Cracking the Codex:
Exploring Medieval Bookbinding Technology Through Experimental Replication

by

Katherine D. Parks
Class of 2015

A thesis submitted to the faculty of Wesleyan University in partial fulfillment of the requirements for the Degree of Bachelor of Arts with Departmental Honors from the College of Letters
Abstract

This thesis explores the technology of medieval bookbinding through the experimental replication of several binding structures. I focus my study on eleventh and twelfth century manuscripts from England, Byzantium, and North Africa in order to understand Romanesque, Byzantine, and Islamic bindings, respectively. Based on descriptions from indirect source material and my own direct observations, I have produced three blank codices in each of the three styles, experiencing firsthand the technical processes required to bind the codex. Based on my personal experience and various historical sources, I ultimately seek to identify, interpret, and compare the functional characteristics and the culturally informed qualities embodied in the medieval binding structure.
Acknowledgements

To the College of Letters and the Lankford Fund, for supporting this thesis.

To Tom Castelli and the Exley Science Center Machine Shop, for their wisdom and assistance.

To my friends, for pushing me when I need it and pulling me back when I need to let go.

To my sister, for feigning interest when it counts.

To my parents, for giving endlessly.

To Professor Torgerson, for jumping right in and taking on this crazy project

And of course, to Michaelle Biddle, for everything. For believing in me when I had doubts, for always making the extra effort, for guiding me through these past two years; all while giving me confidence that will last throughout my life.
Table of Contents

Abstract 2
Acknowledgements 3
Table of Contents 4
Introduction 6
The Archaeology of Technology 9
The Standard View 9
A More Dynamic Approach 11
Experimental Archaeology 15
Theory and Method 15
Experimental Approaches to Codex Technology 19
The Codex 21
Development and the Coptic Tradition 21
North African Codices in the Eleventh and Twelfth Centuries 24
Byzantine Codices in the Eleventh and Twelfth Centuries 33
English Codices in the Eleventh and Twelfth Centuries 41
Preparing the Textblock 47
Writing Supports 47
Selecting a Writing Support 53
Textblock Sizing and Cultural Preference 63
SEWING 73
Determining ‘Sewing Stations’ and Pricking the Gatherings 73
Thread 84
Sewing the Textblock 89
Discussion 108
FORWARDING 112
BOARDS 112
Attaching the Boards to the Textblock 121
Creating the Spine Lining 131
ENDBANDS 136
Discussion 149
FINISHING 158
Fastenings 178
Covering Materials 158
Covering the Codex 164
Decoration 171
Discussion 182
Conclusion 185
Appendix A - Preliminary Survey of Manuscripts 186
Appendix B - Tables and Charts 187
Appendix C - List of Bookbinding Tools and Equipment 195
References 197
Introduction

As a technology, the book is like a hammer. That is to say, it is perfect: a tool ideally suited to its task. Hammers can be tweaked and varied but will never go obsolete. Even when builders pound nails by the thousand with pneumatic nail guns, every household needs a hammer.

–James Gleick

I have a confession: I judge books by their covers. This is not widely considered to be good academic practice. But think about this: how do you uncover a book’s intelligence – all of that portable, transmittable knowledge and wisdom? Anyone who has ever researched will point you to the table of contents, the index, the chapters, the commentary, etc. You know, all those words. But what about that stuff around the words like the covers, leather, and sewing?

The related fields of manuscript studies, paleography, and codicology have largely focused on understanding the medieval manuscript as a purely historical or art historical object, choosing to rely on text and illumination as the main sources of information and study. Increasingly, scholars forgo the materiality of the manuscript entirely, opting to study digitized facsimiles instead. But at what cost?

This thesis seeks explore another aspect of the medieval codex – as a site of medieval technology and culture. The development and reproduction of the codex form, the bound book with two covers and pages between, is undeniably one of the most important technological innovations in mankind’s history. To say it is the technology that allowed a thousand more technologies to come into existence is not an exaggeration.
Instead of studying the content of the book, I will be reproducing the techniques of production in order to unpack the technological choices that went into producing a medieval manuscript. The bulk of this project involves physically reconstructing manuscripts – creating my own binding facsimiles in order to best understand the complicated technical processes of sewing, attaching boards, binding in leather, etc. These volumes are not based on any historic manuscript in particular, nor will they include any text. Since I am seeking to understand how each style manuscript was assembled and bound, the blank volumes will be representative of the culturally specific mode of binding from each location.

Though I aim to apply quantifiable and objective data as often as possible, there is an undeniably subjective component to my project. However, this is not a shortcoming. When I first started this project, I made my observations as quantitative as possible. As I recorded data on the time it took to complete each step in the sequence, I also recorded data on how many cups of coffee I drank, how many times I swore. However, I have chosen not to publish this information. My reputation notwithstanding, I realized that if I used this data in my analysis, I would be reducing the experience of crafting a manuscript to pure positivism. This approach would be an injustice to medieval bookbinders. It would ignore the deeply human, and often quite humorous, experience of making something with your hands.

Christopher Clarkson (1996) has a wonderful article in which he analyzes a previously unseen type of sewing on an English manuscript. After dissecting each stitch, analyzing formal and structural characteristics, weighing the relative merits of this technique against others, and delving deep into the life history of the manuscript,
Clarkson has an epiphany – “The book has, in fact, been sewn inside out.” He concludes that the book must have been sewn together by someone who had never seen the stitch, but rather had heard of it second hand. Clarkson’s mishap absolutely reflects my own experience learning the techniques of medieval bookbinding. While not written as a travelogue or a confessional, this thesis is as much a record of my capers as it is an exploration of the intersection of technology and culture that is embedded in each and every magnificent medieval manuscript.
The Archaeology of Technology

The Standard View

According to the commonsense understanding of technology, often called the ‘Standard View’, technology is created as the necessary response to obstacles in the natural world and can only be interpreted as the purely utilitarian means by which humankind harnesses the power of nature in order to fulfill survival needs. The creation of new technologies is simply an evolutionary tactic that permits the progress of civilization. When looking at the form and stylistic qualities of a technological artifact, the Standard View argues that form always follows function. Pfaffenberger writes:

To be sure, Man decorates his tools and artifacts, but artifacts are adopted to the extent that their form shows a clear and rational relationship to the artifact’s intended function – that is, its ability to satisfy the need that was the raison d’être of the artifact’s creation. Thus, a society’s material culture becomes a physical record of its characteristic survival adaptation; material culture is the primary means by which society effects its reproduction. (1992: 494)

In this view, technology has two dimensions. The primary dimension is related to the function of the artifact. The secondary dimension is the form of the artifact. These secondary characteristics are mere decoration and are not encoded with any information that might be useful or interesting to the archaeologist.

This Standard View of technology is ostensibly problematic because it entirely neglects the role of culture in the formation of new technologies. First of all,
necessity is culturally determined. This is to say that nature alone does not create every circumstance for which there is an incontrovertible need to create a new type of technology. Rather, a society’s system of beliefs, morals, and customs determines when there is a situation for which a new technology must be invented (Pfaffenberger 1992). To illustrate his point, Pfaffenberger writes, “The natives of chilly Tierra del Fuego, after all, were content to do without clothing” (1992: 496).

The Standard View fails to account for style. Style, here, is understood to be empty formalism – decoration without substance. However, archaeologists and anthropologists both agree that style plays a critical role in cultural systems as a non-verbal process of communication (Hegmon 1992). Style is not a passive feature of artifacts. Rather, it is an active means by which people convey pertinent social information to those around them. Moreover, different kinds of style can communicate multiple layers of information. Emblematic style relies on easily readable symbolism to express information about social groups and social boundaries. Assertive style uses subtler techniques to convey information about individual identity and expression (Hegmon 1992: 523).

The greatest issue with the Standard View is that it assumes that there is only one way to solve a technological problem. It believes in an ‘ideal’ artifact (Pfeffenberger 1992: 496). This belief entirely ignores the concept of isochrestic variation. Isochrestic variation occurs when different choices on the part of the craftsman result in two different tools with the same functional end (Hegmon 1992: 522). That is, ‘There’s more than one way to skin a cat.’ Many types of tools can be designed to accomplish one goal, and despite formal variation, each tool has the same
function. Thus, the ‘Standard View’ perpetuates a false dichotomy between form and function that inhibits the archaeologist’s efforts to make sense of technological artifacts.

A More Dynamic Approach

Instead of analyzing technologies in terms of form and function, a more fruitful approach is to look at ‘technological style’. First defined by Heather Lechtman, the concept of ‘technological style’ acknowledges the external factors that influence technological choices. Citing Lechtman (1977) and Stark (1998), Sillar and Tite neatly describe technological style as:

...the idea that ‘style’ resides in every stage of a technological process, that is, in both production and use. The resulting ‘technological style’, therefore reflects the conscious and unconscious elements that together influence the technological choices. In addition, as with morphological and decorative styles, ‘technological style’ can serve a cultural function by conveying information on, for example social status and group identity.

(2000: 8)

This is to say the cultural values of a society and ideological concepts are embedded in the materials and techniques that constitute any technological choice. The notion of technological style opens up the possibility for a dynamic understanding of tools as a locus of human relations and small-scale social processes. Ultimately when archaeologists try to make sense of technologies, they are looking to understand technological style: a conservative system of production that is developed through a combination of material, cultural, and social influences.
Thus, social theory is needed to relate *technical* knowledge and action to *social* knowledge and action. Archaeologists use Pierre Bourdieu’s practice theory—“a theory of how individual social actors actually practiced living in, reproducing, and transforming the culture around them” (Johnson 2010: 108). At the heart of practice theory is the concept of *habitus*. The specific habitus of a group of individuals refers to the lifestyle and values that are embedded in the experiences of everyday life. These norms are then subconsciously reproduced by choices of individual agents, perpetuating the existing social structure. The choices of many agents represent a collective pattern, without a conscious attempt at uniformity (Crang 2009). Every technological artifact is the unique result of a series of choices between alternative techniques. It is these ‘technological choices’ that materialize the “larger cultural epistemologies, ontologies, identities, and differences” (Dobres 2000: 139).

Sillar and Tite (2000) identify five areas of technological choice. They are the *raw materials*, the *tools* used to shape the raw materials, the *energy sources* used to transform raw materials and power tools, the *techniques* of manufacture, and the *sequence* of production. Known as the *chaîne opératoire*, this sequence is more than just the ordering of the steps necessary to produce an artifact. It also concerns the techniques used, and the location of each step.

Many of these technological choices appear to be primarily influenced by the material conditions of manufacture. Sillar and Tite write, “These influence technological choice, first, via the availability of raw materials, tools, energy sources, and techniques, and, second, via the properties and performance characteristics that the options chosen possess in the procuring, processing, forming, surface treatment,
and firing” (2000: 5). These material conditions are direct influences on technological choice because they dictate the parameters of choice.

However, Sillar and Tite caution against trying to separate direct material influences from indirect cultural influences. Using the example of pottery production, they write,

...the availability of raw materials is dependent on the local environment and the technical ability of the potter to collect and process them, but it also depends on the potter’s perception of the clay as a suitable material for pottery making and the politics of who controls the resource. Similarly, choice of both temper and forming method may have some cultural significance or express some aspect of group identity or social status. More generally, ... other culturally based situational factors that can influence technological choices include the social status of the potter, the social network within which potters learn their craft, and the settlement pattern” (2000: 7)

Thus, the cultural values and ideological concepts of a society are embedded in the materials and techniques that constitute any technological choice. Material choices are made through a lens tinted by culture. In trying to understand technology, it is equally important to integrate both functional and material reasons for technological choices within the study of the larger cultural context of production and use.

To understand the relationship between *habitus* and technological choice, one might consider the creation of pottery. When a potter sits down to fashion a pot, he does not consider alternate approaches to potting. There are series of underlying assumptions about the manufacture of a pot that inform the choices of the potter. Bourdieu’s *habitus* minimizes the role of intention and planning in the actions of individuals. Rather, he favors routine, writing that actions can be, “Objectively ‘regular’ and ‘regulated’ without being in any way the product of obedience to rules, they can be collective orchestrated without being the product of the organizing action
of a conductor” (1990: 53). So, the potter, though an individual agent, acts according to a system of cultural rules. These cultural rules are thus embedded in the technological style of the community. The technological style is determined and reproduced by various technical choices.

In order to study technological choices, archaeologists seek to reconstruct the sequence of production, or the chaîne operatoire. As an analytic tool, the chaîne operatoire helps to identify and describe the material sequence of production. At each step, the archaeologist can then understand the technical choice made at and its relationship to habitus and larger social phenomena.

Though medieval book production is dictated by demands of patrons and the standards of individual workshops, habitus is embedded in these demands and the development of these standards. Dobres confirms this point:

*Among the many implications habitus has for the study of social life past or present, then, is the realization that routines (and their variations) are not meaningless and idiosyncratic noise filling up the black box of institutions and structures. Rather, the conventions tacitly and routinely performed in the everyday world of social tradition, and the variable expressions of the agency enacted during them, are the ‘stuff’ of wholesale cultural phenomena...* (2000: 139)

My project seeks to reconstruct the chaîne operatoire of medieval bookbinding. I endeavor to understand the technological choice made at each phase in the sequence. Ultimately, I seek to use my analysis of technological choices as a tool to reconstruct the larger social and cultural mores of North African, Byzantine, and English society.
Experimental Archaeology

In order to study bookbinding technology, I had two options: I could either study surviving manuscripts for evidence of technology or experiment firsthand with these very technologies. Notwithstanding the issue of access (few libraries trust undergraduates with their oldest books), I ultimately chose the experimental approach because it would allow me to experience the chaîne opéraoire of bookbinding. This way, I could evaluate the technological choices made at each step as I myself was performing that same step. Instead of relying on inference, I could use my own personal experience as an analytical and hermeneutic tool.

Theory and Method

Schiffer and Skibo defines experimental archaeology as, “the fabrication of materials, behaviors, or both in order to observe one or more processes involved in the production, use, discard, deterioration, or recovery of material culture” (1987: 18). This avenue of research, though once discredited due to its unfortunate entanglement with historical reenactment and role-playing, is now widely considered a legitimate and worthwhile academic practice. By incorporating the scientific method, experimental archaeology strives to produce repeatable, empirical data in order to support or disprove theories about the effects of human behavior on the material record.

Experimental archaeology developed as a direct response to changing attitudes towards artifact studies. Thus, a brief overview of the history of
archaeological theory is necessary to fully understand the philosophy behind the exercise. In the nineteenth and twentieth centuries, archaeologist’s generally believed that once an artifact was abandoned by a society and discovered by another may years later, all information contained in the object about past people and past ways of life was lost. This approach, known as cultural-historical theory, sought instead to classify material finds into artifact typologies in order to identify changes in object morphology. Such information was used to cobble together artifact chronologies for the relative dating of consequent archaeological finds (Renfrew and Bahn 2012).

By the mid-sixties, archaeology was moving away from cultural-historical theory and towards the goals of anthropology: to understand the social processes of humans. In 1968, a young American archaeologist named Lewis Binford introduced the New Archaeology, also known as Processual Archaeology. Unlike the culture-historical approach, which could only describe change in the archaeological record, Binford’s new theoretical approach set out to explain these changes systematically. According to Colin Renfrew and Paul Bahn, Binford and his processual archaeologists “…sought to avoid the rather vague talk the ‘influences’ of one culture upon another, but rather to analyze a culture as a system which could be broken down into subsystems. This led them to study subsistence in is own right, and technology, and the social subsystem, and the ideological subsystem, and trade and demography, and so forth, with much less emphasis on artifact typology and classification” (2012: 40). Binford and his followers strove to understand past societies not as historians or art-historians, but rather as social anthropologists.
One of the main goals of processual archaeology was to uncover general rules about human behavior that could stand up to the rigors of scientific inquiry. Using the scientific method, processual archaeologists would test hypotheses about past human behavior, making sure that their results were replicable and their conclusions could be tested further. However, due to the nature of archaeology, it is not possible to test the past from the present. Thus, ‘middle-range theory’ was developed in order to bridge the gap between the physical record and the happenings of the past.

At the heart of middle-range theory is the concept of analogy. Archaeologists use analogy in order to explain non-observed behavior by applying observed behavior. For example, ethnoarchaeology is the study of the material habits of modern societies in order to understand the material remains of ancient peoples. Binford called this type of study ‘actualistic’ because observation is taking place in the present. Archaeologists can infer from this type of research that ancient societies behaved the same as their modern counterparts. However, this type of ethnoarchaeological research is only legitimate if both past and present peoples are subjected to nearly identical circumstances.

In the instances in which ethnoarchaeology is impossible, experimental archaeology can substitute. Experimental archaeology seeks to recreate actualistic scenarios in order to understand the past. Some archaeologists argue that experimental archaeology is a better interpretive tool than ethnoarchaeology. Alan K. Outram writes, “An experimental, positivist approach can escape the shackles of simple historicism and empiricism, because it allows one to move beyond the limited range of options made available by records of the currently known world. It allows
investigation of the counter-intuitive and for the possibility of deductive leaps, rather than simply relying upon probabilistic and inductive extrapolations of existing knowledge” (2008: 1). More so than ethnoarchaeology, which can consist of passive observation in unstable environments, experimental archaeology permits controlled testing of limited variables for the collection of the most accurate data. The researcher begins with a specific question in mind and then designs the project to answer this question.

There are five general types of experiments in experimental archaeology. *Construct* experiments create scale models to test hypothetical designs for certain types of structures. *Simulation* experiments explore the formation processes of the archaeological record. *Eventuality trials* are long term experiments that test large-scale systems such as agriculture. *Technological innovation* experiments put archaeological tools into real-life use. Finally, *processes and function experiments* investigate how things were achieved in the past (Reynolds 1999: 158-62, cited in Outram 2008: 3). Processes and function experiments often fall into the category of replication and reproduction. Replication projects can range from ship construction and house building to stone and ceramic tool production. In order for experimental replication projects to be considered legitimate experimental archaeology, researchers must make every effort to be actualistic. The experiments done in the present must employ historically appropriate materials and methods (Coles 1979).

The end goal of replication is not the production of a replica or a facsimile. Toni L. Carrell writes, “The term ‘replica’ is confined to those objects that are authentic in design, manufacture, and materials, reflecting the basic criteria described
for experimental archaeology. Within this narrow working definition, however, replicas can be made only of those objects for which there is complete information” (1992: 5). The archaeologist, instead, must use experimental archaeology to answer questions where there are holes in the record. She calls replication projects “three-dimensional hypotheses,” (citing Grenier, 1992: 5).

**Experimental Approaches to Codex Technology**

As I outlined above, my thesis seeks to answer this question: how is culture embedded in the technology of medieval bookbinding? In order to answer this question, I chose to do a processes and function experiment and replicate the manuscript by recreating the *chaînes operatoires* of codex production.

I also chose to take a comparative approach and compare the *chaînes operatoires* of three unique centers of codex production – North Africa, Byzantium, and England. I decided to make three manuscripts in each style (for a total of nine individual manuscripts) in order to familiarize myself with the techniques and to ensure the repeatability of my observation. To facilitate comparison between the different styles, I made each manuscript according to a set of constant measures. Each manuscript is has a spine height of 200mm and is comprised of 20 sections of 8 pages each for a total of 160 pages per volume. These controls permitted me to directly compare the time and material resources needed for each manuscript.

As often as possible, I sought to use the most authentic materials to create my manuscripts. I describe my efforts to select appropriate supplies in great detail throughout the second part of this thesis. However, I was not able to guarantee the
authenticity of the tools I used. Though it is possible to discern bookbinding materials from existing manuscripts, there is very little written or material evidence that identifies the tools used by medieval binders. In my observations and conclusions, I strive to address the instances when discrepancies between modern and historic tools would have influenced my results.

Methodologically, I looked for material and function motivations for each technological choice before I sought a cultural explanation, by evaluating the performance characteristics at each phase in the sequence. Performance characteristics are “the specific behavioral capabilities of objects that come into play in particular interactions and activities,” (Hollenback and Schiffer 2010: 319). For codices, these performance characteristics are generally concerned with protecting the text and the facilitation of reading. Sometimes the underlying motivations of a technical choice did not result in a noticeable performance characteristic or the technical choice yielded an unsatisfactory performance characteristic that hindered the function of the codex. In these circumstances, I looked for a cultural explanation based on historical sources and informed conjecture.
The Codex

Development and the Coptic Tradition

Before discussing the codex form as it developed in different traditions, a few quick words about the history and development of the codex. The dominant writing material before the codex was the papyrus scroll. Consisting of several long sheets of papyrus pasted together, scribes would write the text in lines running parallel to the long sides of the roll. For more convenient reading, the lines of text would be divided into a series of columns, however these columns did not correspond with the papyrus sheets (Diringer 1982: 135).

Though the roll was dominant throughout the world in antiquity, there were many drawbacks to the roll format. Materially, papyrus was only grown in the Nile Delta, meaning that other nations had to rely on Egypt for writing materials. The scroll form only allowed for writing on one side of the page. In terms of readability, the scroll was difficult, as the reader would need to unroll the entire scroll to read to the end. Moreover, the roll was difficult to store after reading because of its shape (Miller 2010: 21). Often, because the size of a scroll could not be increased, one text would be written on several different scrolls.

The codex was an innovative solution to the problems associated with the scroll. Though historians are not able to pinpoint with certainty the date of its invention, the codex was certainly in use by the second century. Made up of several sheets folded together and sewn, the codex form was much more compact and
convenient to use. The number of pages could be increased at will, so the codex was more comprehensive than the scroll for longer texts (Roberts and Skeat 1983).

Papyrus was not well suited to the codex form, as it had a tendency to crack when folded, and was replaced by parchment sheets (Diringer 1982: 165). Parchment as a writing support contributed to the rise of the codex form. Parchment was more economical, as ink could be used on both sides of the page. Moreover, ink could be scraped off and removed from parchment.¹

---

1 I discuss the change from papyrus to paper in greater depth in the chapter on writing supports.

2 Interestingly enough, these are the same dimensions of an iPad mini. Coincidence?
The majority of surviving codices are from Coptic Egypt, though this does not mean that they originated there or were only used in this part of the world. As one of the earliest Christian communities, the Copts were responsible for the creation and organization of monasticism and many of the earliest codices were created for monastic libraries. The binding techniques developed in these monasteries are foundational to later binding traditions. Throughout this thesis, I reference Coptic binding techniques as a way to highlight instances of technological innovation or cultural conservatism.

Though the codex form is universally used for books today, it did not usurp the scroll immediately. The codex was certainly both a formal and technological innovation. However, rolls were considerably easier to manufacture. The Western Roman Empire never adopted the codex and continued to use the scroll form until the fall of Rome (Diringer 1982).

Scholars attribute the rise of the codex to the rapidly growing community of Christians, who quickly adopted the new form. The codex was especially convenient for the Bible, as the scroll format made it difficult to find specific passages for reference (Diringer 1982). Additionally, the codex was easier to travel with because it was more compact and required half the material of the scroll. At this time, Christianity was just taking hold and the circulation of the Gospels was critical to their early ministry (Roberts and Skeat 1983: 47). Supplementing these functional motivations, Christians may have adopted the codex form to distance themselves culturally from Judaism (Roberts and Skeat 1983). The Torah and other Jewish sacred texts were required to use the roll form. The codex physically separated the Bible
from the Torah and symbolically marked the differences between the old religion and the new religion.

While it could be said that wherever Christianity went, the codex followed, this did not preclude that fact that many other cultures and religions soon adopted the codex. By the rise of Islam in the seventh century, the codex was the dominant form for writing throughout the Arab world and was immediately adopted as the only acceptable form for the *Qur’an*.

