoption, application, and adaptation. The many favorable properties of silk – smoothness, fineness, luster, dye-receptivity, durability, drape, strength, and elasticity – had an important role in shaping the textile material culture of contemporary societies. While historians generally agree on the broad outlines of this process, the conventional understanding of silk as an exclusive material confined to court use in middle Byzantine society is inconsistent with the body of evidence.

Textual and material evidence clearly show that silk at various production stages circulated widely throughout the Mediterranean and Near East region. While the material was a valuable resource to the Byzantine imperial court, it was not exclusive or confined. Apart from pattern scale and inscriptions, there are no technical features that distinguish certain figured silks as 'Byzantine' or imperial. Instead, silk represented a relative and divisible luxury that was found in many forms and was widely re-used.

Rather than continuing the practice of attributing silks to certain production centers on the basis of alleged find spots and inconsistently defined representational styles, technical groupings provide the best means of distinguishing the products of different workshops. Synthesis of textual and material evidence shows that efforts to elevate silk textiles for elite use stimulated development of new weaving technologies combined with commercial incentives to reduce work and differentiate products as a dynamic process. Considered together, the evidence suggests that weaving technology spread through initiative reproduction of figured silk samples.

The framework presented here provides the basis for an expanded study to include additional collections in a formal cross-institutional survey project. The imaging-based methodology supports identification of divided and related fragments. Specific documentation of surviving fragments provides the basis for systematic selection of certain fragments for carbon dating and dye analysis. The overall goal is to situate the material chronologically and technically for art historical re-interpretation. Considered in terms of primary written sources, technical textile studies, carbon dating, dye stuffs and representational analysis, research concerning historic silk production provides strong evidence for material culture interactions.

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