**North African Codices in the Eleventh and Twelfth Centuries**

**Historic Overview**

North Africa, consisting of present-day Morocco, Algeria, Tunisia, and Libya, has long been the location of imperial conquest due to its strategic location along the Mediterranean Sea. Rome established its first African colony in Carthage after the Third Punic War in 146 BCE, officially establishing ties between the African continent and the Western world. In the centuries following the Punic Wars, the North African provinces were among the wealthiest regions in the Roman Empire, due in large part to the commerce of the Erythraean Sea and the granaries of the coastal plains.

During this period, many native North Africans, primarily the Berbers, converted to Christianity, which as Phillip C. Naylor notes, “represented an outstanding example of the transcultural transmission of faith” (2009: 56). However, as multiple forms of Christianity developed, including Arianism, Monophysitism, and
Donatism, the social and cultural cohesion brought on by the early Roman Empire disintegrated. Naylor suggests that these religious schisms paved the way for the arrival of Islam to the region. The North African provinces remained part of the Roman Empire until Vandals conquered the area as part of the fifth century Germanic migrations. Though the Byzantine Emperor Justinian I was briefly able to recover the region, the imperial government was not able to resist the juggernaut of expanding Islam for long (Kaegi 2010).

In the years following the death of Muhammad in 632, rapid Arab military expansion under the Umayyad Caliphate promoted the spread Islam from Mesopotamia to Egypt. Between 647 and 709, a series of three successive Muslim invasions expelled the Byzantines and brought all of North Africa under Umayyad control. Renamed the Maghreb - Arabic for ‘west’ - these military conquests connected North Africa to the Near East.

Though this time period is marked by the rapid dissemination of knowledge and technology, widespread conversion to Islam was limited (Naylor 2009). The Arab caliphs made no systematic effort to covert the native Berber tribes or push out Christian influences. Instead, many Berber solders came in touch with the teachings of Islam through their work as contracted soldiers in the Arab military. The widespread political mistreatment of Berber tribes by the Arab caliphs inspired many indigenous North Africans to adopt Islam for their own purposes. They believed that Islam was a religion of justice and equity and they sought to mobilize the Arab religion to fight the oppression of the Caliphate. These early movements were largely unsuccessful and despite small-scale tribal conflict, the Abbasid Caliphate remained
in control. However, these events initiated the blending of Berbers and Arabs through religion and foreshadowed the unification of the Maghreb of the eleventh and twelfth centuries (Abun-Nasr 1987).

**The Eleventh and Twelfth Centuries**

Up until the eleventh century, the Maghreb lacked a cohesive cultural identity, as various Arab and Berber groups fell in and out of power. Though scholars claim that North Africa during this period was a shining example of transculturalism, the geopolitical and religious divisions in the region were schismatic. Additionally, the relationship between the Maghreb and the Fatimid Caliphate was uncertain. For the most part, North Africa was ruled by local leaders with ties to Arabian nomadic chiefs (Abun-Nasr 1987). However, in the eleventh and twelfth centuries, two powerful Berber states emerged, the Almoravids and the Almohads, who transformed and unified the cultural and religious character of the Maghreb. This transformation is critical to understanding the rise of manuscript production in North Africa.

The Almoravids, the first great Maghrebi state, began as an influential Berber tribe of the Sanhaja confederation of the Western Sahara, who controlled much of the trade between the Maghreb and Ghana. The spiritual leader of Almoravids, ibn Yasin preached a strict Maliki interpretation of Islam. Central to Maliki theology is the belief that the communal life of Muslim should be governed by *shari’a* law. Thus, the first goal of ibn Yasin and his followers was to establish an organized Islamic political body (Abun-Nasr 1987: 80). However, what began as reformist religious teachings quickly developed into an ideology of conquest and domination.
Between 1055 and 1082, Almoravid power and religious influence spread across the North African coast all the way to Algeria. In a campaign against the Christians in al-Andalus, the Almoravids conquered Toledo and Valencia and dominated the region from 1090 to 1145. However, the Almoravid expansion into Spain eventually contributed to empire’s decline, as the traditionally nomadic group was unable to control a distant and far-reaching empire (Naylor 2009).

Despite the failings of the Almoravid state, their religious and cultural legacy was widespread and long lasting. The Almoravid conquests consolidated the religious beliefs of the Maghreb by establishing a lasting legacy of Malikism. They are credited with the beautification of the Maghreb, constructing numerous architectural works and mosques in the Andalusian style. However, this beautification often came in conflict with their rigid religiosity. According to Abun-Nasr, “The single minded pursuit of the moral creed of the early Almoravids began to falter as the commanders and officers in the Andalus learned to appreciate the refined life with which they were surrounded, and sought to acquire the means to cultivate it” (1987: 85). The impiety of leading officials provoked the eventual takeover by the Almohads.

The Almohads were followers of the Moroccan religious scholar Muhammad bn Abd Allah ibn Tumart, who was a vocal critic of Almoravids interpretation of *shari’a* law. Abun-Nasr writes, “Seeking to re-establish the original purity of the faith, he considered the Qur’an, the Prophetic traditions, and the practice of the Prophet’s companions as the objective material sources of the shari’a” (1987: 89). He also argued that the consensus of *sahaba*, the companions of Muhammad, was only valid source of Islamic law. His ideas gained support from the Zanata, the historic
rivals of the Sanhaja, who sought to overthrow Almoravid spiritual power. By 1160, the Almohads had successfully overcome the Almoravids and united the North African coast from Morocco to Libya to al-Andalus. However, like the Almoravids before, the empire proved to be too large for the Almohads to adequately control. By 1248, a series of defeats in al-Andalus forced the dissolution of the Almohad Empire.

The Almohads, with the help of the Almoravids, gave the Maghreb a distinct religious and cultural identity based in Islam that persists even today. As Abun-Nasr puts it,

“Through unifying the Maghreb under their rule, the Almohads gave for the first and only time a concrete historical existence to the conception of the Maghrib as a distinct religio-cultural entity. The conception crystallized in the context of the role which Islam played in transforming the political consciousness of Maghribi society. The rebellions of the Berbers against Arab rule in the name of Islam, the emergence of the Malikite scholars as the defenders of the interests of the poor and downtrodden against arbitrary rule during the ninth and tenth centuries, and the two reformist religious movements which led to the creation of the Almoravid and Almohad states all contributed towards associating legitimate political authority with Islam...” (1987: 101-102).

The cultural transformations of the eleventh and twelfth century unified the North African coast and left behind a legacy that would continued to define the Maghreb for centuries to come.

**Book Culture and Manuscript Production**

The Islamization of North Africa is critical to understanding book culture during this time. By the eleventh century, manuscript production in the Islamic world
was taking place on a scale that was unsurpassed at anywhere in the medieval world. While a monastic library in Europe at this time may have at most 100 manuscripts, the Fatimid Royal Library in Cairo held 1,600,000 manuscripts and pamphlets. Of those million and a half volumes, there were over 2,000 copies of the Qur’an – a figure that doubtless speaks to the integral role of this work to Islam (Monro 2014: 214).

The Qur’an, meaning ‘Recitation’, is the divine word of God, exactly as it was revealed to the prophet Muhammad. Since the Qur’an is understood to be the verbatim word of God, memorization and recitation of the scriptures are a critical part of worship and devotion (Nigosian 2004). The text is understood to be perfection and inimitable. Thus, the reproduction and spread of the final revelations of God were a critical component of Islamic culture.

Many Muslims at this time would have been most familiar with this text through recitation, while relatively few would have read the words in a manuscript. In intellectual circles, the preeminence of the Qur’an and its message, poetry, and laws fueled much study and debate. Though first concerned with scholarly work for religious purposes, Bosch writes, “…the widespread zest for learning, which centered in the study of the Qur’an and Traditions about the life and sayings of Muhammad and his Companions was contagious and early extended to great quantities of books of scientific research in history and geography and to a literature filled with poetry and tales of adventure,” (1981: 12). The Qur’an was both at the center of the intellectual world and the impetus for its expansion into other fields.
In the Maghreb, the religious and political changes of the Almohads invigorated the book trade in the region. Almohad caliphs were also responsible for patronizing some of the greatest thinkers of the time, such as ibn Tufayl and ibn Rushd who were advisors to the Almohad prince. Additionally, religious scholarship flourished, in large part funded by the Almohads themselves as they sought to discredit Malikite teachings and promote the Traditions of the Prophet (Abun-Nasr 1987). In the courts and among the nobility, it was fashionable to study philosophy and to focus on intellectual pursuits.

Books in the Islamic world were more than just a means to a scholarly end. The book as an object itself was a potent symbol of power. Many caliphs built extensive royal libraries and spent exorbitantly to keep authors, calligraphers, and bookbinders on staff. These libraries could contain hundreds of thousands of texts. Bosch writes, "The emphasis on numerical estimates of books in a library shows that books were displayed as material evidence of culture and position though at times they were acquired out of pure vanity (1981: 7). Manuscripts were purchased by the wealthy to fill shelves, rather than to fill minds.

There is certainly an overwhelming amount of explicit material evidence pointing to widespread consumption of texts in the Medieval Islamic world. On the production end of the book trade, however, the evidence is more implicit. We know that the men associated with the book trade were valued in their communities. Bookstores were casual and social venues, where consumers were free to browse, read, and copy works. Of the bookseller, Bosch writes, "His shop provided a meeting place for the others, and his person, often of no mean literary acumen, provided added
stimulation” (1981: 8). The wisdom of the bookstore owner contributed greatly to the popularity of his shop.

Though we know the names of many celebrated scribes and calligraphers, few sources explicitly describe bookbinders. The term for bookbinder, warraq, was often associated with all aspects of book production including calligrapher, artist, and bookstore owner. Bosch argues that through their association with the artistry of Qur’an production bookbinders were consider to be more like artists than craftsmen (1981: 10). Bookbinders may have most often been wage-earning professionals, but their trade was not unbecoming. The author of the earliest source on bookbinding, Tamim ibn al-Mu’izz ibn Badis (1031-1108 CE), was the Fatimid governor of the Zirid realm in Tunisia before the Almohad takeover. Despite the anonymity of the bookbinder, the ornamentation of the book covers has long been considered one of the most splendid features of the bound manuscript.
The Islamic binding style is a culturally conservative tradition. Despite some small local variations, most Islamic books have the same general features (Bosc 1981). One of the most obvious features of the Islamic book is a flap on the book cover. This pentagonal envelope flap is an extension of the lower cover that folds over the fore edge of the book and sits underneath the upper cover. Many Islamic bindings also have a woven endbands with a characteristic bi-color chevron pattern (Szirmai 1999: 58).

**Figure 2** - Islamic Binding Structure (Bosch and Petherbridge: 38)
Sources

There are few surviving manuscripts from North Africa during this period. The largest collection comes from the Great Mosque at Kairouan. In the 1940s, the remains of a medieval library were found in a storeroom of the Mosque. Louis Poinssot and George Marçais (1948) studied the 175 covers and published their findings, but focused primarily on the decoration.

As for primary sources, one treatise on bookbinding survives from the period, the Book of the Staff of the Scribes and Implements of the Discerning, written by al-Mu’izz ibn Badis around 1025 CE. Ibn Badis, described above, was a royal patron of the arts in Kairouan, but is also believed to have practiced the art of bookbinding himself. Other primary sources on Islamic bookbinding are more recent, but are still valuable for understanding the Islamic binding tradition; most notably, Art of Bookbinding and of Gilding (1619) written by craftsman Abu l’Abbas Ahmad ibn Muhammad al-Sufyani and Art of Bookbinding (1185-95) by Bakr al-Ishbili.

Byzantine Codices in the Eleventh and Twelfth Centuries

Historic Overview

The Byzantine Empire is said to have been formed in 330 CE when Emperor Constantine moved the seat of the Roman Empire to Constantinople. The ‘Byzantines’ themselves, as well as their contemporaries, considered the empire to be an unbroken, direct continuation of Roman rule. The emperors called themselves, as they were called by others, “Emperor of the Romans”. Under Justinian the Great in
the sixth century, the Byzantine Empire stretched west to the tip of Gibraltar, north to the Danube, and east to Asia Minor (or ‘Anatolia’ as the Byzantine called it) and Armenia. However, territory would not always be this vast. Over its thousand year history, the boundaries of the Empire were in constant flux. At any moment in history, the Byzantine Empire was composed of a wide array of vastly different landscapes and ethnic groups. This variety precluded the formation of a singular ‘Byzantine’ identity.

Despite this cultural disjointedness, Avery Cameron writes, “This empire was held together by a strong ideology based on its court and capital at Constantinople. This ideology revolved round two axes: the imperial power and the Orthodox religion” (2006: 12). When the Western Roman Empire was eclipsed, the Eastern Roman, or Byzantine Empire saw itself as the continuation of that legacy: besides continuing to refer to their empire as the Roman Empire, the Byzantines inherited systems of imperial bureaucracy and tax collection that underwrote the fullt functioning imperial state (Cameron 2006: 6).

The Byzantines viewed the Emperor as the messenger of Christ and thus, the power of the imperial state was entirely entangled with that of the Orthodox Christian Church, also centered on Constantinople. However, the Code of Justinian did not define the role of the Emperor in church affairs, nor was it ever clear how far the influence of the Church extended into imperial affairs.

Monasticism was a central feature of Byzantine religious culture. Byzantine monasteries were often founded by aristocratic families, but experienced a great deal of diversity in their religious customs and lifestyles (Gregory 2010). There is
evidence of a thriving manuscript culture in these monasteries, which survives to a better degree than for the state or the patriarchate. Many had substantial collections of Classical and religious texts in their libraries and were active centers of manuscript copying.

The Eleventh and Twelfth Centuries

After a period of expansion and prosperity under the Macedonian Dynasty (867-1054), the Byzantine Empire underwent a period of political turmoil, which scholars long considered to be the beginning of the decline of the empire. The Byzantines’ defeat at the Battle of Mantzikert in 1071 to the Seljuk Turks resulted in the loss of Anatolia and has often been attributed to a decline of the military in the decades after the Macedonian era.

After a decade of civil war, Alexios Komnenos rose to power in 1081. After providing military assistance to the Christians during the First Crusade (1098-1099), Alexios was able to recapture much of Anatolia. Additionally, he opened up trade with the Venetians, which stimulated greater production and income. The military victories of Alexios’ son John II Komnenos helped to regain even more of Asia Minor.

John’s successor, his fourth son Manuel, was restored the reputation of the empire and dedicated his reign to building up foreign policy. His alliances with the Pope and kingdoms in Western Europe allowed the Second Crusade to pass through Byzantium with minimal damage. However, Manuel’s attention to foreign affairs in the west is said to have left him blind to the rise of the Turks in the east. In 1176 the
Byzantines suffered yet another devastating loss to the Turks at the Battle of Myroikephalon, after which the empire would never fully regain Anatolia.

Andronikos I Komnenos, the estranged cousin of Manuel I, took to the throne in 1181. He set out to fix corruption and curtail the power of the aristocracy. However, he was soon killed by an angry mob after the loss of Thessaloniki to the Normans in 1185. After the death of the final Komnenoi emperor, the Angelos family came into power. At this point however, the central authority of the state had all but collapsed and largely fell into the hands of local tyrants (Gregory 2010).

The Fourth Crusade marked a sudden point of no return for the Byzantine Empire. Pope Innocent III proclaimed the Fourth Crusade in 1202 with the intention of conquering Muslim-controlled Jerusalem. However, the Normans and especially the Venetians had their sights set on conquering Constantinople (Gregory 2010: 325). Unaware of these undercurrents, the Byzantine prince Alexios IV Angelos met with the Pope and the Crusaders to negotiate the reinstatement of his exiled father, Isaac II. The Crusaders agreed that they would divert to Constantinople to reestablish Isaac and then continue on to Jerusalem with the assistance and resources of the Byzantine military.

Once in power, however, Alexios and his father could not gather the resources to fulfill his end of the agreement. The citizens of Constantinople joined in uprising in 1204, leading to the death of Alexios IV and the imprisonment of Isaac II. Alexios V Doukas ascended to the throne and attempted to fight back against the Crusaders, to no avail. On April 12, 1204, the Crusaders entered Constantinople and violently sacked the city, resulting in the destruction of thousands of manuscripts and valued
works of art. In the wake of the fall of Constantinople, Western leaders divided up the Byzantine territory, effectively the fall of the empire.

Despite the political and military turmoil of the period, life actually improved economically and socially. Warring remained mainly around the outskirts of the empire, so life on the interior core of coastal Asia Minor and the Eastern Balkan seaboard was, for the most part, peaceful. The economy flourished, due in equal parts to Venetian trading and a growth in the wealth of the countryside (Gregory 2010: 313). Though most of the rural population was comprised of tenant farmers for landed aristocracy, the inability of Constantinople to collect taxes greatly contributed to peasant prosperity.

**Book Culture and Manuscript Production**

This period was marked by an increased desire for texts outside of the monastic context. The greatest beneficiaries of this economic expansion were the aristocracy of Constantinople, who often devoted their new wealth to intellectual pursuits. The wealth of the aristocracy provoked a boom in the production of architectural and artistic works. This period was marked by the rise of what has been called ‘family individualism’ and as such, there was a renewed interest in the classical tradition. In literature, there was less focus on the pagan traditions of antiquity, but instead can be attributed with an increased demand for the copying of classical works (Gregory 2010).

Byzantine society placed great importance on the ability to write. Education was encouraged for the leaders of the government and church so that they would be
able to sign their names and draft their own documents (Wilson 1975). During this time period, most teaching was still done by private teachers, but new institutions of higher learning sponsored by the state slowly started to emerge (Gregory 2010: 122). The imperial government established new university posts in law, rhetoric, and philosophy (Cameron 2006). These intellectuals all relied on texts for their studies.

There was clearly a demand for books in the Byzantine Empire during this time, but there is little evidence to support that this demand was ever adequately met. Book production at this time was limited to monasteries. Each monastery had a few books and some even had quite expansive libraries of religious and classical works. Though Byzantine monasteries were not great centers of learning like they would be in Western Europe, monks were required to read when they were not completing manual labor (Wilson 1975) (Jeffries 2008). As such, Byzantine monasteries were responsible for copying texts on a considerable scale (Jeffries 2008).

There was very little book production outside of the monastery at this time. There were few lay calligraphers and the majority worked as professional notaries, not manuscript copyists (Wilson 1975: 9). However, there is evidence of professional scribes in the monasteries who took commissions from the public (Lowden 2008: 465). Byzantine monasteries could also be large-scale lenders of manuscripts, which would have allowed scholars to copy their own texts if they could find the parchment.

Parchment in the Byzantine Empire was extremely difficult to come by, due to a widespread shortage of materials. Parchment was made from the skins of animals slaughtered for food, so the availability of writing materials depended on the meat supply. Lowden notes that during Lent, parchment was almost impossible to find
Moreover, there were few parchment producers. The *Book of the Eparch* does not identify a parchment-makers guild, which suggests that there were not enough to constitute a guild or that tanners produced both leathers and parchments (Wilson 1975: 1). The price of parchment was so high that very few of even the wealthiest Byzantines were able to support personal libraries (Wilson 1975).

Nigel Wilson sums up the state of manuscript production in the Byzantine Empire best. He writes, “This is one area in which the old fashioned idea of Byzantium as an age of decline has some justification. But it can at least be said that the decline was not of the Byzantines’ own choice; they valued education as much as did their [Roman] predecessors, but economic circumstances prevented the circulation of books to many who would have liked to read them” (Wilson 1975: 14). Despite these material constraints, the economic and social conditions of Constantinople in the eleventh and twelfth century allowed book culture and manuscript production to flourish.

*Characteristics of Byzantine Style*

Because the borders of the Byzantine Empire shifted so frequently, the Byzantine bookbinding tradition was practiced in many nearby territories, including Georgia, Syria, Cyprus, Crete, Greece, Russia, the Balkans, Egypt, and St. Catherine’s monastery on Mount Sinai (Szirmai 1999: 62). Additionally, the tradition well outlived the Byzantine Empire. Books continued to be made in the Byzantine style centuries after the fall of Constantinople in 1453. Therefore, when I discuss the
‘Byzantine’ binding, I am referring to a specific typology based on structural features, rather than provenance or dating.

Byzantine bindings are most readily identified by their large endbands, which extend past the head and the tail of the textblock and are sewn onto the edges of the book cover. Additionally, Byzantine bindings have a smooth spine, peg and strap fastenings, and wooden boards with grooved edges.

**Sources**

There are no written sources that describe bookbinding in the Byzantine Empire and very few manuscripts survive from Byzantium due to the destruction of religious texts after the fall of the empire and rampant neglect by librarians. Additionally, many Byzantine texts were rebound centuries later and do not retain
their original covers. Frederici and Houlis (1988) conducted an extensive survey of the Byzantine bindings in the Vatican Library, yet only 94 of the 4700 Greek manuscripts maintain their original binding. Nevertheless, the Frederici and Houlis study is by far the most comprehensive. Szirmai (1999) did his own study of 20 Byzantine bindings. Other sources include Berthe van Regemorter’s (1992a; 1992b) studies of Greek bindings and Guy Petherbridge’s (1991) study of the bindings of 160 codices from the Patmos Monastery of St. John the Theologian.

English Codices in the Eleventh and Twelfth Centuries

Historic Overview

After Rome withdrew from England in the fifth century, the Anglo-Saxon Germanic tribe migrated from the European continent and settled in what is now known as Britain. From 450 to 600 CE, Anglo-Saxons came in droves and organized themselves into kingdoms: Sussex, Wessex, Northumbria, Mercia, East Anglia, and Kent (Sommerville: 2). These kingdoms, with their well-defined structure of authority, taxation, and coinage allowed the new residents of England to quickly establish settled life (Clanchy 2014).

In the seventh century, nearly all of England had converted to Christianity, in large part due to missionaries sent from Rome by Pope Gregory I the Great (Sommerville: 3). The English Church quickly aligned themselves with the papacy and in 669, the Pope appointed Greek monk Theodore of Tarsus as Archbishop of
Canterbury. Both Theodore and Wilfrid, Bishop of York, encouraged the establishment of monasteries. These early monasteries could either be local religious centers or isolated contemplative communities (Blair 2005).

In the late tenth century, English monasticism underwent a series of changes known as the Benedictine reforms. In the eighth and ninth centuries, monastic life in England was in decline. No longer staffed by monks, most pastoral monasteries were managed by clerks, who were often married with children. Inspired by the Cluniac Reforms in continental Europe, the Archbishop of Canterbury, the Bishop of Winchester, the Archbishop of York, and the Bishop of Worcester called upon English monasteries to adopt the Rule of Saint Benedict, a fifth century Italian monk and Christian saint. He is often regarded as the founder of Western monasticism. The Rule of Saint Benedict organized the day into a schedule of prayer, rest, manual labor, and reading. Thus, these revitalized monasteries had a great need for texts and became the dominant producers of manuscripts in England.

**The Eleventh and Twelfth Centuries**

In 1066, Duke William II of Normandy invaded England in order to claim the throne left behind by Edward the Confessor. The Norman invasion marked the end of the Anglo-Saxon era and the beginning of the overseas domination of political and cultural life. The Normans considered themselves to be a very religious people. William the Conqueror had strong ties to the papacy and as such, instituted a massive restructuring of the Anglo-Saxon religious hierarchy, replacing high-ranking English
clergy with Norman imports. William named Lanfranc, a French abbot, as Archbishop of Canterbury.

Lanfranc’s greatest legacy in England was the institution of Gregorian reform. In addition to granting divine charge to the Pope, the Gregorian reform required all clergy to live the according to the monastic rules of religious perfection. During this period, the number of monasteries in England exploded, growing from 1000 to 5000. Increasingly, these houses organized into orders such as the Cistercians and the Cluniacs (Clanchy 2014: 77). For the most part, these new orders were staffed by members of the aristocracy, who often donated their personal collections of manuscripts to the monastic library.

In the twelfth century, England experienced what is now known as the Twelfth Century Renaissance. This period was marked by a revitalization of intellectual life and a renewal in creativity and craft expertise. This intellectual renaissance contributed to an outpouring of new texts and commentaries. The great writers and thinkers of the twelfth century were largely ambivalent to the Classics. Instead, they ascribed primacy to their own culture and dedicated their attention to philosophical and scientific works (Clancy 2014).

**Book Production**

Nearly all book production took place in the monasteries. Diringer writes,

> “The Christian monasteries were the main book producers of the Middle Ages. With the din of arms around him, it was the monk who, by preserving and, especially, transcribing ancient manuscripts, both Christian and – although to a much lesser degree – pagan, as well as
by recording in writing his observations on contemporary events was handing down the torch of knowledge to future generations.” (1983: 206).

This was certainly true in England. Before the Normans, monks were responsible for educating the laity and would copy texts in both Latin and the vernacular English, leading to the codification of Old English. After the Normans, the schools moved out of the monasteries and aristocratic learned men moved in, bringing along their own manuscripts for scribes to copy (Burton 1994).

The Rule of Saint Benedict greatly increased the need for texts, as monks were meant to spend a portion of each day in quiet study. Often monks would spend years on a single text, ruminating over the pages. English monastic libraries were paltry by modern standards. The largest collection of manuscripts was held at Durham and was no greater than 550 volumes in the twelfth century (Burton 1994).

The rise of universities at the end of the twelfth century changed the nature of book production in Europe. Students and scholars required more texts than were available and monastic scriptoria could not keep up with the demand. Around 1100, many monasteries were forced to hire professional scribes and illuminations to increase manuscript output. By the mid-twelfth century, scribes and illuminators set up their own businesses in urban centers, effectively marking the birth of commercial book production in England and Europe (Burton 1994).
Characteristics of Romanesque Style

Figure 4 - Covered Romanesque Manuscript (Clarkson 1993: 148)

Romanesque bindings are sewn on raised bands, called sewing supports. This technique requires the binder to use the sewing frame – a twelfth century invention. In addition to the sewing, the Romanesque binding has spine tab endbands, which extend off of the head and tail of the textblock. English bindings in particular categorically use quarter-sawn oak for their book boards. The boards are attached using a sophisticated system of carved tunnels.

Sources

Most early studies of Romanesque bindings paid attention to the decoration only. However, Szirmai (1999) and Christopher Clarkson (1993) offer the most compelling surveys of Romanesque manuscripts. Szimai looks at Romanesque
bindings from all of Europe, whereas Clarkson focuses specifically on bindings of English origin.
Preparing the Textblock

Before the manuscript could be passed into the hands of a scribe or bookbinder, a number of choices needed to be made regarding the material, shape, and size of the textblock. The textblock is the folded sheets that make up the body of a book. The pages of the textblock are also known as the writing supports.

Writing Supports

During the eleventh and twelfth centuries, the technology of bookbinding was changing. The growth of papermaking threatened to overtake the long-established dominance of parchment as the main material for writing. Technologically, paper was easier and more efficient to make than parchment. Economically, paper was cheaper and less labor intensive. Yet, only the Muslim world and parts of the Byzantine Empire were willing to incorporate the new technology. Nearly all of Western Europe refused to forego parchment until well into the fifteenth century. Why was the adoption of paper so uneven in the medieval world when the advantages of the new technology seem so obvious?

Nearly one thousand years earlier, the technology of writing had experienced a similar shift. As far as we can understand it, this shift, however, occurred for purely functional reasons. By the second century, parchment replaced papyrus as the preferred writing material in the ancient Mediterranean world (Clemens & Graham 2007: 9), which necessitated the replacement of the scroll with the codex. As the codex usurped the scroll form, parchment was deemed more suitable than papyrus.
because of its durability and resistance to tearing at the spine folds (B. 1999). Roberts and Skeat write, “…even the strongest supporters of papyrus would not deny that parchment of good quality is the finest writing material ever devised by man. It is immensely strong, remains flexible indefinitely under normal conditions, does not deteriorate with age, and possesses a smooth even surface which is both pleasant to the eye and provides unlimited scope for the finest writing and illumination” (1983: 8). Moreover, the production of parchment was not limited to one region, unlike papyrus, which could only be grown in Egypt. Parchment was almost universally deemed to be the superior writing support and subsequently replaced papyrus because of its material advantage.

When we discuss the diffusion of papermaking technology, we are discussing an entirely different phenomenon. The paper codex was not a fundamentally different technology, such that it required an entirely new form of construction. Paper and parchment were equally well suited for the codex form. Thus, we might legitimately turn the previous question on its head and ask: why was the Muslim world so quick to adopt paper? And, why Europe and the Byzantine Empire might have been wary of the new material?

**Parchment**

According to Raymond Clemens and Timothy Graham, “Parchment is literally the substrate upon which virtually all knowledge of the Middle Ages has been transmitted to us” (2007: 9). Much has been written on the subject of parchment, as
knowledge of its subtleties can provide valuable information in order to establish date, provenance, and the authenticity of the manuscript and text.

Parchment, made from dried animal skins, was first developed in the kingdom of Pergamon around 300 BCE in order to counter the Egyptian embargo on papyrus export to this burgeoning center of intellectual life (Meyer 2013: 93). Though some scholars use the terms parchment and *vellum* interchangeably, *vellum* technically refers only to calfskin parchment and not simply high quality parchment (Clemens & Graham 2007: 9). In this study, I use “parchment” to refer to all qualities of writing material made from dried animal skin.

Parchment and leather are made from the same type of skin (usually calf, sheep, or goat), but the vastly different methods of preparation result in structurally, visually, and microscopically different types of materials (Reed 1972: 118) (Clemens & Graham 2007: 9). Skins that become parchments and leathers must first be dehaired, by soaking the skin in a solution of water and lime (Meyer 2013: 94). After removing as much hair from the skins with their hands, the tanner *scuds* the skin, scraping off the remaining hair with a curved, two-handled blade (Clemens & Graham 2007: 10).

At this point in the process, the tanner decides whether the skin will become leather or parchment. Skins that are to become leather are tanned or tawed with various chemicals. Skins that are to become parchment are stretched on a frame and left to dry (Clemens & Graham 2007: 10). Because animal pelts naturally shrink as they dry, the process of drying the skin under tension actually changes the character of the collagen fibers in the skin (Reed 1972: 121). Animal skins are composed of a
complex network of fibers held together by chemical polymer bonds. Whereas leather and untreated skins have a complex and randomized arrangement of fibers, parchment has a very flattened fiber arrangement (Reed 1972: 122). The flat arrangement of the fibers in a network of parallel layers becomes permanent as the skin dries (Clemens & Graham 2007: 11).

In order to remove any last bits of hair, the tanner uses a curved knife to gently scrape (Clemens & Graham 2007: 11). Once the skin is completely dry, it is sanded on both sides to make thinner sheets with a smooth surface for writing (Meyer 2013: 95). However, despite these efforts to give both sides of the skin an even and consistent finish, there was often a marked difference between the hair-side of the skin and the flesh-side of the skin. The hair-side of the skin tends to be slick and shiny, with a noticeable pattern of hair follicle marks. The flesh-side has a velvety texture, similar to suede, and does not have follicle marking. The final step in making parchment is removing the skin from the frame and cutting it into sheets. According to Clemens & Graham (2007: 11), an average-size calfskin would only yield three and a half medium-sized sheets (so, three bifolia and one single leaf) of parchment. The tanner would need to produce many, many skins of parchment in order to fulfill the demands of just one manuscript.

Paper

Though knowledge of paper has been documented in parts of the Arab world as early as 650 CE, there seems to have been no knowledge of papermaking until the battle of Talas in 751 CE when the Arabs conquered the Chinese at Samarquand
(Bosch and Petherbridge 1981: 26). First chronicled by the Arab historian Thaalibi in the popular *Book of Curious and Entertaining Information*, the author claims that prisoners from the Chinese base at Samarquand taught their Arab conquerors how to make paper after the fall of Talas by the forces of Abbasid Caliphate from Baghdad.

Contemporary Chinese sources challenge the details of Thaalibi’s account, leading many scholars to believe that the story of Talas is more myth than history. The ancient city of Talas was an important site for Silk Road traders and in 751 CE it was the westernmost point of China’s rule under the Tang Dynasty. Jonathan Bloom (2001) argues that Muslim writers may have chosen to perpetuate this legend simply because Chinese paper was considered to be especially fine. If anything, the legend of Talas gives heroic origins to the craft of Arab papermaking.

Despite the inaccuracy of the Talas legend, paper was indeed present in surrounding provinces decades before the capture of Talas. Al-Nadim, a tenth century author from Baghdad, writes, “…some say [paper] appeared in the days of the Umayyads, while others say it was during the Abbasid regime. Some say that it is an ancient product and others say it is recent. It is stated that craftsmen from China made it in Khurasan (a neighboring province) in the form of Chinese paper” (cited in Bloom 2001: 44).

The earliest account of papermaking and the only account to survive from the Arab world comes from a document written by an Algerian prince Tamim ibn al-Muiz ibn Badis. His eleventh century treatise *Staff of the Scribes and the Implements of the Discerning* details the manufacture of paper, from flax to fiber to flat sheet.

*The best white flax is purified from its reed. It is moistened and combed until it softens. Then it is soaked in a quicklime a night until morning. It is then*
rubbed with the hands and spread out in the sun until all of it dries in the daylight. … When the quicklime is gone out from it, then it is pounded in a mortar very finely while it is moist. Then, nothing will be left of the lumps. Other water is put on it in a clean vessel. It is dissolved until it reaches a silky viscosity. Then it is introduced into the molds in the desired size. These are made from the straw used for baskets, mails, and the walls are collapsible. Under it is an empty rib. The flax is beaten with the hand vigorously until it is mixed. Then it is thrown with the hand flat in the mold so that it will not be thick in one place and thin in another. When it is evened, then its water dries away. It is found proper in its mold. When the desired is attained, it is adjusted on a flat tablet. Then it is bound to a wall and straightened with the hand. It is left to dry. It separates and falls off. (ibn Badis, cited in Bosch and Petherbridge 1981: 28).

Bloom (2001) questions the accuracy of ibn Badis’s treatise because it does not mention the use of rags, instead describing the outdated method of using exclusively virgin fibers. Though ibn Badis claims that virgin fibers were preferred, rags continued to be used as the primary source of fibers well into the era of European papermaking. Bosch and Petherbridge’s findings give credence to Bloom’s doubts, asserting that the linen and hemp fibers came to the paper mill as rags and cordage, respectively (1981: 28).

Of course there was variety in medieval paper-making, and the use of paper was not only limited to the Islamic world. For instance, in Muslim Spain, paper was made much the same way because of the penninsular Islamic heritage. According to Bloom (2007: 206), both the Muslims and Christians of the Iberian Peninsula was quick to adopt papermaking because of the, “…sharing of material and technical culture under the Umayyad caliphate.” Spanish paper was noted for its irregular laid lines – a result of weak, unstable molds (Bloom 2007: 206).
According to Bloom, “Just as the spread of Islam in the seventh century was unprecedented in human history, so the introduction of paper and papermaking across the Islamic lands was a remarkable historical and technological achievement that transformed society in its wake” (2001: 47). Ultimately it was the decision of the Abbasid Caliphate to use paper for official government documents that lead to its widespread acceptance across all Islamic lands. The art of papermaking would spread from the Islamic world, up the Iberian Peninsula, and into Europe over the course of several centuries (Bloom 2001: 47).

Selecting a Writing Support

*Selecting an appropriate writing support for a twelfth-century North African codex*

Despite paper’s popularity across the Islamic diaspora, scribes in North Africa continued to prefer parchment, as the provinces of Ifriqiya in modern-day Tunisia were major centers of leather and parchment manufacture and sheep raising remained one of the more popular occupations. Though parchment was most often made from the skins of goats and sheep, the skins of wild animals were also used. Bosch and Petherbridge note that Islamic parchment tends to be “very supple with a wonderful velvety white color” (1981: 25).

Though parchment was used in North Africa until the fifteenth century, papermaking in the Maghreb took place as early as the eleventh century (Bloom 2001). By the second half of the tenth century, paper could be found in Tunis, Tlemcen, Ceuta, and Fez (Bosch and Petherbridge 1981: 30). By the end of the
twelfth century, the city of Fez boasted 472 paper mills, due in large part to the industrial power provided by the stream flowing through the city center (Bloom 2001). Though the Maghreb was initially slow to wholeheartedly adopt paper, Bloom claims that this region was responsible for the introduction of papermaking technology to Europe, due to its proximity to the Iberian Peninsula.

Generally speaking, Islamic papers are often characterized by the prominent chain lines left behind by the papermaking molds. They are also noted for their somewhat unrefined quality. Traditional Islamic papers tend to have many inclusions, a result of the pulp being poorly beaten. In my research I noticed that in normal lighting the long fibers, clumps of pulp matter, and bubbles from heated water were obvious. When I held a piece of medieval Islamic paper from OR MS 4 at Trinity College up to a light source, the paper appeared cloudy, with some areas somewhat thinner or thicker than the others.

Islamic papermakers did not use watermarks to identify their papers. However, Spanish papers from Valencia would use a brush or pointed tool to make zigzag marks on the moist pages of freshly made paper. Though not true watermarks, these characteristic marks were used from the twelfth to fourteenth centuries and may imitate the knife marks of parchment makers. These papers are found in manuscripts across North Africa, a testament to the close trade relationship between Spain and the Maghreb (Bosch and Petherbridge 1981: 30). Spanish paper was especially popular among scribes in the Maghreb for its heavy weight, bright white color and smooth, glossy finish (Bloom 2001).
Colored papers were very popular in North Africa for apparently practical, more than aesthetic, reasons. Ninth century author Simi of Nishapur writes in his *Treatise on Calligraphic Arts: A Disquisition on Paper, Colors, Inks, and Pens*, “It is better to give paper a slight tint because white is hard on the eyes…” (cited in Thackston. 1990: 219). This it not to say that there are no culturally embedded reasons for these preferences. Simi asserts that dyed paper is also elegant; even though it is no longer correct to use dyed paper for correspondence with sultans and nobles. “However, among friends and acquaintances any amount of ornamentation is all right,” (1990: 222).

Simi’s treatise provides his readers with an authentic recipe book for dyeing papers in any number of colors from a handful of natural materials. Based on the method of preparation, it is possible to yield yellow, rose, black, and orange papers using saffron. Copper leaf and vinegar give paper a verdigris hue. Blue paper can come from either indigo or blue flowers, but flowers tend to result in more purplish pages. The more difficult colors like light red require several treatments of safflower, sal ammoniac (a rare mineral salt), and sour apricot juice. Level, Krek, and Haddad (1956) argue that Simi’s dyeing techniques are not recent innovations. Rather, these methods are the result of thousands of years of tradition, dating back to at least Ancient Mesopotamia, where Sumerian tablets have been found detailing similar dyeing recipes.

After scouring the catalogues of paper distributors, I could only find one mill that continues to hand-make papers in the traditional Islamic way. The Khadi paper mill, based in India, uses traditional hemp fibers from rags in order to make their
Sunn Hemp paper. This type of paper is handcrafted by Mahomed Hussain Kagzi using a grass-stem screen and natural plant dyes. In order to achieve an even surface for writing, the papermaker burnishes each sheet with a stone. While this paper would have made an excellent substitution for authentic Islamic North African paper, the cost of importing handmade, artisanal paper from India greatly exceeded the extent of my research grant.

In lieu of authentic Islamic paper produced using medieval techniques, I choose a material that shared the structural qualities of medieval Islamic paper rather than a mere visual resemblance. As the focus of my project is binding rather than illumination or calligraphy, I feel that these qualities provide the most accurate representation of what it may have been like to handle and sew a North African Islamic book. A lightweight cream paper was generously donated by the Olin Library Book Preservation Lab. I chose this paper because it was the most similar to medieval Islamic paper in the key qualities of opacity, texture, and thickness.

Though this paper is machine-made, it still retains many of the qualities of Islamic handmade paper. When held up to the light, it is possible to see the cloudy, uneven texture of the pulp. This is a quality shared by many Islamic papers, as the rag fibers were often not adequately pulped before being placed in the molds. The paper has a smooth, not-quite glossy finish - much like a stone-burnished surface. The neutral, yellowy color prevents glare from the bright sun and I imagine it would dye nicely. Unfortunately, there are no chain-lines or fiber inclusions, which would make it a particularly authentic representation of the kind of paper produced in Islamic
North Africa. Though these aesthetic qualities did not affect my experience binding with the paper, the reader may wish to acknowledge this discrepancy.

**Selecting an appropriate writing support for a twelfth-century Byzantine codex**

It might come as a surprise that there is evidence of paper usage in the Byzantine Empire during this time period. Nicolas Oikonomides suggests that paper was used in Byzantium as early as the ninth or tenth century and that paper manuscripts can be found from as early as the eleventh century (2002: 590). Byzantine paper was known as *bombicine* or *bombikinon* and had a light brown color, shiny surface, and no watermarks (Lowden 2008: 464). Nevertheless, it seems that during the eleventh and twelfth centuries Byzantines used paper mainly for administrative documents.

Though the type of animal is usually difficult to discern, the pages of most Byzantine manuscripts were made of parchment (Szirmai 1999: 64). Goat was used to make parchment in Greece up until the eleventh century (Reed 1972). In my research, I observed that the parchment used in the Byzantine bindings (Trinity MS 1, Beinecke MS 237, Beinecke MS 267) was markedly thinner and more translucent than the parchment I found in English manuscripts (Beinecke MS 590, Marston MS 219, Beinecke MS 322). The parchment I saw had a very even finish and was almost entirely free of follicle marks. Though the sewing had a tendency to pucker the folds of each gathering, this parchment appeared to be very resilient and difficult to tear.

According to Vilena Kiryeva’s study of Byzantine parchment under an electron microscope, medieval parchment makers from Greece coated both sides of the
finished pages in an egg white and linseed oil mixture in order to give the pages a
glossy finish (Kiryeva 1999). This would account for the smooth, even finish I
observed.

For this project, it was unreasonable and, in my view, unethical to use animal
parchment. To recreate the six complete manuscripts on parchment, I would have
needed 275 skins. I chose instead to use a paper that shared many of the same
qualities as parchment. Much like with the Islamic book, I made my choices not
based on visual similarity, but rather tangible characteristics that would influence my
experience binding.

For both the Byzantine codex book, I used a heavyweight book paper from
Zerkall, a German paper mill. I chose to use the cream-color with a vellum finish in
the 140gsm weight. I was immediately drawn to this paper because it had a hair-side
and a flesh-side finish. The “hair”-side is smooth, while the “flesh”-side has a toothy
texture. This unexpected feature nicely mimics the visual and tactile experience of
true animal parchment.

The cream color of the paper is similar to the yellowy color of sheepskin
parchment, as it is usually only calfskin that produces the smooth, creamy color of
finer parchments and vellums (Clemens & Graham 2007: 9). I wanted to create a
book that reflected the qualities of an average workaday manuscript, so I chose to
emulate what is colloquially referred to as ‘cheap sheep’. Such parchment tends to be
slightly translucent, which unfortunately this paper is not.

The paper I have used is incredibly robust. It has a thickness of 0.22mm and is
much stiffer than an average sheet of copy paper. The pages do not fold easily and I
found it challenging to poke my needle through without pricking with an awl first. My largest complaint was how easily the fibers of the paper separated. On many occasions, I would accidently drag my needle across the page and I would skin off the top layer of paper. True parchment is very dense and firm, so it is not as easily damaged by such a careless needle scrape. Fortunately, because the books were bound with blank pages, I never damaged any text or illumination.

*Selecting an appropriate writing-support for a twelfth-century Romanesque codex*

The textblock of a Romanesque manuscript was always made of parchment. A large majority of this parchment is calfskin, though the distinction between different species of animals is not always obvious (Szirmai 1999: 142). Though, as I have mentioned, paper was known in Europe during this time period, it was not widely used. The earliest surviving paper on the continent dates to the twelfth century, though the origin of manufacture is unknown (Clemens & Graham 2007: 6). Though there were paper mills in both Christian and Muslim Spain by the eleventh century, it is likely that this paper was imported from somewhere in the Arab world (Bloom 2001: 206). Most scribes were unwilling to use paper because the quality was far inferior to parchment, even though paper was less expensive. It was not until the invention of the printing press and movable type in the fifteenth century that paper became the dominant material for books (Bloom 2001: 213).

Nicholas Hadgraft (1998) believes that Romanesque manuscripts represent the pinnacle of bookbinding technique: binders were highly adept at managing parchment
because they were heirs to a tradition that had worked exclusively with this medium for centuries. He writes, “The Romanesque binder was fundamentally at home with the material having dealt with nothing else, and he came to it with the full knowledge of its hygroscopic nature, of its irregularities, of its natural features and so on” (1998: 47). Hadgraft maintains that in order to produce a well-structured binding, it is critical to understand the intricacies of the textblock. His assessment is reflected in the technical choices made by Romanesque bookbinders. Everything from the weight of the boards to the clasps around the fore-edge were designed to compress the manuscript in order to prevent the parchment from swelling and warping over time with changes in humidity.

I used the same kind of paper for the Romanesque codex as I did for the Byzantine codex. As I mentioned above, Byzantine parchment was often glossy because of an egg white glaze applied to the fresh skins. However, this difference in surface texture would not cause a significant change in the thickness or strength of the material. I observed that the English parchment tended to be slightly thicker than the Byzantine parchment, but I did not find any sources that corroborated my findings. I surmise that my observation may have been biased due to my exceedingly small sample size.

Discussion: comparing technological choices

The contemporary twenty-first century world, is experiencing an analogous shift in the technology of writing supports, as digital media threatens to overtake print media. E-book technology is to paper as paper was to parchment: easier to produce,
cheaper to access, more environmentally friendly, and a more efficient means of transmitting knowledge.

However, just as parchment had its holdouts, so too does paper. According to Jeffrey R. Di Leo, the printed book remains the medium of academia, as many claim digital scholarship promotes plagiarism or that digital publications are less permanent than print. He writes,

*The real difference – the real reason that academe has been slow to embrace digitization – is cultural not material: an attitude rooted in the belief that the printed book is intrinsic to scholarship. ...they believe that the comfortable manner in which readers approach a paper-and-ink object is fundamentally different from the attitude they bring to a digital copy. These attitudes are the products of cultural conditioning and habit." (Di Leo 2010).

This attitude in response to the possibility of change in the material culture of the transmission of knowledge may be similar to that of eleventh and twelfth century Anglo-Normans and Byzantines towards parchment. The English considered paper to be vulgar because of its negative association with Islam. Additionally, parchment came to symbolize the body of Christ, upon which the word of God was written (Ellis 2013: 135). To replace parchment with paper would mean losing this rich layer of meaning in the very materiality of the Gospels and other religious texts.

In the Byzantine world, the choice of parchment for manuscripts is curious. As discussed above (page 42), there was a significant parchment shortage in the Byzantine Empire that drastically limited the copying and transmission of texts. Paper, only other hand, was widely available and was sold at nearly half the price of parchment (Oikonomides 2002: 590). However, Wilson suggests that the Byzantine
Bombicine paper was far inferior in quality and durability and was thus an unsuitable replacement for parchment (1975: 3).

In an analysis of the economic history of Byzantine writing materials, Oikonomides (2002) found that there were some manuscripts with leaves of both parchment and paper. This choice combines the performance characteristics of each material - the strength of parchment with the economy of paper. The combination of paper and parchment would not be considered a technological innovation because it did not result in any improvement. Rather, this choice can be understood as a technological compromise based on the surrounding social conditions. Schiffer and Skibo write,

"The artisan experiments and creates, but the success of the process or product – whether or not it is adopted – is determined by extratechnological factors. Eventually, the tinkering artisan, building on an expanded basic science, arrives at a series of technical choices that produce performance characteristics acceptable under prevailing societal conditions." (1987: 600)

The choice to combine paper and parchment reflects the scribe’s and the binder’s attempt to materially mitigate an increasing demand for manuscripts with the decreasing availability of parchment without conceding the overall strength of the binding. Yet given the limited number of mixed media manuscripts, the compromise may not have been particularly popular. This line of reasoning leads me to wonder whether parchment might have been prized not only for its material strength, but also for underlying cultural reasons. We know that Byzantines liked highly polished parchment, even though it damaged the illuminations (Lowden 2008: 468). One conjecture might be that shiny parchment reflected certain values or social status. By this line of reasoning, the most important feature of a manuscript would not have
been the quality of the text or illumination, but rather its ability to signify certain encoded social information. Unfortunately, the evidence supporting this or any other hypothesis is scant and circumstantial at best. By the thirteenth century, paper manuscripts are common in the Byzantine Empire, so an underlying cultural preference for parchment obviously did not last.

Textblock Sizing and Cultural Preference

In order to allow for easy and accurate comparisons between the different binding styles, I wanted to establish as many constants between the three different book types as possible. I realized that glaring differences in book size would make it impossible to draw conclusions about economy or labor hours. It was not feasible to make the width of the books consistent due to the fact that each style has a different proportion of spine height to width. However, while scholars acknowledge this general difference, I was not able to find any specific information in the literature on what exactly those proportions were. I set out to find the information on my own by compiling a small database of manuscript dimensions, derived from the information available on museum and library catalogues. After compiling all of this data, I was able to calculate the ratio of spine height to textblock width. These tables can be found in Appendix A. I chose to have a constant spine height of 200mm, and used my tables to determine the proportional dimensions of my manuscripts based on the 200mm constant of the spine.

The Dimensions of a ‘typical’ Twelfth-century North African Codex
North African Islamic books from the eleventh century are unique in that they are most often formatted in what codicologists refer to as the oblong *à l’italienne* style rather than the traditional *à la française*: these volumes are wider than they are high. The oblong book faded out of use in North Africa in the twelfth century, to be replaced by the standard vertical format used in the West. It has been suggested that the vertical format is meant to emulate the Qur’anic plaques used in architecture (Ettenhausen, cited in Bosch & Petherbridge 1981: 25).

However, it is more likely that the oblong format may have developed in response to the rise of the Kufic script in the tenth century (Bosch & Petherbridge 1981: 25). Kufic script is much more rounded than its rectilinear predecessors and tends to take up more space on the page (Blair 2006: 127). Calligraphy was the highest art throughout the Islamic world due to the Qur’anic emphasis placed on the word of God. Islamic manuscripts did not contain images, so the artistic focus was on the beauty of the words (Blair 2006: 4-5). The oblong format was better suited to showcasing the flowing new calligraphic style. This shift in the orientation of North African manuscripts is an excellent example of technology evolving to accommodate cultural preferences.

The largest collection of medieval North African manuscripts was discovered at the Grand Mosque at Kairouan in Tunisia. Szirmai includes a table with the average size of a Kairouan manuscript for each century (1999: 52). According to his study, the average size of the oblong Kairouan manuscripts from the eleventh century was 105 mm by 161 mm. In order to confirm Szirmai’s findings before relying on them, I decided to assess the data on my own: mean size is not necessarily
representative of mean proportions. I used the measurements and dating recorded by Marçais and Poinssot in their 1948 catalogue of these manuscripts as my source of raw data. Using the measurements from the 51 eleventh century manuscripts in the oblong format, I found that on average the Kairouan manuscripts were 1.51 times as wide as high. I calculated this figure by plotting each individual manuscript on a graph of spine height vs. textblock width. I fit the graph with a linear regression line with a slope of 1.51. This trend line represents the average ratio of spine height to textblock width for the entire data set. With an $r^2$ value of 0.95, there was an extremely high correlation between the actual data points and the trend line, meaning that 95% of the individual manuscripts fit the trend.

According to the table in Appendix B, there were no manuscripts with a spine height greater than 170mm. I suspect that this upper limit is not based on a cultural preference for smaller books, but rather by the size of the paper. Islamic papermakers cut paper into sheets based on a system of standard paper sizes. Qalqashandi (1356-1418) suggests that the system was based on the measurements used for papyrus scrolls, with the full size Baghudi sheet equaling the linen cubit used in Egypt (cited in Bosch and Petherbridge 1981: 31). Though scholars have tried to reconstruct the system of paper sizes from existing manuscripts, there is no general consensus as to what exactly the standard measurements were. It appears that papermakers in Spain and the Middle East each used their own independent systems (Bosch and Petherbridge 1981: 31). The data from Kairouan suggests that the paper used for North African manuscripts could not produce a textblock larger than 170mm by 235mm. Thus,
despite establishing a 200mm constant, I decided not to make the spine of my Islamic book 200mm, instead choosing to have a width of 200mm. I opted to have a book with a 133mm spine and a width of 200mm.² These dimensions are well within the boundaries of the Kairouan range.

*The Dimensions of a ‘typical’ Twelfth-century Byzantine Codex*

When compiling the measurements for the Byzantine sizing, I was not able to find a collection from one region or monastery that was large enough to serve as a representative sample. I therefore relied on the collections from the British Library, the Metropolitan Museum, and the Beinecke Library at Yale for my data. I only included manuscripts from the eleventh to thirteenth centuries, though there was a wide geographical distribution. This data is included in Appendix B. From this data, I used the same algorithm as above and calculated that the width of the book is 75% the height of the spine. This data had an extremely high correlation value – \( r^2 = 0.96 \). Therefore, based on my calculations, I determined that my Byzantine codex should be 200mm by 150mm.

It was only after I had started sewing my textblock that I found Frederici and Houli’s excellent catalogue of the Byzantine manuscripts in the Vatican collection (1988). The eleventh and twelfth century manuscripts from this collection had a slightly different relationship between spine height and width, with the width as 69% of the spine height. This table is included in Appendix B.

² Interestingly enough, these are the same dimensions of an iPad mini. Coincidence?
Frederici and Houlis made a distinction in their catalogue that I had not encountered anywhere else – they included the height of the spine and the height of the boards. For Byzantine books especially, each measurement tends to be quite different because these manuscripts have a large endband that protrudes past the boards. The height of the spine can be anywhere from 9 to 16 mm taller than the height of the boards. I calculated that width of the boards for the Vatican collection was 72% the height of the boards.

Though this small distinction in how the manuscript is measured only accounts for 3% difference, it made me call into question the validity of my prior calculations. The catalogues I took my data from never specified if the height was board height or spine height. This was concerning as I had already cut the boards and paper for my facsimiles based on what had the potential to be inaccurate proportions. In order to test how far off my own calculations might be, I subtracted 10mm from each height (assuming that the height was measured from the greatest point) and redid my ratio calculations. Fortunately, my proportions remained the same.

This incident is a clear indicator of the difficulties faced by book conservators and historians. Most manuscript catalogues are written by art historians who lack knowledge of bookbinding and book structures. Therefore, the information in these catalogues is not only inaccurate, but it is misleading for those who seek to study bindings. Frederici and Houlis are book conservators, so they understand the importance of including both measurements, as the large, double-cored endbands are considered one the defining features of Byzantine manuscripts. Frederici and Houlis’s detailed catalogue of manuscripts is the most useful for the conservator because it
pays attention not only to the decoration, but also gives special attention to the
minutiae of Byzantine binding structures.

*The Dimensions of a ‘typical’ Twelfth-century Romanesque Codex*

I conducted a random sampling of English Romanesque books -
methodologically similar to the procedure for the Byzantine codices - by taking my
data from the catalogues at the British Museum, the Beinecke, and from a catalogue
of English manuscripts. The data can be found in Appendix A. The manuscripts I
looked at were considerably larger than the manuscript I was planning on producing,
but the proportions did not appear to vary based on size. For English Romanesque
books, the width is on average 68% the height of the spine with an $r^2$ value of 0.95.
This means my manuscript would have to be 200mm by 136mm. Thus, the
Romanesque codex is slightly less wide (136mm compared to 150mm) than the
Byzantine codex.

*Discussion: comparing the textblock and writing supports of three ‘typical’ twelfth-
century codices*

In comparing the Byzantine and Romanesque data, I was curious as to why
the Romanesque books tended to be consistently narrower than the Byzantine books.
My first thought was that perhaps it had something to do with the size of the animal
skins – a material influence on technical choice. As I mentioned above, Romanesque
manuscripts used calf or sheep hide and Byzantine manuscripts used goat hide. Both
Wilson and Oikonomides confirm that each goatskin would yield two rectangular leaves of parchment, meaning that the animal was cut exactly in half (1975: 2) (2002: 589). Perhaps the shape of a cowhide or sheepskin was better at producing narrower sheets of parchment. However, were the English manuscripts made out of sheep parchment instead of calf, this explanation would not account for the variation.

According to Townsend Leather, a leather supply company for furniture designers, calfskins and goatskins differ in shape, which could account for the variation in parchment size. Whereas a goatskin is nearly as wide across the shoulders as it is across the hind, a calfskin is about 20 inches wider across the hide than it is across the shoulders (figure 4). A goatskin would yield exactly the same number of sheets at both ends of the skin. A calfskin, however, could yield more sheets at the bottom. So as a parchment maker, I might choose to cut narrower sheets at the top so I could cut more sheets of that same size at the bottom.

![Figure 5 - Dimensions of Calf Hide and Dimensions of Goat Hide](image)
To put this in more concrete terms, I will use some actual numbers. For ease of calculation, I will use inches instead of millimeters. I want the shoulders of the calfskin to yield 2 sheets of paper. If I used as much of the skin as possible, I would cut two sheets of 22.5 inches at the top (figure 5). If I were to keep the size of the sheets at a consistent 22.5 inches when I cut the hind end of the skin, I would only be able to cut 2 sheets from this part, even though I have much more skin to work with. However, if I were to be economical, I could make the width of the sheets slightly less at the top, so I could yield more sheets at the bottom. If my sheets were 20 inches instead of 22.5 inches, I would only get two sheets at the top of the skin, but I could cut three sheets of 20 inches from the bottom of the skin (figure 6). This technique is economical, as it increases the number of sheets of parchment per skin and decreases the amount of leftover skin.

However, this theory is not without problems. Medieval animals were much smaller than their modern counterparts, so the skin sizes I have used may not reflect the medieval reality. Additionally, this idea is really only useful for smaller sheets of parchment. For larger sheets, the top and bottom of the skin would yield the same amount. Moreover, the dimensions of English manuscripts were not determined by the size of the sheets of parchment, like the standard sizes of paper in North Africa dictated the size of the manuscript. Rather, the dimensions of English manuscripts were determined by the scriptorium, so parchment would be cut to order and not based on some efficiency-optimizing algorithm.
Figure 7 - 22.5 inch sheets

Figure 6 - 20 inch sheets
Regardless of the underlying reasons for the different shapes of English and Byzantine manuscripts, this example perfectly illustrates the concept of *habitus*. In this example, the shape of the manuscript is a part of each literary community’s *habitus*. Based on my study, there was very clearly a definite set of proportions to which Byzantine and English bookbinders adhere in the eleventh and twelfth centuries. There was no obvious functional reason for this shape, nor was it expressing valuable social or cultural information. Yet, the shape remained and was reproduced to the point where it became a purely formal and unquestioned reality. And in continuing to make manuscripts with this set of proportions, the individuals of each culture perpetually reaffirmed the construct. English and Byzantine readers expected the book to have a certain shape based on their physical experience with it; they expected it to feel a certain way in their hands when they open it. As Bourdieu wrote, it “goes without saying because it comes without saying” (1977: 167).
SEWING

After the scribe had finished copying the text and preparing the illuminations, the completed pages of the manuscript would be sent over to the bindery. While the leaf was the unit of the scribe, folded sections of several sheets, called gatherings, were the basic unit of the binder. The first step of the binder would be to sew the gatherings of the manuscript together to form what is known as the textblock.

Since my manuscripts contain no script (and are therefore not actually manuscripts, but rather codices), I was free to decide how many pages to use for my textblocks. For comparative purposes, I wanted to my textblocks to be consistent across binding styles. I arbitrarily decided that each textblock would consist of 20 gatherings and that each gathering would consist of 4 bifolia, or 8 leaves. This means that each textblock was a standard 160 leaves in length.

Determining Sewing Stations and Pricking the Gatherings

Before the textblock could be sewn, certain steps were taken in order to prepare the gatherings. The binder first needed to decide where on the spine he was going to put his stitches. These locations, called sewing stations, would be marked along the spine by pricking small holes through the center of the gathering in the spine folds. It was crucial that these prick marks were positioned exactly the same on each gathering. If the stitch linking two gatherings was uneven, there would be undue tension in the sewing that could cause paper to rip (Lindsay 2009: 61-62).
Replicating North African Pricking Practices

Islamic books were sewn after the text had been copied. They usually arrived at the bindery as a collated stack of loose pages in an envelope portfolio. These portfolios were sometimes the actual bookcovers that would later be used to cover the bound manuscript (Bosch and Petherbridge 1981: 45). Binders pre-pricked the inside folds of the gatherings with the *ishfa* awl, a type of needle awl, in order to mark the positions of the sewing stations. Regardless of the size of the texts, most Islamic manuscripts only used two sewing stations, which evenly divided the spine into thirds (Szirmai 1999: 54) (Parker 2002).

For my reproduction, I placed my sewing stations at 66mm and 133mm from the top of the spine. I pricked the spine fold of each gathering twice using a needle awl. For each textblock of twenty quires, the entire pricking process took, on average, seven minutes.

![Figure 8 - Distribution of Sewing Stations](image)

**Figure 8** - Distribution of Sewing Stations

![Figure 9 - Pricked Islamic Gatherings](image)

**Figure 9** - Pricked Islamic Gatherings
Replicating Byzantine Pricking Practices

Surviving Byzantine codices indicate that there was no standard number of sewing stations, as there were for Islamic codices. Frederici and Houlis’ 1988 study of Vatican bindings by revealed a huge variety in sewing stations per codex, ranging anywhere from three to seven. Frederici and Houlis found that the number of sewing stations was not related to the height of the spine, nor could they connect the number of sewing stations to a particular workshop or provenance.

Szirmai (1999) reviewed this data and determined that there were two distinct types, or patterns in the distribution of sewing stations. These patterns could be distinguished by the spacing of the intermediate stations (that is, those in the middle) and the outer stations (that is, those closest to the head and tail of the book). Szirmai’s pattern A used between three and five sewing stations, evenly spaced along the spine so that, “the distance between the outermost stations and the head and tail of the book, that is, the outer spine segments, equals about half the distance between the intermediate stations” (Szirmai 1999: 64). Szirmai noted that Pattern A occurs more frequently in manuscripts sewn prior to the 14th century (1999: 66).

Szirmai’s Pattern B used between five and seven sewing stations, and “shows the same even spacing of the intermediate stations.” However, Pattern B is distinctive because “the outer spine segment is divided by an additional station…which takes over the change-over function” (Szirmai 1999: 66). This is to say that a codex with five sewing stations would have three sewing stations placed evenly along the spine. A fourth station would be created roughly between the head, or “top” of the spine and the closest of the three evenly-placed internal stations; the fifth station would,
likewise, be placed roughly between the tail, or “bottom” of the book and the closest of the three evenly-spaced stations. Houlis (1993) observed these same two patterns and noted that the stations closest to the head and tail for manuscripts with Pattern B were often marked with knife slits instead of V-shaped nicks. As we will see, this was likely because the stations along the edge of the textblock used a less bulky stitch than the stations in the middle.

Figure 10 - Two Patterns of Sewing Station Distribution (Szirmai 1999: 68)
A unique feature of Byzantine codices/gatherings is that unlike the North African gatherings, the sewing stations are not marked by awl pricks at the spine folds. That is, rather than pushing a sharp awl through a gathering, binders would cut out the hole they needed by using a knife or chisel to make triangular nicks along the edges of the folds. As we will see, these large holes better accommodated the bulky chain-link sewing that bound the gatherings together, allowing the spine to appear smooth and flat when covered (Petherbridge 1992) (Frederici & Houlis 1988).

Figure 11 - Diagram of Nicked Gatherings (Frederici and Houlis 1998: 23)
In making my reproduction of a twelfth-century Byzantine codex, I chose to use four sewing stations following Szirmai’s Pattern A. Along my 200mm spine, I placed my sewing stations at 25mm, 75mm, 125mm, and 175mm. The main characteristic of Pattern A is that the stations are evenly measured and spaced, so I determined that the intermediate stations would be 50mm apart while the outer stations would be half that distance (25mm) from the edge of the boards.

![Distribution of Byzantine Sewing Stations](image)

**Figure 12 - Distribution of Byzantine Sewing Stations**

The process of cutting the nicks for the sewing stations was surprisingly time consuming and difficult, requiring at least 30 minutes and a significant amount of physical strength to make my sewing-station nicks. I chose to use a chisel because I thought this might create more consistently sized sewing stations along the spine. When consulting one of my manuscript models, the eleventh-century lectionary *Trinity College MS 2*, I observed that the nicks were 4mm across and 4 mm deep. I decided to try to replicate these holes, and so chose a small stainless steel chisel with a 5mm tip, and used a weighted mallet in order to force the chisel to cut. It was possible to cut through all eight layers of paper and make each cut with one loud and firm stroke (strong enough to shake the entire workbench), or two or three less forceful blows. After marking 10 gatherings, I could feel my wrists start to ache with
the constant hammering.

Though I could often make a perfectly triangular nick, I sometimes was not able to connect both sides of the triangle at the top point due to the template shifting. Therefore, I needed to pull off the leftover paper with my hands, leaving behind a somewhat trapezoidal-shaped nick.

Figure 14 - Gathering with nicks

Figure 13 - Nicks along the spine folds of several gatherings
By actually working through the process of making the nicks in the gatherings to create the sewing stations for the codex, I discovered that there was an obvious visual difference between chiseled nicks and cut nicks. Looking at *Trinity College MS 2*, I was able to discern that the nick marks were made with a knife. The chisel left behind a very distinctive set of tool markings. The binder of *Trinity College MS 2* had made his or her first diagonal cut along the spine edge from left to right and then completed the nick by always making the second diagonal cut from right to left. I believe that I can make this determination on the direction of the craftsman’s knife marks, because the second cut (from right to left) often extended just a little bit further than the cut from the other direction. Given my own struggles with consistently cutting out the nick cleanly (and not having to pull it out), I would surmise that the craftsman cut just slightly deeper on this second pass in order to insure that he cut out the entire triangle.

**Figure 15** – *(right)* Nick made with chisel

**Figure 16** – *(above)* Nicks made with knife on MS 2
The Byzantine pricking process was substantially more involved than for the other two manuscripts. In addition to requiring double or triple the time, it was also a physically taxing process. Not only did I have to channel my upper body strength, but I also needed precision and finesse to make sure that chisel did not shift out of position. If I pricked a hole in the wrong place on the other two manuscripts, I could prick another hole in the proper spot with little consequence. However, a misplaced nick on the Byzantine manuscript would be highly noticeable in the center of the gatherings. Chiseling nicks is actually a somewhat high stakes process, unlike pricking. Though normally, the binder would prepare the gatherings with pricks and nicks after it had been written, I wonder if Byzantine nicks were actually prepared by the scribe before copying the text. This way, gatherings with misplaced nicks would not be included in the manuscript. However, given the high price of parchment in the Byzantine Empire, as I discussed above, I doubt that badly nicked gatherings would be discarded.

Replicating Romanesque Pricking Practices

English manuscripts could be sewn with anywhere from 2 to 6 sewing stations. Though there is no correspondence between the height of the spine and the number of sewing stations, there is a geographical correlation indicating that English books most frequently employed either four or five stations (Szirmai 1999: 144). Each station is pricked with an awl at the spine fold of the gather in order to keep the sewing even. The sewing used on the English manuscript is not nearly as bulky as the
sewing used on the Byzantine manuscript, thus large triangular marks were not needed.

For manuscripts with two sewing stations, there is a slight degree of variation in the placement of the sewing stations along the spine. Szirmai’s diagram shows that the spine is not evenly divided into thirds by the supports (1999: 145). The distance between the outermost stations and edge of the spine are either 20% shorter or 20% longer than the average distance between the two inner stations. However, Szirmai writes, “a majority of bindings...displays only a minor deviation, negative or positive...in absolute terms amounting to c. 2-6mm” (1999: 144). He suggests that these slight variations may be indicators of characteristic differences among monastic workshops, perhaps regionally or by order.

Figure 17 - Most common distribution of sewing stations for manuscripts with two supports: Solid line represents support, light dotted line represents changeover station Dark dashed line represents next interstation distance (Szirmai 1999: 145)
I chose to place my outermost stations just 6mm from the edges of the spine, much closer to the edge than with the Byzantine and the Islamic books. To place the intermediate sewing stations, I divided spine roughly into thirds, but with a larger distance between the intermediate stations themselves than between the intermediate stations and the edge of the textblock. Along a 200mm spine, there were sewing stations at 6mm, 64mm, 132mm, and 194mm.

Pricking took about 10-13 minutes. Even though I was not using real parchment, I observed that it was ostensibly more difficult to pierce through the thicker paper than it was to pierce through the thin Islamic paper. I needed to use more pressure to force the needle through and I was not always able to pierce directly into the center of the gathering.

![Figure 18 - Romanesque Sewing Station Distribution](image)

![Figure 19 - Pricked spine folds between boards](image)
In terms of effort and time, the English and North African pricking processes were undoubtedly the least strenuous. The English manuscript took longer than the North African manuscript because my English manuscript has four sewing stations and thus four holes to prick per gathering, whereas the North African manuscript only had two. However, I am certain that it is more difficult to pierce through four layers of parchment than it is to pierce through four layers of sturdy paper. This is one of those instances with this project where not having the exact materials limits my interpretation. Though both the North African and the English manuscript use the same technique, the choice of paper or parchment would likely influence the amount of time and effort it takes to complete the pricking.

**Thread**

After receiving the copied textblock, the binder has his first opportunity to choose materials for the manuscript. Though he was not able to choose the writing support for the text, with thread he was able to determine the final look of the bound work. The choice of thread determines the tension of the sewing and the swell of the textblock and greatly affects the long-term stability of the book.

Two important concepts when studying thread are **ply** and **twist**. Ply refers to the number of individual threads spun together. So, a two-ply thread would be spun from two threads and a six-ply thread would be from six. Plying is done in order to create a balanced thread that does not twist and tangle. It is possible to measure the direction of the spinning, called twist. A twist that moves from left to right is called an s-twist because it resembles the letter s. A twist that moves from right to left is
called a z-twist.

*North African thread*

Most Islamic manuscripts are sewn with colored silk or linen thread (Bosch and Petherbridge 1981: 46). Though this type of thread was very fine and did not contribute much to the width of the spine, it was also far too thin to adequately keep the gatherings together (Bosch and Petherbridge 1981: 46). Often, the thread would slice through the pages and destabilize the entire manuscript. The sewing thread used on the Kairouan manuscripts only survives in small trace amounts (Marçais and Poinssot 1948).

Sewing with silk is difficult, especially for me because I lacked experience with the material. I was especially concerned about pulling the silk thread too forcefully and cutting through the spine folds, as the fineness of the material makes it sharp – sharp enough that it is often used to slice cheese. I chose instead to use red 25/3 linen thread that was 0.26mm in diameter. Though it is colored like a silk thread, it is much less likely to slice through my pages and is resistant to kinking.

*Byzantine thread*

Byzantine manuscripts are most often sewn with either linen or hemp thread, though silk and cotton thread have been observed (Petherbridge 1991). It is often difficult to distinguish between the linen and hemp, so without further study it is not possible to precisely identify if there was any kind of regional preference for one
material over another. Regardless of the fiber, Byzantine thread is known for its thickness. Szirmai cites a ninth/tenth century Georgian manuscript sewn with threads that were 1.3 to 1.8 mm in diameter (1999: 69). This Byzantine thread is so thick it can be almost cordlike and as such, is rarely used as sewing thread in modern bookbinding.

Recall from my earlier discussion that Byzantine textblocks were sewn in two halves that are then joined together with thread. It is not evident whether a separate thread was used to link the two halves of the textblock. Distinctions between different types of threads used for different binding procedures seem to be a lacuna in the scholarly literature. Discussions are limited to noting that the same thread was used to attach the boards and sew the gatherings of the textblock (Szirmai 1999) (Houlis 1993).

The eleventh century Byzantine manuscript MS1 at Trinity College gives us some insight as to the variety of thread choices. This manuscript exists only as a sewn textblock as it has lost its boards and spine over the years. Thus, I was able to clearly see three different types of thread that were used to sew the manuscript.

The sewing thread of MS1 was quite robust. It appeared to be made of cotton because the fibers were short and the thread was soft. The thread was six-ply and had an S-twist, however I could not identify the twist of the plying threads. I measured the thread with a digital caliper, a handheld tool used for precision measuring. The sewing thread was 0.24 mm in diameter, but the jaws of the caliper compressed the thread slightly, so I am not entirely confident with this measure.

The thread used to join the parts of the textblock appeared to be even thicker
than the sewing thread. Its taupe color and rough texture indicated that it was made of linen or hemp. This thread was three-ply and had an S-twist thread. This time, the caliper did not condense the thread and read a diameter of 0.50mm.

The third kind of thread was used for to stay stitch the folds of the gatherings, with a two-ply S-twist and a thickness of 0.23mm. When the spine is covered, this stitch is nearly invisible, so one of the only ways to observe its presence is on an uncovered spine. Stay stitching is a small overcast stitch that loops around the outside spine fold of a gathering. It is used to bind the leaves of a gathering together to keep leaves of the gathering from separating or to prevent the centermost bifolium from protruding. In contemporary binding and conservation practice, this type of stitch is used only sparingly because it is not very kind to parchment and paper. Since the sewing holes of the stay-stitch are so close together, the fine thread can easily slice through the pages.

Figure 20 - Sewing on MS 1
According to Petherbridge (1991), stay stitching is not uncommon in Byzantine binding. He believes that the use of this technique indicates that Byzantine scribes wrote in the manuscripts after they were bound. Petherbridge’s theory challenges traditional assumptions about the sequence of manufacture. Later on in the chapter, I will discuss the other evidence that supports his compelling hypothesis.

For my Byzantine books, I used an 18/6 linen thread for the primary sewing, for attaching the boards, and for the endband. At 1.27mm in diameter, this thread was actually closer in weight to a light cord, though it was thinner than the cord I observed on MS1. Somewhat surprisingly, the thick linen proved to be quite challenging to work with. It would kink often and left burns on my hands when I sewed with it. As I had observed with the nicking process, sewing with this thread requires both strength and sensitivity. To work with this thread on a daily basis, I would absolutely need to build up callouses to ease my rope burns. However, in eleventh and twelfth century Byzantium, the benefits of this thread apparently outweighed the adverse effects on the binder, as it would have likely kept a manuscript securely bound for a long time.
Romanesque Thread

There is very limited information on Romanesque sewing thread. Based on a systematic study of 76 bindings, Szirmai calculated that the average diameter of the thread was 0.91mm (1999: 151). He also notes that the majority of the thread was Z-twist, however, these threads were plied with a combination of Z-twist and S-twist fibers. For my manuscript I used a 12/3 linen thread that was 0.66mm in diameter.

Sewing the Textblock

After all of these preparation steps – determining sewing stations, pricking/nicking the gatherings, choosing an appropriate thread – the textblock was finally ready to be sewn. It is important to note that there is potential for significant discrepancy between my own sewing that that of a twelfth-century craftsman. It was my first time doing all of these stitches, so there was a significant learning component. Repetition of any sewing practice results in the adjustment of one’s technique to the specificities of a new material. Though usually by the third copy I felt confident with the new style, it is very unlikely that I ever made it to the level of competent medieval binder.

Sewing North African Gatherings

Islamic bookbinders used what is called the “Coptic link stitch” to sew
together the gatherings of the text. This stitch is essentially what is now just called the “link stitch”, because each gathering is linked to the previous gathering. Moreover, when completed, this stitch resembles the links of a chain running along the spine (Szirmai 1999: 55)

![Figure 22 - Link stitch sewing (Szirmai 1999: 46)](image)

The use of the link stitch is well documented in manuscripts after the thirteenth century. However, the surviving manuscripts from prior to the thirteenth century do not offer enough evidence to say with certainty that this same stitch was used. In the eleventh and twelfth century manuscripts from Kairouan, the colored silk sewing thread had almost entirely disintegrated with age and made it impossible to determine the stitch used for sewing (Marçais and Poinssot 1948).

Ibn Badis (1031-1108) is vague in his description of Islamic sewing, writing only, “Sewing may be done by several methods: one which the artisan employs for
swiftness and speed, in which the needle pierces the section in only two places, and another done with two or three stitches. Still another type of sewing is current with the Byzantines, but I am unable to describe it” (cited in Bosch 1961: 6). This quotation supports that North African binders did in fact use a simple stitch at two stations, which very well could have been the link stitch. However, ibn Badis’ remark also suggests that there were a variety of stitches in use at this time, so it appears that the link stitch was not the standard.

The chains formed by the link stitch tend to cause the textblock to swell, which may have been seen as an aesthetic disadvantage. Binders seem to have been concerned with having a flat, even text block, as we have evidence that they went to great lengths to minimize swelling such as pounding the spine folds with a mallet after sewing. Ibn Badis writes to beat on the textblock, “…with a heavy mallet weighing six pounds, or five, or four. In result of this beating is what befits the condition. And the hammering must be equally distributed for each portion until it fits the book and its paper softens, and gathers to each other from the strength of the beating…” (cited in Bosch 1981: 47-48). Though in the short term, this technique may have reduced the swelling, these beatings would have hastened the disintegration of the textblock by forcing the weak paper right against the sharp silk thread. As we will see over and over in the Islamic binding process, priority was always given to the aesthetics of the binding rather than the long-term stability of the work.

I used the Coptic link stitch to sew my North African textblocks. Despite using the less-acute linen thread, I still ended up tearing the paper. Any time I pulled the thread tight, I was dangerously close to cutting the spine fold. I found that I could
avoid this damage by pulling against the thread rather than against the paper: instead of pulling the thread tight on the paper side of the knot, I would pull tight on the thread side of the knot. In other words, instead of tightening the slack immediately after pulling the thread through the hole, I would make the stitch with plenty of slack and then pull. Pulling against the thread in this way protected the page from ripping simply through the necessary process of making a tight knot. This ad hoc technique (or one similar) would have been absolutely essential in order to protect the spine folds. Though I rarely cut the paper, over time the thread would no doubt cut through the paper as it had with the Kairouan manuscripts.

Figure 23 - Link stitch sewing
As to the efficiency of the process, though my first book took nearly 50 minutes to complete, I was able to sew the third book together in merely 22 minutes, from first threading the needle to tying the final knot. This speaks to the ease with which North African bookbinders would have been able to assemble a manuscript once they were provided with evenly cut sheets of paper. If we add the amount of time it took to punch the sewing station holes through all of the quires, the total time for assembly is still under half an hour. This raises the question: were Islamic books made quickly because there were many readers, or did the ease of making a book allow there to be many readers? In other words, was the swift binding process developed in response to demand or did it create the demand?

Figure 24 - Sewn Islamic Manuscript with Boards
**Sewing Byzantine Gatherings**

Byzantine bookbinders used two types of stitch to sew the gatherings of the textblock, both of which have been attributed to the Coptic tradition (Houlis 1993). The first stitch is called the kettle stitch and is a variation on the Coptic link stitch, just described in the context of the North African bindings. Unlike the link stitch, which simply passes from one gathering to the next, the kettle stitch connects each gathering with a knot. The kettle stitch is used only at the stations nearest the head and tail, also called the changeover stations. This name comes from the fact that the thread changes from one gathering to another at these outermost stations. The kettle stitch passes from the end of one gathering and enters the gathering being added on, linking the two gatherings together and creating a solid anchor between the two gatherings.

The second stitch is the chain stitch, which is again similar in technique to the link stitch. Chain stitches are made by passing the thread from inside the spine fold, through the V-shaped nick, and under the chain stitch of the previous quire. The thread then re-enters the spine fold through the original nick and passes along the inside of the quire, exiting again at the next sewing station (Szirmai 1999: 68) On the spine, the stitches appear like links of a chain or a series of stacked V’s depending on the tension used by the binder.
Figure 25 - Chain stitches and kettle stitches along spine

Figure 26 - Links of chain stitch along spine
Though this stitch is quite bulky, the V-shaped nicks accommodate any swelling and allow a flat spine, producing a very strongly bound manuscript (van Regemorter 1992b). Like the North African binders, the Byzantines wanted to achieve a flat spine without swell. However, they were not willing to sacrifice strength for aesthetics. The V-shaped nicks can thus be understood as a technological innovation in response to functional and cultural concerns.

I observed on Beinecke MS 237 and MS 267 that the thread caused the parchment to pucker in the center of the gatherings between the nicks. This indicates that the thread must have originally been pulled very tightly at each sewing station. With my sewing, I endeavored to do the same, pulling the thread as tightly as I could without regard for the well being of the paper. The application of this force—necessary to achieve the desired appearance—produced rope burns on the outside of my palm and on the inside of my thumb, making the process very painful to repeat on each subsequent book. However, by making the effort to pull tighter, the chain stitch came to resemble the links in a chain, allowing me to faithfully re-create the appearance of the manuscripts I had observed. By pulling the thread upwards instead of to the side, I was able to ensure that each link looked very well defined.

The bulky nature of the thread, combined with the bulky nature of the stitch used to tie the gatherings together made it very clear why Byzantine binders needed to cut nicks for their sewing stations. The thread perfectly nestled inside of the nick, so that the spine was able to lie flat without any robust sewing sticking out. I doubt it would be possible to use such a stitch on an awl-pricked textblock such as the Romanesque. The heavy thread would have stretched the sewing holes and damaged
the spine folds, possibly contributing to the ripping of the pages. As I would discover at the next stage, the nicks at the changeover stations, while only half-filled by the kettle stitch, had enough room left over to also house the sewing for the primary endband. I was easily able to insert the endband thread into these nicks again without fear of ruining them.

![Figure 27 - Sewn Byzantine textblock](image)

![Figure 28 - Close up of kettle stitch (left) and chain stitch (right)](image)
An interesting and unique feature of Byzantine manuscripts is that the textblock is sewn in two parts, which are later sewn together. This type of sewing is known as biaxial stitch deposition (Szirmai 1999: 68). As of now, there is no consensus as to why this type of sewing was used by Byzantine binders. I will present my own interpretation of this unusual choice at the end of this chapter. The two halves of the textblock are sewn separately and later linked together with another length of thread. Looking at the uncovered spine of a Byzantine textblock, one would be able to see the chain stitches moving in opposite directions and meeting in the middle (>>>><<<<) with a joining thread at the center (Houlis 1993).

A simple figure eight hitch at each sewing station was considered enough to attach the two halves of the textblock for a Byzantine codex. Frederici and Houlis’ 1988 study of the Vatican’s manuscripts shows that each sewing station was joined via a figure eight using a separate thread at each station. However, in his diagram, Szirmai indicates that only one thread was used to make all four hitches (1999: 68). Once all four stations had been joined with the figure eight, the thread was knotted in the center of the spine fold of either the last gathering of the first textblock half or the first gathering of the second textblock half.

I chose to use separate threads at each sewing station because it is easier to sew with shorter lengths of thread. In order to best explain the process, I have assigned a number to each gathering.
According to Houlis (1993) the knots of the hitching thread were tied on the inside of the gatherings, so I entered though the center of the tenth gathering to start. I then did one stitch at gatherings 10 and 1, two stitches at 9 and 2, one stitch at 8 and 3, and then two stitches at 9 and 2. Though this hitch was exceptionally secure, the packed thread on the figure eight created tall mounds that protruded from the spine in a very noticeable way.

When I tried to move on to the next stage of binding and apply the spine lining, I noticed that I would not be able to hide the thread bumps even under a lining of linen and a cover of leather. My choices had violated the aesthetic integrity of the
binding. So I undid all of my hitching sewing and adjusted the placement and frequency of my stitches: one stitch at 10 and 1, one at 9 and 2, one at 8 and 3, and then one at 9 and 2. This greatly reduced the size of the packing.

When considering these adjustments, my presumption was that the sewer’s goal would have been to make the lumpy thread and knots, the combination of which ensure the security of the Byzantine codex, disappear into the notches. However, Byzantine bookbinders used thick, un-pared pieces of leather to cover the manuscript. Perhaps the motivation behind this choice was to disguise the heavy sewing underneath. Therefore, the binders would not have to worry about making their hitching less conspicuous. Again, we are seeing the prioritization of strength over beauty with the Byzantine manuscript.

The use of biaxial stitch deposition is the most distinctive and unusual feature of Byzantine bookbinding. Yet, even after sewing three textblocks I am still uncertain as to why this was a common practice. It took 30 minutes on average to sew each half of the textblock and it took another 30 minutes to complete the linking portion. The timing was consistent for all three manuscripts.

One theory for biaxial stitch deposition concerns the material quality of the chain stitch. The chain stitch may have the advantage of long-term resilience, but this strength comes at an aesthetic and structural cost. Because the chain stitch is pulled so tight, it often causes the spine to curve in on itself convexly. Not only is this unsightly, but it is also harmful to the textblock.
Figure 31 - Two sewn textblock halves

Figure 32 - Halves joined by figure eight hitch

Figure 30 - Close up of figure eight hitch
The second theory deals with the stages of manuscript manufacture. Szirmai notes that Byzantine scribes wrote on the textblock after it was bound (1999). Perhaps the scribal labor was shared between two different scribes, which would halve the time required to copy the text. This practice would only work if the amount of pages were determined beforehand, as it would have been for a liturgical work. According to Jefferies, Byzantine monasteries did not have the reputation of being centers of learning. Rather, texts were copied so they could be preserved for religious purposes (2008: 797). If Byzantine monks were primarily concerned with the reproduction of religious texts, this division of labor theory could potentially offer a cultural explanation for this curious technical choice.

**Sewing Romanesque Gatherings**

The gatherings of a Romanesque manuscript were sewn using a method called flexible sewing. A sewing support is a cord or thong that is sewn to the textblock and later used to connect the textblock to the boards.

In order to sew on thongs, the binder would use a mechanism called the sewing frame. This frame has an adjustable crossbeam that allows the binder to suspend the sewing supports while sewing together the gatherings of the textblock. The sewing frame is necessary in order to achieve a proper balance between the sewing thread and the support (Hadgraft 1998). The earliest representation of the sewing frame is an illumination from a twelfth century manuscript from a monastery in Bamberg. These frames were likely introduced earlier in order to facilitate supported sewing (Szirmai 1999: 141) (Hadgraft 1998).
The gatherings were attached to this external support rather than to each other as we have seen with the Islamic and Byzantine codices. The sewing supports onto which the text blocks of English codices were sewn were made of alum-tawed skin and were generally around 4mm thick and anywhere between 8mm and 12mm in width. There does not appear to be an obvious correspondence between the size of the textblock and the size of the sewing supports (Hadgraft 1998). The band was cut down the middle. This slit was exactly as long as the width of the spine. Both Clarkson (1993) and Hadgraft believe this suggests that the slit was cut on the frame during the sewing.

The experience of using a sewing frame for the first time led to a great deal of frustration in getting used to an unfamiliar apparatus. Sewing the first reproduction textblock required me to restart the process several times over. However, by the second and third book, I was able to set up the press in 14 minutes. Despite my obvious improvement, it still took me several attempts to get the frame perfectly adjusted, and I doubt that an experienced monk took this long to set up his frame.
The key to setting up the sewing frame successfully is to achieve the requisite tension. Each time I needed to reset my frame, it was because the tension in the thongs was unbalanced. It was tempting and sometimes possible to rectify unbalanced tension by simply raising the crossbar on only one side to even out the tension. Nevertheless, I learned that maintaining a level crossbar was also critical. When set up successfully, the sewing frame makes it possible to maintain the same level of tension in each thong. This is absolutely necessary prevent uneven sewing, as otherwise the spine would be lumpy and slanted. This delicate balancing act is so precise that the sewing frame can only be set up with one set of hands – the precise “tightness” established by an individual set of hands is what permits the frame to be perfectly balanced. If two people were each to set up a thong, the tensions would not match even if there were minute differences between the strength of their hands.

Figure 34 - Sewing frame with supports
Though single straight sewing and packed straight sewing have been used, the herringbone stitch is characteristic of Romanesque manuscripts. Clarkson (1993) uses the term ‘helical’ to describe the herringbone stitch. Sewn with one needle, the thread of a helical stitch connects the gathering to the support by wrapping around the thong at each station. The herringbone stitch exits the gathering through the slit, wraps right, drops underneath the thread of the previous gathering and then reenters the gathering through the slit (Szirmai 1999: 148). This creates a series of thread chevrons along the support. At the changeover stations, a simple kettle stitch is used. We have seen this same technique with the Byzantine manuscript, where a kettle stitch is also used at the changeover stations.

\[\text{Figure 36 - Herringbone stitch (Clarkson 1993: 148)}\]

\[\text{Figure 35 - Cross-section of herringbone stitch}\]
At a glance, the herringbone stitch appears to be complex and highly involved. However, the stitch itself is actually much simpler than the above diagram might suggest. Yet, it took me nearly three hours to complete my first textblock with the herringbone stitch. For the second codex I clocked in at two and a half hours, and by the third codex I was able to finish in two hours.

My main difficulty with the herringbone stitch was the aesthetics. I found it really challenging to have regular and even stitches along the spine while still maintaining tautness on the inside of the quires. Every time I would pull tightly to adjust the tension on the inside of the quire, I would end up cinching the alum-tawed thongs with my thread. It seemed like for every adjustment, there was an equal and opposite readjustment somewhere else. I was not able to manage to have tight thread on the inside and beautiful stitches on the outside.

In the end, I chose aesthetics over strength. I dedicated most of my time to adjusting the thread sewn around the thongs so that it had a perfectly even herringbone appearance. I ended up using tweezers to adjust the tightness of the thread along the thongs and a needle awl to adjust the placement of the thread. As I was doing this, I was constantly asking myself if a true English monk would have dedicated his efforts to this task, knowing that it would eventually be covered up by the binding. According to the Rule of Saint Benedict, monks must spend a portion of each day involved in manual labor in order to keep idleness at bay. Bookbinding and copying were considered manual labor. Benedict writes that these labors should be performed “…with humility, gravity and reverence…” (47). Based on this rule, a
faithful monk should have taken the extra time to make his stitches as lovely as he could because it would demonstrate his reverence for God through his manual labor.

The piece of alum-tawed skin I used to make my supports was less thick than the standard 4 mm thick, so there is a little discrepancy between the traditional experience sewing on alum-tawed thongs and my own experience. However, this gave me insight as to why thick bands were necessary for this type of sewing. My first two books were sewn on relatively thin alum-tawed thongs and I found with each gathering it was increasingly difficult to prevent the thongs from curling up with the thread. However, on the last book, I used the fattest part of the skin for my bands. These alum-tawed thongs were markedly thicker than the other two sets and were by far the most pleasant to sew on. I had the liberty to pull as tightly as I needed to without fear of mangling the outward appearance of the thongs. With the thicker bands, I did not have to make a compromise between the appearance and the structural integrity.

Figure 37 - Herringbone stitches
Romanesque manuscripts were meant to be bricklike, with as little swelling as possible. Already, at this stage, I realized that in spite of my good intentions and careful preparations, all three of my books were already suffering from a great deal of swelling. What I did not realize is that I had missed a crucial step in the sewing process that would have alleviated this problem. At each new gathering, the Romanesque binder would have used a flat wooden dowel to beat the air out from in between the pages. This additional step is the difference between a puffy, swollen textblock like mine and the perfectly flat textblock of the English monastery.

Recall that North African binders also beat the spine folds of the finished textblock. However, the English method was not nearly as damaging to the thread and parchment. Because it took place during sewing, the binder was able to compress at each gathering. This allowed the textblock to be sewn more tightly, thus preempting swell. The Islamic method, on the other hand, tries to salvage an already swollen textblock by beating the swell out of spine.

Discussion

My struggles with the sewing frame and my experience with the herringbone stitch provoked my clearest revelations about Romanesque books: in order for the binding to be successful, each component relies on precise craftsmanship, attention to details like tension on the dewing frame, and frequent readjustment and fine-tuning. In order to achieve these aesthetic and technical goals in the Romanesque codex, vast

---

3 My advisor Michaele clued me in to my mistake after comparing the swell of her own Romanesque to mine.
amounts of time were necessary. It took me 3 hours to sew my first textblock. By the last book, I was still clocking in at 2 hours of sewing without break. Over the course of these two to three hours, every motion of the needle was accompanied by some sort of additional step: adjusting the tension of the thread, fixing the appearance of the herringbone on the spine, or sucking on my poor fingers.

As we saw, the Islamic book, by comparison, took all of 27 minutes to sew. These 27 minutes were spent passively stitching rather than actively wrangling bunching and knots. That is, as the binder of an Islamic book, I was able to fall into a rhythm with my needle. Instead of relying on purely visual indications of error, I was able to feel when something was not quite right – when there was a knot in the thread or I had pulled too tightly and cut the paper. These two sewing experiences illustrate opposite ends of the spectrum in terms of necessary attention, skill, and artistry.

The Byzantine sewing structure was more similar to the Islamic structure than the Romanesque in terms of the sewing technology. This similarity is reflected in the relatively minimal amount of time it took to sew the textblock, especially compared to the Romanesque book. However, sewing the Byzantine textblock presented a unique challenge in terms of physical exertion. Without the necessary callouses, it would not be possible to complete more than one textblock per day. Whereas time was the limiting factor for Romanesque production, experience was the limiting factor for Byzantine production.

Time and effort were not the only factors considered when choosing an appropriate sewing structure. Each stitch has several associated performance characteristics that were likely considered. Coptic link stitch and the chain stitch used
on the Islamic and Byzantine codices are both types of **unsupported sewing.** These types of stitches allow the book to lie completely flat when opened (Link Frost 1996: 93). However, as the book is opened and the gatherings are pulled apart, the thread has a tendency to saw through the folds (Horton 1997: 11-12). This type of sewing also creates a great deal of swelling.

Islamic bookbinders must have preferred the Coptic link stitch for its speed because the other qualities of the stitch were either unrealized or damaging to the textblock. Though the sewn Islamic textblock could open flat, once the endband was sewn on the angle of opening was severely limited. I will discuss this in later detail in the section on endbands. Even though Islamic binders tried to reduce the swelling caused by this structure with silk thread and beating, their actions likely aggravated the tendency of the stitch to rip the spine folds. Ultimately they did not care about the overall strength of the textblock, nor were they concerned about the opening qualities. Thus, the only benefit this stitch could have provided to the binders was ease of use and speed.

Byzantine binders did more to counteract the structural weaknesses of the chain stitch. In order to reduce the swelling, they made triangular shaped nicks, which also would have allowed the thread to move upon opening without ripping the spine folds. They sewed their textblock in two halves to reduce the spine curvature caused by this stitch. However, based on my personal experience, I am certain they did not choose the chain stitch for its simplicity and speed. It seems that the strength of the chain stitch was the motivating factor, as it would have been very difficult to break in half. The thickness of the sewing thread confirms these motivations.
The herringbone stitch is a type of supported sewing, meaning that gatherings of the textblock are sewn to cords that rest against the back of spine. This type of sewing creates a curve in the spine when opened, but still allows the pages of the textblock to lie completely flat. The herringbone stitch is noted for the strength of the attachment between the gatherings and the supports. However, this stitch is considered superior because it allows the textblock to open with a free range of motion without creating tension in the sewing thread (Horton 1997: 42). Romanesque binders favored this stitch for its strength, but also its durability. Link Frost lauds supported sewing because, “a pliant, well sewn text assure a non-damaging, self-preserving response to the reader’s actions” (1996: 97). The herringbone stitch could withstand frequent abuse by even the roughest readers. Though supported sewing takes longer to complete, Romanesque binders seem to have been most concerned with ensuring the long-term usability of their manuscripts.
FORWARDING

In bookbinding, forwarding refers to all of the processes associated with covering the book. This includes creating and attaching the boards, treating the spine, and sewing the endbands to the head and tail of the manuscript. The structures created during forwarding are designed to protect the fragile textblock from the wear of use. However, these structures also determine how the reader interacts with the text and the experience of reading.

Boards

The boards of the manuscript are connected to the textblock and create a protective cover. The upper board refers to the top or first cover of the book. The lower board refers to the bottom or last cover of the book.

North African pasteboard covers

The earliest manuscripts from Kairouan were made with wooden boards. After the tenth century, however, binders began using pasteboard covers: a thin flexible board made of several sheets of paper pasted together (Marçais and Poinssot 1948). By the twelfth century, pasteboard covers were the standard for North African binders. Sufyani (b. 1619) described the preparation of pasteboard in the following terms:
You take the paper and smear a leaf of it with starch and leave it to your right and smear another paper I mean which faces it and place down the pasted page of one paper upon the pasted face of the second and press upon it with both your palms and turn it over…And take up two other papers, and treat them, as you did in the case of the two papers which preceded them. Until you join the papers all two by two and spread them in a warm place upon the earth which does not contain (dirt) that might stick to the pasted leaves. (cited in Bosch and Petherbridge 1981: 57)

The binder would then cut the boards for the manuscript to the desired size from the dry pasteboard. The boards were trimmed to be exactly flush with the textblock. Thus, during the twelfth century in North Africa, books were being produced that used the older practice of wooden boards, as well as the newer pasteboards described by Sufyani.

For my reproduction, I decided to use pasteboards to reflect the growing importance of paper in the North African context during this time period. I chose not to make my own pasteboard, in the interest of time. I imagine that each workshop would have had a stock of pre-made pasteboard to use when needed rather than making new sheets for each project. Perhaps pasteboard preparation would be a task for the apprentices. For the reproduction, I chose to use a 0.8mm binder’s board that mimics the thickness of true pasteboard. However, these boards are light blue in color, so I pasted an additional sheet of the paper I used within the codex onto either side of the board to, ensuring the replication of the appearance of pasteboard. Islamic boards are always flush with the textblock so I cut the boards to exactly the size of my textblock - 133mm by 200mm (Szirmai 1999: 54).

Additionally, I needed to cut the board for the pentagonal flap. Recall that one

---

4 A quick note on paste: I alternated between using Nori paste – a rice starch paste from Japan – and wheat starch paste that I prepared myself.
of the characteristic features of an Islamic binding is the flap, which extends from the lower cover and wraps around the fore edge. For each textblock, I carefully measured the spine to determine the size of the board that covers the fore edge. I then subtracted 2 board widths from the spine measure to make sure there was room for the linen attaching hinges without the fore edge board being too wide. It is important to have this piece as precisely measured as possible to have a book that lies perfectly flat, as was the custom. I then created a template for the pentagonal flap for a uniform shape on all three books.

**Byzantine wooden (poplar) covers**

Byzantine bindings used wooden boards for their book covers, most often of poplar wood with a vertical grain (Frederici & Houlis 1988). Boards are cut so that they lie perfectly flush against the textblock. They were often slightly rounded on the spine edge of the boards, creating the illusion of a curved spine.

Tom Castelli of the Exley Science Center Machine Shop very kindly cut poplar boards for me according to a template I constructed with the dimensions. Since Byzantine boards are flush with the textblock, the boards were cut to exactly the size of my textblock - 200mm by 150mm. The boards were cut to 11.7mm thick - the average thickness of the Byzantine codices from the Vatican collection (Szirmai 1999: 74). Mr. Castelli also rounded the spine edge of the boards.

Byzantine book boards often have a chiseled groove along the head, tail, and fore edges of the board. Though there is some variation, a triangular groove was the most common (Szirmai 1999: 75). This groove could have been carved with a
cabinet-maker’s chisel or alternatively, could be created by pasting two thinner beveled boards together to make one board (van Regemorter 1992b). I had Tom carve a triangular groove into three sides of my board to create this effect.

![Possible board grooves](image1.png)

**Figure 39a & b** - Possible board grooves

![Triangular grooved boards](image2.png)

**Figure 38** - Triangular grooved boards

It has been suggested that these grooves are meant to imitate the look of Coptic double pasteboard covers. Coptic pasteboards were made using papyrus and were covered with leather. The binder would then paste two boards together to form one cover with leather on both sides. The book cover would have a groove where the two boards came together. Byzantine binders would chisel the groove into the boards,
even when the board was made of only one layer of wood. Van Regemorter (1992a: 57) suggests that Byzantine binders carried on this tradition for aesthetic and cultural reasons. She claims that Byzantine ‘bibliophiles’ had grown to expect the groove. However, she does not provide any explanation as to how this Coptic feature became a standard Byzantine feature.
Van Regemorter vaguely points to the religious connection between Christian Copts and Byzantines to explain the board grooves, but she does not say if this link influenced the transmission of the trait or if Byzantine binders included grooves to invoke the early Christian tradition. She also suggests that Coptic binding only influenced Christian countries, which we know is not true. As I have discussed before, the Islamic manuscript incorporates many Coptic features and techniques. This makes me question her knowledge of various bookbinding practices and their cultural antecedents and I am lead to doubt her conclusions on this topic. However, earlier I identified a possible connection between the shape of Byzantine manuscripts (and thus their boards) and the shape of Coptic manuscripts. Are the board grooves another indication of this trend?

**Romanesque wood (oaken) covers**

Romanesque English boards were always made of **quarter-sawn** oak. Clarkson (1992) writes that it is highly suspect to find boards made of any other type of wood. Often the boards will have a slight wedge facing the spine edge, partly as a result of sawing the wood across the radials. However, this feature of the wood also serves a structural function. By placing the thicker edge of the boards towards the spine, there is more material to support the lacing tunnels that attach the textblock to the spine (Hadgraft 1998).

The boards are attached by lacing the alum-tawed sewing supports through a series of straight tunnels carved into the oak boards. These tunnels generally extend
10-20mm on to the board. Clarkson (1992) identifies two different types of lacing paths: short and long. With the short lacing path, the thong enters the tunnel, extends onto the outer face of the board, and passes through a hole in the board to end on the inner face of the board. The long lacing path begins the same, but extends further.

Figure 40 - a) short lacing path; b) long lacing path (Clarkson 1993: 188)

Mr. Castelli from the machine shop again cut my English oak boards. I specified that the dimensions of the boards should be 200mm by 136mm, with a thickness of 10.9mm – the mean thickness of English boards calculated by Szirmai (1999: 151). Tom was gracious enough to drive up to New Hampshire to find quartersawn oak - beautiful enough to make one wonder who would ever want to cover them up. Because oak is a slow-growing tree with only a small amount of growth each year, the rings are close together and quite pronounced, and as a result the boards are incredibly dense and heavy. Even though the English boards are slightly thinner and 14mm less wide, they are noticeably heavier than the poplar boards I used for my Byzantine binding.
I also asked Mr. Castelli to carve the channels used to lace in the alum-tawed sewing thongs. I chose to use the short-lacing path described by Clarkson because it seemed less complicated to carve. At each sewing station, Tom chiseled a small tunnel that opened on the outer-face of the board, which then ended in a hole around 20mm from the edge of the board. I measured the alum-tawed thongs to size the channels - wide enough to accommodate the width of the thongs, but not too wide that the thongs slipped and deep enough so that the thongs would be flush with the outer-face of the board.

In order to accommodate the endband, the boards would be **back-cornered**, with angled corners at the head and tail of the spine edge. This practice first appears on Romanesque manuscripts (Szirmai 1999: 156). This allows the endband to sit comfortably on top of the boards without protruding. On some English bindings, the binder carved a tunnel into the back cornering to house the endband core. Like the channels used to attach the boards, these tunnels emerge on the inner face of the boards and are secured with a wooden peg. It was necessary to drill these tunnels on the diagonal, anywhere from 35 to 75 degrees away from the spine edge, in order to reduce strain on the endband core (Hadgraft 1998).
Attaching the Boards to the Textblock

*Attaching the North African pasteboards*

There are two methods of attaching the sewn textblock to the pasteboards. The first method of board attachment is described in depth by ibn Badis and was used for pasteboard coverings. It is similar to modern *case bindings*, in which the book cover is prepared independently and then adhered to the textblock with paste. This method also incorporates a system of hinges made of paper that the binder would paste or sew to the textblock to then be pasted to the boards. The inherent weakness of this method of attachment accounts for the many examples of detached book covers surviving without a textblock.

The second method is almost exclusively used on manuscripts with wooden boards from Kairouan and there are no primary sources that describe this method. This process seems to have involved hinging on the textblock to the boards with thread. Binders would drill holes in the boards and then sew hinging loops with thread around the spine edge of the board. The binder would then anchor the textblock to the boards linking the sewing thread to the hinging loops (Szirmai 1999: 55). The hinges were then glued onto the boards and covered with the endpapers (Gacek 1993).

It is unclear if the boards were attached directly to the textblock at the time of sewing with the same thread as the sewing or if the loops were created with a different length of thread entirely. Additionally, it is unclear if the textblock was sewn
prior to board attachment or if the boards were sewn to the first quire as part of the textblock sewing process (Szirmai 1999: 55). If the textblock was sewn first and then attached to the boards, there would need to be three separate threads: one to sew the textblock, one to create the hinging loops on the covers, and another to link the textblock thread to the board thread. I use this method of board attachment on my Byzantine codices.

![Diagram of boards attachment](Image)

**Figure 41** - Boards are attached to textblock with same thread (Szirmai 1999: 55)

Even though I used pasteboard covers, I decided to attach the boards in the style usually used for wooden boards. I was most interested in this approach because it reflects a continuity of the Coptic tradition. Additionally, this attachment method is similar to that used on Byzantine manuscripts. I was interested in seeing if the difference in board materials would alter the effectiveness of the technique. This would provide a possible explanation for why North African binders changed to the case binding.
I actually prepared the hinging loops on the boards before I started sewing. I made my hinging loops out of the same thread I used to sew the textblock. I took extra care to avoid crossing the thread when I sewed the hinging loops. I pushed the knot into the hole and pasted down the loose ends in order to make the threads lie as evenly as possible on the board. I sewed my textblock directly to the hinges, so that each new gathering was sewn on directly to the board. After the twentieth gathering, I sewed on the second board, tied off the thread, and was finished with my sewing.

Though it was not terribly difficult to lace the boards, I imagine it would be considerably quicker to simply paste the cover directly onto the spine. This would also allow the covers to be decorated and covered before being attached to the textblock. This means two people could be working on one binding at the same time, speeding up the process.

This method of attaching the boards is incredibly weak. Though the quires of the textblock remained in place, the boards were only loosely joined to the textblock. This may have been a result of my unfamiliarity with the style, but I think it is more likely that this is simply a consequence of this rudimentary method of attachment.

*Figure 42 - Loose sewing and board attachment*
*Attaching the Byzantine wooden boards*

In order to attach the boards to the textblock, it was necessary to drill a series of holes through the board along the spine edge. These holes would be laced with thread, creating the hinges used to connect the boards and textblock.

The boards are attached to the textblock with thread that is looped through holes in the board. These holes are drilled perpendicularly into the boards. Most often there are the same number of holes for the attachment loops as there are sewing stations. Houlis (1993) has found some exceptions to this general rule, noting that on some bindings there are no loops to connect the kettle-stitches at the changeover stations to the boards.

As with the Islamic book, the boards of a Byzantine book needed to be laced with thread before they could be connected to the textblock. There appear to have been several methods of lacing the boards with thread to create the hinging loops, often with regional affiliations. However, for the purposes of this reproduction, I will only discuss the zigzag method, which is the most frequently employed technique. Like many aspects of the Byzantine manuscript, the zigzag method is adopted from late Coptic codices. For each sewing station on the textblock, two holes are drilled into the board surface, perpendicular to the spine. These holes can be drilled straight into the boards, or at an angle to minimize the appearance of the thread on the opposite side of the board (Szirmai 1999: 72). The thread is worked through the holes, looping around the edge of the board, up and back through the holes, and then crossing diagonally to the next set of holes. This type of lacing creates a zigzag pattern of thread on one side of the board. Most typically, the zigzags are on
the inner edge of the board (Frederici & Houlis 1988). In some instances, shallow channels are chiseled into the inner face of the board to accommodate the bulky thread and give the boards the appearance of a flush surface (Szirmai 1999: 64). The thread loops on the spine edge of the board are then used for attaching the textblock.

Figure 43 - Zigzag lacing (Frederici and Houlis 1988: 29)

Figure 44 - Zigzag lacing on Vatican 1549 (Frederici and Houlis 1988: 144)
It is not entirely clear how Byzantine bookbinders attached the textblock to the boards. The only way to fully understand the process requires complete access to both sides of the boards and the spine. However, this privileged access to the manuscript is rarely possible, as board covers, pastedowns, and spine linings obstruct the view. Though some books are damaged enough to reveal their hinging structures, there is simply not enough of this type of evidence to pull together a decisive theory of board attachment.

Szirmai neatly puts the theories into three categories (1999: 69). Method A stipulates that the binder uses the same thread to create the hinging loops and to sew the quires of the textblock. This means that after looping the thread in and around the wooden boards, the binder uses the same length of thread to attach the first several quires to the board. Szirmai notes that this method was likely the most efficient for sewing the book together in two halves (1999: 70).

Figure 45 - Board attachment A (Frederici and Houlis 1988: 24)
Houlis (1993) believes the evidence for this technique can be found by studying knots in the sewing thread. A knot in the center of a spine fold indicates where the binder added on more thread via weaver’s knot. Houlis notes a high frequency of knots in the first three/four quires and in the last three/four quires. He writes:

*It is illogical to suppose that the binder, about to sew a substantial number of quires, only used enough thread to sew a few. This leads one to surmise that the thread used to sew the first quires was from the same thread-length used for the [hinging loops]. This thread-length naturally could not be too long otherwise the binder would have had difficulty in linking to the boards.* (1999: 262)

However, of the 32 volumes he studied, only 9 display this structure, which does not provide enough evidence to suggest that this technique was employed frequently.

Method B is similar to how Islamic bookbinders hinged on the textblock. The boards are laced with hinging loops first and tied off. Then another length of thread is

*Figure 46 - Board Attachment B (Frederici and Houlis 1988: 25)*
used to link the first quire to the hinges. The binder then continues with this same thread to sew the rest of the quires of the textblock.

In Method C, the boards and the textblock are prepared independently, requiring the binder to use three different lengths of thread. The boards first receive the appropriate hinging loops and are tied off. Then the two halves of the textblock are sewn and joined together with the figure-eight knots. Any loose threads are knotted and tucked into the center of the gatherings. The textblock is attached to the board hinges with a single loop at each sewing station. Szirmai notes that Methods B and C may have been used for repairs rather than the primary binding (1999: 70). This makes sense because the weakest part of a Byzantine binding is the hinging loops. These loops frequently break. Instead of rebinding the entire manuscript, a binder may choose reattach the boards to the existing textblock by to creating a new set of hinges.

![Figure 47 - Board Attachment C (Frederici and Houlis 1988: 25)](image)
I chose to use Method C because it allowed me to evaluate the textblock as a separate component. Instead of having the textblock immediately joined to the boards, I wanted to isolate the textblock in order to compare it to the isolated Islamic and Romanesque textblocks.

I sewed my textblock in two halves before lacing the boards. I doubled the thread I used to create the zigzag pattern to lend some strength to the hinges. I ended up needing to drill larger holes where I had knotted the thread in order to hide the knot by pushing it into the hole. It took about 12 minutes to thread each board and a surprising 3 three meters of thread. To attach the textblock to the boards, I wrapped the thread once around the hinging loops and once around the sewing at the first gathering and knotted off. Like the Islamic book, this method of hinging did not seem to be the most stable. The boards hung very far from the edge of the textblock and wobbled around freely.

Figure 48 - Laced Byzantine board
Attaching the Romanesque wooden boards

In order to attach the boards to the Romanesque textblock, all I needed to do was pull the ends of the alum-tawed thongs through the pre-carved channels in the boards. It took a bit of time to adjust the thongs so that when the book was opened and closed the boards would lie flush with the textblock. After everything was in place I gently hammered a piece of wood into the hole from the outside to hold the thongs in place and then cut off the excess wood and leather. I could not find any information on exactly where these wooden pegs might have come from in the Middle Ages, but I assumed that were likely carved down from scrap pieces of wood. I ended up using clothespins as my peg. The slightly wedged shape of the tip of a clothespin is perfect for securing the thongs because it is easy to hammer in and very difficult to pull out.
Figure 50 - Board attachment steps
Creating the Spine Lining

The spine lining is a piece of material, usually cloth, that is adhered to the spine folds of the gatherings in order to provide uniform flexibility to the spine and to provide an even surface on which to paste the covers. Additionally, the spine lining may also serve to strengthen the attachment of the boards.

The North African Spine Lining

The spine is lined with an open-weave piece of linen, which extends onto the pasteboard covers in order to strengthen the board attachment. Ibn Badis describes using asphodel paste to adhere the linen to the spine (Bosch 1961). While pasting the linen to the spine, the binder has the opportunity to give the spine its final shape. Al-Ishbili tells us that the spine should be rounded in order to prevent the book from becoming concave. He argues that the spine flattens as time goes on, so by rounding the spine a binder can preemptively solve the problem of a protruding fore-edge flap (Gacek 1993).

There is a different method of attachment for the case binding. The spine lining is cut so that 20-25 mm of fabric hangs over either side of the spine in order to create a set of hinges. The case is then adhered to these hinges and the spine (Bosch and Petherbridge 1981: 56) (Szirmai 1999: 59). Strips of paper were often used to reinforce the hinges at the joint, as this kind of case binding came with the large risk of the textblock being ripped from the case due to the weakness of the paper. Additionally, the pastedowns could be used for additional joint support (Bosch and
I used the first method of spine lining because I had already attached my boards. I used a piece of pre-washed linen to cover the spine and attach the pieces of the pentagonal flap. On a sample book I made for practice, I followed al-Ishbili’s direction and rounded the spine, but I ran into several issues. Though I had no difficulty creating the shape as, I struggled to accommodate the curve when I was preparing the endband. I was not able to cut a flat piece of leather for the endband core that matched the shape of the curve and had ends that were able to fold neatly over the edges of the boards. I determined that it would have been much easier to create the chevron endband with a flat spine. However, as I will discuss below, the flat chevron endband was not the only style used by Islamic binders. Perhaps the rounded spine is more suited for these other styles. However, since I planned to create the chevron endband, I did not round the spine of my three final codices and instead created a flat spine.

Figure 51 - Islamic spine lining and flap attachment
The Byzantine Spine Lining

Byzantine bindings are lined with a swatch of cloth that extends onto the outer face of the boards, much like Islamic spine linings. Szirmai notes that the cloth used often had a coarse texture and could be blue (1999: 75). Though we cannot determine, it is generally assumed to be a type of starch paste.

I used a piece of linen cloth to cover my spine. I was not able to completely disguise the lumps of the figure-eight hitches, but I was able to mostly create the illusion of a flat back. The joining stitching pushed the center gatherings back, creating a large valley in the spine. The spine lining did a good job of minimizing the appearance of the valley and provided a smooth, even surface for applying the leather covering.

Figure 52 - Byzantine lined spine
**The Romanesque Spine lining**

The spine was lined with chamois leather, an oil tanned leather known for its resilience. Sometimes the tab was an extension of the spine lining, with one long piece of leather covering the length of the book and extending past the endbands. However, the spine lining could also be a simple patch lining. Separate pieces of leather would be used to construct the tab and to cover the spaces in between the sewing stations without covering the thongs. Oftentimes, multiple layers of chamois would be used, so a patch lining could be covered with a full-spine lining (Szirmai 1999: 158). The lining was attached with a heavy coating of paste, more likely a starch paste than an animal-based glue.

I chose to use a patch spine lining so I would not have to cover my herringbone stitch. I cut a piece of alum-tawed skin to the size of the gap in between the thongs and pared down the edges for easy application. I then applied paste to the flesh side of the skin and attached the leather to the gatherings and the edges of the boards.

![Figure 53 - Patch spine lining and spine tabs](image-url)
**ENDBANDS**

An **endband** is a functional or ornamental band at the head and the tail of the book. The endband consists of a **core**, usually a thin strip of leather or cord, which is affixed to the edge of the textblock with threads that are sewn, or **tied down**, to each gathering. The **primary endband** refers to the first endband sewing. The **secondary endband** refers to additional sewing on top of the primary endband, usually decorative.

**Crafting the North African Chevron Endbands:**

After the edges of the textblock were trimmed to be perfectly flush with the boards, endbands were attached to the head and the tail of the manuscript. With the book tilted upwards in the press, the binder would paste a thin strip of leather to the edge of the textblock, creating the endband core. This strip was both practical and decorative. It would prevent the threads of the primary endband from slicing through the center of the quires and gave the sewn endband a rounded three-dimensional appearance (Bosch and Petherbridge 1981: 53).

The sewing of the endband takes place in two stages. The first stage involves the construction of the primary endband. The thread of the primary endband is often colored silk and usually the same material as the textblock sewing thread. Starting at the first quire, the primary endband thread passes through the inside fold of each gathering and exits from the spine, generally 30-40mm from the edge of textblock (Bosch and Petherbridge 1981: 54). The thread then crosses over the endband core
and enters the following quire. This process produces a series of parallel threads that resemble the warps of a loom.

The secondary endband is woven through the loom created by the primary endband and is purely decorative. Most often, the binder will use two silk threads in different colors to produce a small woven pattern (Szirmai 1999: 58). The bi-colored chevron endband is characteristic of Islamic bindings of the Maghreb and the Near East (Bosch and Petherbridge 1981: 53). Though there is little evidence for this style endband on the Kairouan bindings (as only primary endbands and leather cores have survived on a very small number of the bindings), François Déroche (1986) has found evidence of chevron endbands on a ninth century manuscript from Damascus. It is therefore possible that Islamic North African manuscripts could have also used the standard Islamic chevron endband, as the style was known during this period.

I decided to do a chevron endband using the linen primary sewing thread for the primary endband and blue and yellow silk thread for the secondary endband. It took around 12 minutes to sew the primary endband around the leather core. The only
issue I encountered was the leather core slipping down the spine after it had been pasted down and sewed over. My temptation at first was to just undo the sewing and start from scratch, but I was able to use a pair of tweezers and a needle awl to jimmy the leather core back up to the edge of the textblock in a less invasive procedure. Of course there is no way of knowing what a North African binder would have done in such a scenario.

Figure 54 - Chevron Endband
Even though the chevron secondary endband has no structural function and is purely decorative weaving, it was the longest part of the entire forwarding process. Each endband took me an hour and a half to complete and I was not able to cut my time down at all by the sixth endband. Though sewing the chevron pattern was simply a matter of twisting the two strands of thread together in the proper direction, it was a challenge to create the chevron pattern. This was another scenario in which tension was everything. I worked with a pair of tweezers and an awl to constantly readjust my sewing to create the illusion of even stitches. At first, I was only able to fit four rows of chevrons on the endband, but as my weaving became more consistent and refined, I was able to sew five rows. Then as I became more confident with the stitch, I focused my efforts to working the silk. In between each stitch, I re-twisted my thread in order to create the sheen that characterizes fine silk sewing. The re-twisting aligns the plies of the thread so that they line up with the plies on the other rows, creating a mirror-like shine across the surface of the endband. In the bright desert sun, I imagine this effect would be eye-catching and would add a little glint to the leather-bound volume.

**Crafting the Byzantine Endbands**

The three holes for the endband were drilled into the top and bottom of the board at an angle, so that the endband thread would enter through the top of the board and exit on the inside cover with the triangular groove stopping at the endband holes. There are generally three or four tunnels on either side of the spine for
attaching the endband. The tunnels are drilled obliquely into the boards, allowing the endband thread to pass through the top of the board and lay flat against the board when it exits. Additionally, because the endbands protrude over the edge of the board, it is illogical to shelve the book vertically. This lends extra strength to the book because it forces the manuscript to be stored horizontally, which is gentler on the binding.

The core of the Greek endband is most frequently made of cord, though there are examples of leather or rolled parchment cores. One of the unique features of the standard Greek endband is the double core (Szirmai 1999: 77). The first core sits directly on top of the textblock with the second cord resting right on top. The endbanding thread is woven between the two cores, making this structure incredibly strong and resilient (Boudalis 2007).

Figure 55 - Greek on two cores endband (Boudalis 2007: )
Though there are many remaining Byzantine endbands from the period after the fifteenth century, very few survive from the eleventh and twelfth centuries. Even if the textblock dates from this period, most manuscripts were rebound in the intervening centuries with new endbands. Therefore, it is difficult to say with any certainty what an eleventh century endband may have looked like.

Al-Ishbili, a century bookbinder who wrote a treatise on Arabic bookbinding, offers the only written description of Byzantine endbands. He writes that eight types of Greek endbands were known; yet he is only able to describe four of them. There is an endband of one color, an endband with alternating colors that resembles a chessboard, and two types of chevron endbands (Gacek 1990).

Boudalis (2007) includes one photograph of a century binding (fig. 7, Sinai Greek 263) with a contemporary endband, though offers no detail beyond that one core was made of rolled parchment. After studying the image, I have determined the endband is constructed with a double core. The second core appears to be made of a thinner cord. The sewing appears to wrap around both cores in some places and seems to dart in between the two cores at other places. The endband thread is not wrapped perfectly vertically, though I cannot tell with certainty if the sewing on the first core is intentionally oblique or if the some of the threads have slipped out of place over time. The endband appears to be made of a natural-colored thread and is tied down at every quire.
Based on Boudalis’ extensive endband typology, I am tempted to say that the endband on the Sinai Greek 263 manuscript is some variation on the Greek-on-two-cores style endband, without any secondary endband sewing. However, in order to have any real understanding of eleventh and twelfth century endbands, I need more than one grainy photograph. It has proven challenging to find manuscripts from this period with their original endbands for several reasons. It is very rare to find a manuscript this old that has not been rebound at some point. However, perhaps most frustratingly, very few catalogues provide this type of detailed information on bindings. Most are instead concerned with the text, illumination, and less often the decorative elements of the cover. The only satisfactory source I have found that focuses in depth on the binding features is Frederici and Houlis’ study of the Vatican manuscripts (1988).

Due to the lack of evidence, I was forced to turn to trial and error experimentation in order to understand the eleventh century endband. I first
experimented with creating rolled parchment cores to see if I could mimic the twelfth century endband described by Boudalis. I was skeptical of the idea of a parchment endband core because parchment is something of an inflexible material. I could not imagine a scenario in which a parchment endband would allow the book free range of motion.

As it turns out, my suspicions were correct. I tried six different methods of preparing the parchment cores and I was unable to find a single one that would be suitable for an endband. I pared a piece of soaked parchment quite thin, hoping that by removing much of the bulk I would be able to promote flexibility. I then cut this piece into six smaller pieces. I tried folding the parchment into a core, rolling it several ways, wrapping it around a piece of thread, and then wrapping it around a wooden dowel. After applying huge glops of paste to the cores, I allowed them to dry overnight. When I returned the next morning, the dried cores were just as stiff as before. Instead of bending in multiple directions, they would crease and then snap. From this experiment, I determined that it would not have been structurally beneficial to use a rolled parchment core over a piece of cord or rolled leather. Maybe there is some parchment preparation technique that I am not aware of that would have created the perfect parchment endband core.

After the parchment incident, I decided the cut my losses and abandon the idea of reconstructing the twelfth century endband in Boudalis’s article. The information he provides is so sparse and the picture is so vague, I was not confident that my finished product would be authentic if I decided to experiment. I instead decided to use a helical with core endband for my primary sewing (the same as the
Islamic primary endband) with a buttonhole stitch as my secondary endband.

According to Boudalis, this is the same stitch found on Coptic codices and the Stonyhurst Gospel from the seventh century (2007: 35). In addition, a late twelfth century manuscript from the Metropolitan Museum (2001.730) uses a buttonhole endband. Though the cataloguing does not indicate if the manuscript has been rebound, the absence of the traditional Greek endband leads me believe to it has not been.

It took me about an hour to complete the primary and secondary sewing for this endband. I used a 20-ply linen cord for my endband, which protruded about 6mm from the edge of the spine. Instead of only attaching buttonhole stitches to the primary endband thread, I decided to pack my sewing – sewing in the spaces between the primary threads in order to give the endband a uniform appearance. This way, the secondary endband is continuous and has no gaps where the cord shows through.

Once I had completed my endband, I returned to the endband on the Metropolitan manuscript. My endband was much smaller and did not protrude as far off the edges of the boards. After a closer look, I realize I misinterpreted the

Figure 57 - Buttonhole stitch endband on 2001.730
Metropolitan photograph. The Metropolitan endband actually appears to be made with two endband cores, rather than one. Though the functional primary endband was the same on both my manuscript and the Metropolitan manuscript, the decorative buttonhole stitching was slightly different. The first core was tied down at each station. The second core was attached to the sewing of the first with the buttonhole stitch. The additional core on the original manuscript was purely to increase the size of protruding endband, indicating that there may have been a preference for pronounced endbands.

**Figure 58** - Completed endband

**Figure 60** - Primary Endband

**Figure 59** - Tie downs on board
Crafting the Romanesque tab endband

One of the most unique features of the Romanesque manuscript is the tab endbands, which are leather extensions on either edge of the spine that serve as a backing for the endband. The binder would cut a piece of heavy alum-tawed skin with a fabric (probably linen) backing into a rounded shape and would attach this piece to the spine with paste. Often, these tabs would have fabric hinges that could be pasted to the board (Clarkson 1993).

The endband would be sewn right through the leather tab. Using the same thread as the textblock sewing, binders could construct the endband with a slit-tawed core or a cord core. Clarkson (1993) provides the only description of tab endbands, but he fails to adequately explain the mechanics of sewing the primary endband. Looking at his Figure 10, it appears that the endband had packed sewing along the core. On the back side of the tab, there appears to be a back bead and tie down at every quire.

For my endbands, I used a single core of rolled alum-tawed skin. Though many Romanesque bindings used a split piece of leather, six pre-1200 manuscripts at Hereford Cathedral have single core endbands (O.I.6, O.III.6, O.III.8: II.10: IV.11). I threaded the ends of the cores through a hole in the boards and secured them with a peg made from a bamboo skewer.

I made my tabs out of alum-tawed skin and linen cloth for the backing. I did a buttonhole stitch around the perimeter to make the edges look neat. Alum-tawed skin is very strong and is not punctured easily, so I pre-pricked the holes for the sewing. The English monks might have used a glover’s needle – a triangular needle used by
glove makers designed to punch holes in leather. In interest of time, however, I used a modern Japanese screw punch.

Figure 61 - Spine tab endband (Clarkson 1993: 144)

Figure 62 - Cross-section of spine tab endband
(Szirmai 1999: 145)
It took me about 45 minutes to complete a single endband. Most of this time I spent struggling to force the needle out of the gatherings. I tied down my endband at the outermost sewing stations where I had sewn the kettle stitch. The pricks I had prepared prior to sewing the textblock were just large enough to accommodate the sewing thread and the endband thread, but not the needle. At each gathering, I needed to coax the needle out the other end by pushing and pulling it. Needles, being so thin, are difficult to grasp, so initially I used a pair of pliers to pull the needle through the gathering. However, I could not find any evidence to support the existence of pliers in Medieval England, so I was compelled to find a historically authentic tool. As a compromise, I chose to use a small piece of scrap leather between my fingers to aid my grip. Though it certainly was not as effective as the pliers, this method did ease the process. However, it did not protect my fingers from being pricked. I needed to use several different scraps because I kept bloodying the others.

Figure 63 - Spine Tab Endband
Discussion

The forwarding process for all three codices was a multi-day affair, largely because the spine lining needed at least 24 hours to dry. In terms of minutes spent actively working, the Islamic and the Byzantine each took about two hours and fifteen minutes. However, the distribution of the time spent on each step varied from style to style. The Romanesque took only about an hour and forty-five minutes. To attach the textblock to the boards, it took 20 minutes for the Islamic codex; 40 minutes for the Byzantine; and 20 for the Romanesque. The Byzantine boards took longer to attach because I needed to lace the boards with the hinging loops. To adhere the spine lining, it took 20 minutes for both the Islamic and Byzantine; and 30 minutes for the Romanesque because I needed to pare the leather. For the endbands, the Islamic took 20 minutes for the primary and 90 minutes for the secondary; the Byzantine took 30 for the primary and 45 for the secondary. The Romanesque endband was only a primary and took an hour.

Not reflected in this data, however, is the time spent preparing the boards. Each codex was meant to have boards flush with the textblock, requiring the binder to specially craft the boards for each text. For the North African binders, this process would have been as simple as cutting out the appropriate pieces from a stock of pre-made pasteboard. However, for the English and Byzantines, cutting and preparing the wooden boards was a much greater task. It is unclear if the same person responsible for sewing the endbands or pasting the spine lining was the same person responsible for cutting the boards. In a monastery, it is possible that this task was outsourced to the cabinetry monks, just as I outsourced my boards to the machine shop. However, it
may have been possible to do the smaller tasks such as drilling holes and carving the board grooves in house. The boards were specially prepared in order to fit the specifications of the sewn textblock. That is, the position of the sewing stations on the boards was determined by their position on the textblock and not the other way around. Unless the binder possessed great foresight, the boards were probably prepared after sewing had taken place, adding days to the turnaround time. Whereas an Islamic binder was always at attention and ready to bind an incoming textblock, the Romanesque and Byzantine binder would have needed ample time to procure materials.

This study of boards also speaks to the relative portability of each manuscript. Pasteboard covers are light and flexible and could have easily been shoved in a knapsack for a long journey. It would have been feasible to transport many manuscripts from centers of book production to decentralized regions, allowing widespread access to manuscripts.

The Byzantine and Romanesque books, on the other hand, were less apt to travel due to the wooden boards, which added both weight and width to the manuscript. The typical Romanesque manuscript, as evidenced in Appendix A, was generally much larger than my facsimile. With their heavy oaken boards, it would have been quite cumbersome just to move the volume from room to room, never mind across the hilly English landscape. However, the weight of the boards may not have been viewed as negative performance characteristic, but rather positive and desired. If manuscripts could hardly move around the monastery, they would certainly be difficult to steal. In fact, many Romanesque manuscripts show evidence
of having been chained to shelves and desks as a theft precaution (Clemens and Graham 2007). On the material level, the heavy oak boards would have compressed the parchment leaves and prevented them from warping in humid conditions – certainly a legitimate concern in rainy England.

The poplar boards of the Byzantine manuscript, though larger, are not nearly as heavy as the Romanesque boards. Poplar trees have the ability to grow very tall very quickly, so the wood tends to be soft and porous, making for a lightweight board (Poplar 2014). Thus, a Byzantine manuscript would have been less arduous to travel with than a comparably sized Romanesque manuscript. This might have been advantageous for the transmission of texts. Monastic libraries often lent out their texts for copying, as manuscripts were scarce among the laity. Though this would be a compelling reason for choosing poplar boards, there is no direct, causal evidence to suggest that portability was the intended consequence of lightweight poplar boards. Poplar may have been cheap, readily available, or valued for its lightness for another culturally constructed reason.

The board attachment, spine lining, and endband all contribute to the mobility of the binding, determining how the codex opens for reading. When comparing the three bindings, it was immediately evident that the forwarding process of the North African codex actually hindered the mobility of the textblock. Though the chevron endband is nice to look at, it significantly limited how much the book could open. Prior to the addition of the endband, the book could be opened to a flat 180 degrees. With the endband, I could scarcely open the book past 90 or 100 degrees.
Szirmai suggests that the weakness of this kind of binding may have motivated the invention of the *rahl*, a type of book cradle popular in the Middle East (1999: 57). The cradle prevented the book from being open more than 100°. Likewise, it is possible that the use of the *rahl* discouraged binders from experimenting with more flexible endbands. Despite the negative performance characteristics associated with the chevron endband, North African binders devoted nearly two hours to its creation – four times longer than they devoted to the sewing of the textblock. The limited opening capacity caused by the chevron endband would have prevented readers from seeing the text closest to the inside margins. The combination of these two consequences reads a preference for the aesthetically pleasing endband and little concern for the readability of the text.
The opening characteristics of Byzantine codex were not improved in the forwarding process. The pages of the forwarded manuscript no longer lay flat. The spine lining and the endband make the leaves stiff and slightly resistant to turning.

![Opening action of Byzantine binding](image)

**Figure 66 - Opening action of Byzantine binding**

Though the forwarding of the Byzantine manuscript does not contribute to its opening characteristics in any meaningful way, the combination of forwarding processes work together to create strength and stability in the attachment of the boards. The endbands of Byzantine binding are critical to the overall structural integrity of the manuscript. According to Giorgios Boudalis (2007), long after the hinging loops have broken, there are many manuscripts in which the endband is the only surviving attachment between the textblock and the boards. This is because Byzantine endbands extend 20-30mm onto the wooden boards and are tied down through the holes in the boards, as well as being tied down at each quire. These linings are meant to strengthen the board attachment. Even in instances of broken
hinging loops, the cloth spine lining is strong enough to keep boards attached to the textblock (Szirmai 1999: 75).

The Romanesque codex, on the other hand, is flexible and handles the manipulations of the reader with grace and strength. This observation is not unique to me. David Link Frost, an obvious advocate of the Romanesque binding, writes,

“Here the opening is self restraining as the heavy sewing supports resist a sharp throw-up and tend to cantilever off the text back causing the fold stitches to tighten. The boards are more influential in their control of the opening motions as their leverage is directly transmitted to the text through the laced support, and through other components, such as the vellum back linings” (1996: 93).

He compares the motion of the text to the continuous, self-induced mobility of a Slinky. “Such action in books is exemplary, enabling the relatively great leverage of the boards to be dissipated and utilized without hazard to the structure” (Link Frost 1996: 95). Among bookbinders, supported sewn binding laced into wooden boards - that is, the Romanesque binding – is considered the pinnacle of binding structures.

Figure 67 - Opening action of English binding
This comparison offers some very interesting insights into the *habitus* of medieval binders and the literate community. I was fascinated by the indifference of Islamic binders. I understood why they might have chosen to use the Coptic link stitch, despite its weakness. Speed necessitates technical compromises. At the rate at which the Islamic world was churning out manuscripts, it is reasonable to choose speed over strength. However, to deliberately choose to incorporate a feature that inhibits the reader’s ability to actually read is shocking.

What is more shocking is that to create this feature was the longest part of the entire sewing and forwarding process. In fact, it took twice as long to construct the chevron endband as it did to sew the textblock, attach the boards, and line the spine. I am forced to question the motivations of North African book consumers. Were they genuinely interested in partaking in text-based knowledge, or were they primarily motivated to purchase manuscripts for their decorative value? As I discussed in the introduction to medieval North Africa, books were considered a prestige item that displayed social status and cultivation. However, I did not expect the technology to so blatantly reflect this materialism.

Byzantine bindings yet again show concern for strength above all else. However, what I find most interesting is that the Byzantine binding is really only a variation on the Coptic binding. Despite a demonstrated significance placed on structural durability, there seems to be little innovation. Houlis’s study of knots reveals that the weakness of the hinging method of board attachment was a legitimate problem that binders constantly needed to repair. But instead of addressing the
weakness of the hinged board attachment by actually changing the way the boards were attached, the Byzantines instead developed a new ultra strong endband tied down onto the boards. The endband proved to be so strong that when the boards detached (and they did detach), they would still be connected via the endband. This seems to be an entirely roundabout way of solving the true problem. In fact, as I will discuss in the new chapter, the raised endband actually created problems of its own when it came to covering bound volume. Coupled with the Coptic-inspired grooved book boards, which served no functional purpose, there is a clear trend of cultural conservatism with Byzantine bookbinding. Yet, why harken back to the olden days of the Copts?

The Romanesque binding is the only example of true technological innovation. From the supported sewing to the tunnels for attaching the boards, the Romanesque binders developed solutions that not only fixed structural flaws of the Coptic and Carolingian codices, but these improvements actually enhanced the reader’s experience with the text. From these observations, I understand the Romanesque codex as the working codex. By this, I mean that Romanesque binders understood that the book was more than just a decorative item, but rather a tool. As a tool, it would be forced to endure frequent use and as a consequence, abuse. Thus, they designed the binding to be resilient, but also malleable and self-healing. And though the Byzantines were also concerned with strength (yet, were wholly unwilling re-design), there is a fundamental difference between the Byzantine binder and the Romanesque binder. The Romanesque binder was not only concerned with the effect of the reader on the manuscript, but also the effect of the manuscript on the reader. He
designed the binding so that the pages would lie flat unattended, so that the pages were buoyant and turned gently. An industrial designer today might say this is attention to ergonomics. However, an archaeologist or a theorist of materiality would say this is attention to the agency of objects, the reflexivity of human-object relationships. That is, the reader acts on the manuscript, but the manuscript also acts on the reader. What is common to both interpretations is that the binder took the opportunity to enhance the act of study through materiality. This higher order of thought is unique to the Romanesque tradition.
FINISHING

*Finishing* refers to the final process of decorating the outside of the manuscript. This includes covering the forwarded work with leather or cloth, using iron tools to impress leather designs on the cover, and adding clasps to keep the covers of the book shut.

Covering Materials

*Selecting an appropriate North African Leather*

Islamic bookbinders are known for using finely pared leather on their manuscripts and North African books are no different. Between the tenth and the twelfth century, North Africa produced some of the highest quality leather of the time, exporting their goods as far as Baghdad (Bosch and Petherbridge 1981: 58). Islamic bookbinders were required to have a strong working knowledge of leather preparation, as they rarely used skins from the tannery without making modifications of their own. After selecting a skin, ibn Badis instructs binders to wash the leather again in a bath of warm salt water to soften the texture. Once nearly dry, ibn Badis instructs the reader how to pare the leather without tearing through the skin (Bosch 1961). Typically the paring knife was curved with a bevel facing the leather, unlike most European knives, which had the bevel facing the opposite direction (Bosch and Petherbridge 1981: 63). A combination of this unique paring knife and short, precise strokes allowed the binder to pare the leather quite thin.
Nearly all of the Kairouan bindings are covered in red-brown sheepskin, but there are at least nine bindings from the eleventh century that are covered in a black goatskin (Marçais & Poinssot 1948). It is likely that these skins are of local origin, as the Maghreb was huge center of leather production. However, ibn Badis describes in depth how to dye leather a variety of colors, including red, yellow, and green (Bosch 1961). According to Bosch, these are the most common colors of Islamic bookbindings (Bosch and Petherbridge 1981: 61).

Though it would have been interesting to follow ibn Badis’ instructions for preparing bookbinding leather, I decided that this process was well beyond the scope of my timeframe and budget. I decided to find a quality leather on my own that might have met Ibn Badis’ rigorous standards for bookbinding. I wanted to find a skin that was already thinly pared and soft enough for tooling. Talas, a professional book conservation supplier, recommended that I look at the Oasis goatskin line from Russells Fine Leathers. The skins themselves are from Nigeria and are vegetable tanned and aniline dyed in the United Kingdom. These skins are known for their shallow grain and smooth finish and are pared to a slim 1mm (Young 1995: 28). This leather fit all of my specifications, so I turned to the sample book to find the right shade.

Instead of searching for a red-brown sheepskin that would imitate the manuscripts at Kairouan, ibn Badis’ discussion of leather dyeing inspired me to choose a colored leather for my manuscript. I wanted to be authentic with my choice, so I was lent a scrap piece of Nigerian goat leather tanned in the traditional manner and dyed with Brazil-wood to use as reference. According to ibn Badis, to obtain red
dye, powered Brazil-wood is added to water and boiled down to a thick liquid. This paste is then diluted and painted onto the skin. The final step involved rubbing dilute alum into the skin to remove moisture and prevent rotting. The skin is then rinsed and hung to dry (Bosch 1961). Based on my sample leather, the final result is not a brilliant red color, but rather a dark burnt orange. The “terra cotta” shade in the Russells line was a near perfect match to the Nigerian sample.

Figure 68 - Brazilwood dyed leather (right) and Russells Oasis in Terra Cotta
Selecting an appropriate Byzantine leather

With the exception of treasure bindings, which were covered in fine textiles, the typical Byzantine codex was covered with leather. Van Regemorter (1992b) suggests that the leather was likely either goat or sheepskin and were generally brown, red-brown, or black in color. Van Regemorter notes that some skins had a fine-grained morocco finish. Byzantine binders did not pare their leather and often used the raw edges of the skin to make their turn-ins (Frederici and Houlis 1988).

For the Byzantine leather, I chose a Nigerian goatskin leather from Harmatan Leathers. Though the leather was pared down more than I would have wanted for a Byzantine book, the skin was soft, supple and perfect for blind tooling. I selected the Maroon 25 finish for my skin, thinking it would match the red-brown leathers described by van Regemorter. The maroon color turned out to be more purple than red-brown. Though the color was not entirely authentic, it in no way altered my experience covering the manuscript.

Figure 69 - Harmatan goatskin and uncovered Byzantine book
Selecting an appropriate Romanesque leather

The most frequent covering used on English books was thinly pared alum-tawed calf or sheep leather. Hadgraft writes, “The primary covering…was probably sampled to encourage close fitting - giving rise to an almost skeletal appearance” (1998: 70). This white skin could be quite stretchy and created neat turn-ins on the inner face of the board (Clarkson 1993). In fact, on many examples, the skin was so thin that it did not need to be pared at the edges. White alum-tawed skin could be stained with color, usually kermes scarlet, green and blue (Clarkson 1993: 194).

Clarkson is quick to note the difference between staining and dyeing – staining involved covering the surface with pigment, dyeing involved immersing the skin entirely in liquid dye. Most English covers are not tooled, but in the rare instances that they are, brown vegetable-tanned leather is used to cover the manuscript (Szirmai 1999: 162).

I chose not to cover my Romanesque codex with a primary covering of leather in order to allow the sewing to remain exposed. I instead chose to sew a lightweight book jacket called a ‘chemise’. English monastic books were often finished with a secondary covering called a chemise. Much like modern-day dust jackets, chemises are detachable coverings that attach to the upper and lower cover with sewn-in pockets. Medieval chemise bindings also had flaps that extended beyond the covers to fold over the exposed edges of the textblock. These extra covers were meant to provide an additional layer of protection for the manuscript and in some cases, the chemise served as the only cover on the manuscript (Szirmai 1999: 165)
In the eleventh and twelfth centuries, the chemise covering was almost exclusively made of alum-tawed skin (Szirmai 1999: 165). However, Bearman notes that the English chemise could have also been made from chamois leather. I used chamois leather made from buckskin that was generously donated by my advisor, Michaelle. Like alum-tawed skin, chamois is an incredibly durable material. It also has the additional benefit of stretch, which allowed the chemise to sling snugly to the covers of the codex.

Figure 70 - Diagram of chemise (Clarkson 1993: 184)
Covering the Codex

North African covering techniques

I chose to cover my North African manuscript with one piece of leather, though there is evidence that multiple pieces could be used to create the covering. According to Marçais and Poinssot, the boards of the Kairouan manuscripts could be covered with one continuous piece of leather or they could be covered with three pieces – one for each board and one for the spine (Marçais & Poinssot 1948: 16). Al-Ishbili says that two pieces of leather could be used, but only if the pentagonal flap was prepared separately (cited in Gacek 1991: 109). Since my boards and pentagonal flap were already attached to the textblock, I did not need to use multiple pieces of leather.

After cutting out an appropriately sized piece of leather, I set out to work on paring down the edges of the covering so that they would adhere to the edges of the boards. As this was my first time working with leather, I did not feel comfortable using a paring knife. As my leather had already been pared quite thin, I doubted my ability to shave off the remaining millimeter of flesh without cutting through the epidermis of the skin. Instead of using a knife, I used a paring machine called a Scharff n Fix. Though this is absolutely not a historically accurate technique, I felt it was justified in this case, as I chose not to replicate the earlier stages of North African leather preparation.
The first step when covering with leather is to thoroughly dampen the skin so that the adhesive will penetrate the material. After applying a generous coating of paste to the flesh side of the skin, I placed the manuscript onto the leather and attached the cover by smoothing the leather over the boards. Using my hands and a folder, I made sure that the leather was well adhered to the boards by pressing out air and wrinkles in the skin.

The next step was to paste the edges of the leather, or the turn-ins, onto the inside of the boards. Islamic binders did not miter the corners of their turn-ins so that the edges of leather would not overlap. They simply folded the corners with a lap-miter (Bosch and Petherbridge 1981: 64). I found that it was difficult to make the corners of the leather stay adhered, as the paste was not strong enough to keep the two layers of leather together. To solve this problem, I used pressure to aid the paste, placing small weights on top of the problem areas. There was no evidence in the literature to suggest that weights were used to help the adhesion of the cover. This

Figure 71 - Three leather covers cut to size
was problem solving on my part. However, I do not doubt that a North African bindery would have had weights on hand to compress wet paper.

**Figure 72** - Leather turn-ins

**Figure 73** - Lap mitering on boards and flap
**Byzantine Covering Techniques**

Because the endbands extend over the edges of the board, the covered Byzantine manuscript must have raised turn-ins at the head and tail, which gives the finished volume ‘cheeks’ (Szirmai 1999: 79). In order to do this, the binder would make a short cut in the leather at the turn-in. Grosdidier de Matons argues that the turn-ins were cut at the corner, following angle of board. This technique left edges of board near the spine uncovered, so the binder would create a leather patch to cover the gap (1991: 418) According to Szirmai, nearly 40% of the turn-ins he studied were neatly mitred with a single straight cut (1999: 79-80).

I began the covering process for the Byzantine book in the same way as I did for the Islamic book. I moistened the leather, applied a coating of paste, and smoothed the cover over the boards and spine. However, the nature of the raised endbands and the grooved board edges added an additional layer of difficulty to this project. To make the cheeks around the endband, I made two diagonal cuts in the leather and folded the skin so that it matched the height of the endband. Using my hands and a folder, I molded the folded edge around the endband. The molding process took about 10 minutes for each endband.

The most difficult part of this process were the turn-ins on account of the grooved board edges. Though the leather adhered nicely to the inside of the grooves, it was not clear how I was supposed to cut the leather around the corners of the board so that I could make the turn-ins. I needed to make my own template for cutting the leather so that it would neatly wrap around the corners. I used a piece of paper to test
different approaches to cutting the cover around the corners. This process of trial and error helped me to design a pattern for cutting the leather around the corners.

Figure 76 - Covered spine with visible sewing

Figure 74 - Turn-in

Figure 75 - Endband "cheek" and covered grooves
Including the time it took me to make this pattern, I spent two and a half hours covering my Byzantine manuscript. When making my pattern, I struggled to conceptualize how to use a two-dimensional material to cover the three-dimensional Byzantine boards. This was not an issue for the Islamic manuscript, as the flat pasteboards were just as flat as the leather covering. For an experienced Byzantine binder, however, the covering process would not have been a spatial reasoning puzzle like it was for me. He would not have needed to make a new pattern for each new manuscript because his mechanical knowledge of the process would have been embedded in his body knowledge.

Romanesque

Clarkson suggests that each chemise was made to order at the time of binding because the pockets of the chemise fit very snugly around the edges of the boards (1993: 197). The continuous piece of skin needed to be big enough to cover the book with enough extra material to form a ‘skirt’ that covered the edges of the textblock. Generally, the skirt would be about half the thickness of the book, so that when the book was closed, the material would meet in the middle of the textblock to cover the head and tail (Clarkson 1993: 198).

Figure 77 - Chemise Diagram (Szirmai 1999: 165)
After the piece of skin was cut, the next step was to sew the envelope-pocket for the book boards. Around the lower board, the skin was folded over the edge of the board and sewed at the head and tail with a simple running stitch. The flap of the upper cover was meant to cover the fore-edge of the textblock, so a simple running stitch was used on three sides of the board to separate the pocket from the fore-edge flap (Clarkson 1993). On Osborn a56 at the Beinecke library, the extant chemise was very casually sewn together, with only 5 very loose running stitches.

![Figure 78 - Detail of stitching on Osborn a56](image1)

![Figure 79 - Chemise envelope pocket on Osborn a56](image2)
The strap and pin fastening could still be used with the chemise. The pin would poke through the chemise on the lower cover of the manuscript (Bearman 1996: 166). The fastening was attached to the boards underneath the chemise and protruded through a slit in the fore-edge flap. It could be attached to the chemise itself with a small thread tacket for easier opening (Clarkson 1996).

The chemise was very quick and very easy to make. After cutting out a rectangular piece of chamois, I prepared my sewing holes with the screw punch. Then, I just folded the edges of the chamois in to create the flaps and button hole-stitched the two pieces together. When I had created the flaps, I slipped the manuscript inside of my chemise and marked where I needed to sew the pockets so they fit around the boards. I used the basic running stitch to sew the pockets closed. After about an hour total, my chemise was complete.

Figure 80 - Chemise
**Decoration**

**Islamic Blind Tooling**

Sufyani writes the cover decoration took place immediately after covering the book, while the leather was still wet. Some scholars have suggested that the tools were heated before they were impressed on the leather. However, an examination of the surviving tools reveals that this was not possible. The tools consisted of only a metal shank without a handle. If these tools were heated, they would have also burned the hands of the binder. Additionally, there is evidence of hammer marks on the ends of the shanks, indicating that the tools were impressed with force (Szirmai 1999: 59).

According to Petersen (1954), the blind-tooling of the Kairouan manuscripts was done on moistened leather with unheated irons. Over 240 different stamps were used to decorate the Kairouan covers. Though there is a great variety in the ornamentation, the covers always consisted of a panel framed by some type of border, often a twisted rope pattern. Fifteen of the eleventh century bindings have “small central ornamentation of circular, diamond, or star-shaped contours” (Petersen 1954: 51). Nine of the eleventh century bindings have relief decoration, created by a pattern of raised cords attached to the board underneath the leather covering.

I decorated the covers right after I had finished attaching the leather. Even though I had planned the design in advance, it took nearly two hours to finish just the upper cover and flap. This was because I needed to go over my stamps once or twice more in order to have a clear and deep impression. The decorating process also required a lot of upper body strength in order to apply enough pressure to make an imprint in the leather. I found it easiest to tool when the book was on a low
workbench because it allowed me to mobilize my entire body weight to bear down on
the stamp.

Figure 81 - Eleventh Century Kairouan Model

Figure 82 - Blind tooled North African cover
Byzantine Blind Tooling

The leather coverings of Byzantine bindings were always decorated with blind-tooling. Several scholars have been able to identify individual binderies by the group of tools used on particular covers. Frederici and Houlis (1988) as well as van Regemorter (1992b&c) provide detailed descriptions and rubbings of the various tools and designs used on Byzantine covers. Byzantine covers could be tooled well after covering as long as the leather was re-dampened.

I based my tooling off of II. Vat. gr. 508: a twelfth century Byzantine manuscript in the Vatican collection. I did the tooling around the borders with a panel stamp, which made the process go by much more quickly than the Islamic manuscript with its many individual tools. I ordered a new iron tool with a dragon emblem to match the tool used on VI. Leg. Vat. gr. 854, an eleventh century Vatican manuscript. Unfortunately, it did not arrive in time from overseas to be used by April 10th. I left the middle panel empty to leave room for this stamp when it arrives.
Figure 83 - II. Vat. gr. 508

Figure 84 - VI. Leg. Vat. gr. 854
Figure 85 - Byzantine Blind Tooling

Romanesque Decorative Sewing
The chemise was not decorated with tooling or any sort of leather working. However, several of the chemises from Hereford Cathedral used colorful thread for the perimeter sewing (Mynors and Thompson 1993). I used red linen thread for my sewing, which added a small pop of color to the otherwise beige parchment, boards, and chamois chemise.

**Fastenings**

Many medieval manuscripts needed some type of fastening around the fore edge to keep the covers of the book closed. On both paper and parchment manuscripts, humidity and other various climate conditions could cause the pages of the textblock to wrinkle. Fastenings ensured that the warped pages would be compressed and flattened under the weight of the boards.

**North African Fastenings**

Islamic bindings from this time period did not use fastenings. The pentagonal flap was sufficient to cover and protect the fore-edge of the textblock. Al-Ishbili writes that the flap is to lie on the textblock so that there is no need for a fastening (Gacek 1991: 109). Additionally, paper does not suffer from significant warping in humid conditions, unlike parchment. Therefore, a fastening was not needed to compress the textblock with the boards.
Byzantine Fastenings

Many Byzantine manuscripts use a peg and strap fastening. A typical manuscript can have anywhere from one to four fastenings, however there are manuscripts with as many as twelve – three on each edge of the board. The pegs, usually made of iron or bronze, are hammered into the edge of the upper board. The straps consist of one piece of leather wrapped around a brass ring. This strip of leather is then cut into three smaller strips, each of which is slit-braided. The smaller straps are threaded through a cluster of three holes in the lower cover of the book (Szirmai 1999: 81). These holes are often clustered in a triangular shape (Frederici and Houlis 1988). The tails of the straps are then pasted down on the inner face of the lower board and are covered with the endsheet (Szirmai 1999: 81). Few binders cut off the tails, so even when the inner boards are covered with a pastedown the ends of the straps leave visible lumps on the board.

I chose to use only one strap for my manuscript, deeming it too small for multiple fastenings. Initially, I struggled to cut the leather into the proper shape,
nearly depleting my stock of scrap leather. The slit-braiding technique was not terribly involved, but I did at one point need to use tweezers to pull the thick leather strip through the tiny slit. After I had attached the fastening by threading the tails through the cluster of holes in the lower cover, the manuscript no longer sat flat on the table because of the thick fastenings.

Figure 86 - Foredge with strap

Figure 87 - Inner cover of lower board

Figure 88 - Slit braided strap

Figure 89 - Cut out strap
Romanesque Fastenings

English bindings use the long-strap type of fastening. A variation on the peg and strap, the long-strap is fastened near the edge of the upper board and attached to a peg in the center of the lower board (Szirmai 1999: 167). It seems strange that the peg would be on the lower cover of the manuscript, as it would prevent the manuscript from laying flat on the surface. Yet, Clarkson’s study of twelfth century English bookbinding confirms that the pegs were in fact hammered into the lower cover (1993: 198). Additionally, the three English manuscripts I observed at Yale have the peg on the back cover (Osborn a56, Beinecke MS590, Marston MS 219). However, the thickness of the chemise material made it so that the pin did not jut out too far from the edge of the board.

The strap consisted of at least two layers of chamois or alum-tawed leather. In between these layers, there could sometimes be a strip of parchment (Szirmai 1999: 167). The layers would be cut and stitched together to make a strap long enough to reach slightly past the center of the lower board. A bronze hasp was attached around the end of the strap and punched with a hole to fit the peg (Szirmai 1999: 168).

To construct my strap, I first pasted two pieces of alum-tawed skin to a scrap of parchment and let it dry. From this, I cut out a strap of the appropriate length. The multi-layer material was very stiff, due to the parchment core and I found it nearly impossible to prepare the sewing holes with a regular awl. Even my Japanese screw punch was reluctant to punch through the strap, but eventually I was able to prepare sewing holes around the perimeter of the strap. With red linen thread (for a touch of color), I used a simple running stitch to finish the edges.
Szirmai describes two methods for attaching the metal hasp: riveting metal plates around the strap and wrapping a sheet of metal to be slipped onto the strap (1999: 168). Based on the tools available to me, I chose to try the wrapping method. Using the world’s tiniest anvil and hammer, I folded a small strip of bronze sheet metal around my strap. With a pair of tinsnips, I cut the bronze so that there would be a slight overlap on the back of the strap. I hammered the bronze and strap on the anvil one last time to make sure that it was flat and square. I used a heavy-duty hole punch from the machine shop to create the hole in the hasp.

Figure 90 – Upper board with strap

Figure 91 – Lower board with peg
Discussion

These final decorative steps strongly highlighted the different contexts of manuscript use in each culture. The North African book, with its beautifully decorated covers, is meant to be seen and admired. I find it very revealing that it only took about an hour and a half to construct the binding, but it took at least five hours to complete the decorative endbands and cover design. It seems as if North African readers were more concerned with the binding as an art object than as a means of protecting and preserving a valuable text. These lightweight, portable manuscripts almost appear to be accessories used to make a fashion statement. This idea is corroborated by Bosch and Petherbridge, who suggest that books were collected in libraries and displayed to indicate wealth, culture, and status (1981: 7). Often, wealthy collectors would buy a new volume simply to fill a void on his shelf: like putting a new painting on a blank wall.

The Byzantine covering was challenging, due to the board grooves. For a purely aesthetic attribute, the grooved board edges were certainly troublesome. Up until this point, the Byzantine codex has appeared to be quite utilitarian, concerned with sturdiness and durability. In comparison, the grooved edges seem out of place due to their frivolity. Yet again, I am forced to wonder why the Byzantines were so adamant about maintaining this feature that was functional on the Coptic codex, but is now decorative.

The English book, especially when compared to ostentatious North African books, appears to be very much a working book. Instead of decorative tooled leather covers, the monks preferred instead to make a simple, durable leather wrapping. The
binding seems to be understood as merely the protective vessel for the text. However, Bearman suggests that the chemise was not merely functional, but rather took on rich religious symbolism. He believes the chemise was associated with the practice of covering the hands when holding a sacred book. In Anglo-Saxon portraiture, often Saints are depicted with a manuscript covered in cloth (Bearman 1996: 170). The act of draping ones hands was a symbol of piety and veneration. Thus, the chemise becomes a protective covering to show respect to the text when handling it.
Conclusion

This study, by picking apart the technological choices that went into the production of the medieval codex, has revealed a distinct personality in each binding tradition. The North African Islamic codex is fast, flimsy, and ostentatious. The Byzantine codex is strong, stiff, and misunderstood. The English Romanesque codex is graceful, resilient, and respected. These personalities hint to some elusive cultural history that is embedded in the technology of its production. By reproducing these technologies, we have the unique opportunity to unearth the past by allowing these technologies to speak to us in the present.
Appendix A

Preliminary Survey of Bindings

<table>
<thead>
<tr>
<th>Style</th>
<th>Manuscript</th>
<th>Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Islamic</td>
<td>OR MS 3</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>OR MS 4</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>OR MS 1</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>OR MS6</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>BV 4254.3 .M42 1497</td>
<td>Trinity</td>
<td>1497</td>
</tr>
<tr>
<td>European</td>
<td>PA 6661 .A1 1492</td>
<td>Trinity</td>
<td>1492</td>
</tr>
<tr>
<td>European</td>
<td>BT20 .H9 1490</td>
<td>Trinity</td>
<td>1490</td>
</tr>
<tr>
<td>European</td>
<td>BX890 .A5 1478</td>
<td>Trinity</td>
<td>1478</td>
</tr>
<tr>
<td>European</td>
<td>BX890 .A4 1475</td>
<td>Trinity</td>
<td>1475</td>
</tr>
<tr>
<td>European</td>
<td>BX2215 .A5 S8 1474</td>
<td>Trinity</td>
<td>1474</td>
</tr>
<tr>
<td>European</td>
<td>BS 1415 .T46 1474</td>
<td>Trinity</td>
<td>1474</td>
</tr>
<tr>
<td>European</td>
<td>BJ1249 .N5 M3 1467</td>
<td>Trinity</td>
<td>1467</td>
</tr>
<tr>
<td>European</td>
<td>BX1749 .I49 1478</td>
<td>Trinity</td>
<td>1478</td>
</tr>
<tr>
<td>European</td>
<td>KBR1532.2 1470</td>
<td>Trinity</td>
<td>1470</td>
</tr>
<tr>
<td>European</td>
<td>PA8101 .P5 1479</td>
<td>Trinity</td>
<td>1479</td>
</tr>
<tr>
<td>European</td>
<td>MS3</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>Byzantine</td>
<td>MS1</td>
<td>Trinity</td>
<td>XI</td>
</tr>
<tr>
<td>Byzantine</td>
<td>MS2</td>
<td>Trinity</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>Arabic 749</td>
<td>Beinecke</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>Arabic 685</td>
<td>Beinecke</td>
<td></td>
</tr>
<tr>
<td>Islamic</td>
<td>Arabic 70</td>
<td>Beinecke</td>
<td></td>
</tr>
<tr>
<td>Romanesque</td>
<td>Osborn a56</td>
<td>Beinecke</td>
<td>1175-1250</td>
</tr>
<tr>
<td>Romanesque</td>
<td>Beinecke MS 590</td>
<td>Beinecke</td>
<td>1250-1275</td>
</tr>
<tr>
<td>Byzantine</td>
<td>Beinecke MS 237</td>
<td>Beinecke</td>
<td>1200</td>
</tr>
<tr>
<td>Byzantine</td>
<td>Beinecke MS 267</td>
<td>Beinecke</td>
<td>1400-1600</td>
</tr>
<tr>
<td>Byzantine</td>
<td>Beinecke MS 1180</td>
<td>Beinecke</td>
<td>1200-1249</td>
</tr>
</tbody>
</table>
## Appendix B

### English Romanesque Manuscript Dimensions

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Location</th>
<th>Original</th>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>H:W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arundel 44</td>
<td>XII</td>
<td>British Museum, Germany, S.</td>
<td></td>
<td>280</td>
<td>185</td>
<td>0.66</td>
</tr>
<tr>
<td>Arundel 60</td>
<td>XI</td>
<td>British Museum, Canterbury</td>
<td></td>
<td>305</td>
<td>195</td>
<td>0.64</td>
</tr>
<tr>
<td>Arundel 91</td>
<td>XII</td>
<td>British Museum, Canterbury</td>
<td></td>
<td>325</td>
<td>230</td>
<td>0.71</td>
</tr>
<tr>
<td>Harley 315</td>
<td>XII</td>
<td>British Museum, Canterbury</td>
<td></td>
<td>380</td>
<td>270</td>
<td>0.71</td>
</tr>
<tr>
<td>Harley 603</td>
<td>XI</td>
<td>British Museum, Canterbury</td>
<td></td>
<td>380</td>
<td>310</td>
<td>0.82</td>
</tr>
<tr>
<td>Harley 624</td>
<td>XII</td>
<td>British Museum, Canterbury</td>
<td></td>
<td>375</td>
<td>240</td>
<td>0.64</td>
</tr>
<tr>
<td>MS 154</td>
<td>XII</td>
<td>Beinecke, England</td>
<td></td>
<td>350</td>
<td>239</td>
<td>0.68</td>
</tr>
<tr>
<td>MS 181</td>
<td>XII</td>
<td>Beinecke, England</td>
<td></td>
<td>154</td>
<td>108</td>
<td>0.70</td>
</tr>
<tr>
<td>MS 189</td>
<td>XII</td>
<td>Beinecke, England</td>
<td></td>
<td>275</td>
<td>190</td>
<td>0.69</td>
</tr>
<tr>
<td>MS 21</td>
<td>XIII</td>
<td>Beinecke, England</td>
<td></td>
<td>245</td>
<td>197</td>
<td>0.80</td>
</tr>
<tr>
<td>MS 81</td>
<td>XIII</td>
<td>Beinecke, England</td>
<td></td>
<td>185</td>
<td>118</td>
<td>0.64</td>
</tr>
<tr>
<td>MS 315</td>
<td>XII/XII</td>
<td>Beinecke, England</td>
<td></td>
<td>232</td>
<td>161</td>
<td>0.69</td>
</tr>
<tr>
<td>MS 322</td>
<td>XIII</td>
<td>Beinecke, England</td>
<td></td>
<td>351</td>
<td>226</td>
<td>0.64</td>
</tr>
<tr>
<td>MS 455</td>
<td>XIII</td>
<td>Beinecke, England</td>
<td></td>
<td>326</td>
<td>230</td>
<td>0.71</td>
</tr>
<tr>
<td>St. Aug. Commentary</td>
<td>XI</td>
<td>Trinity College, Christ Church</td>
<td></td>
<td>343</td>
<td>244</td>
<td>0.71</td>
</tr>
<tr>
<td>Lucan</td>
<td>XII</td>
<td>Trinity College, Rochester</td>
<td></td>
<td>216</td>
<td>137</td>
<td>0.63</td>
</tr>
<tr>
<td>St. Aug. Sermons</td>
<td>XII</td>
<td>Lincoln Cathedral, Lincoln</td>
<td></td>
<td>330</td>
<td>209</td>
<td>0.63</td>
</tr>
<tr>
<td>Tractatus de</td>
<td>XII</td>
<td>Gonville and Catus, English</td>
<td></td>
<td>194</td>
<td>117</td>
<td>0.60</td>
</tr>
<tr>
<td>Bede: Life of St.</td>
<td>XII</td>
<td>Oxford, Durham</td>
<td></td>
<td>197</td>
<td>121</td>
<td>0.61</td>
</tr>
<tr>
<td>New Testament</td>
<td>XII</td>
<td>Pembroke College, Bury St.</td>
<td></td>
<td>412</td>
<td>273</td>
<td>0.66</td>
</tr>
<tr>
<td>Bible Part I</td>
<td>XII</td>
<td>Corpus Christi College, Christ Church</td>
<td></td>
<td>514</td>
<td>356</td>
<td>0.69</td>
</tr>
<tr>
<td>Josephus</td>
<td>XII</td>
<td>St. John's College, Christ Church</td>
<td></td>
<td>381</td>
<td>285</td>
<td>0.75</td>
</tr>
<tr>
<td>Boethius</td>
<td>XII</td>
<td>Cambridge University, Christ Church</td>
<td></td>
<td>298</td>
<td>216</td>
<td>0.72</td>
</tr>
<tr>
<td>Tripartite Psalter</td>
<td>XII</td>
<td>Trinity College, Christ Church</td>
<td></td>
<td>457</td>
<td>330</td>
<td>0.72</td>
</tr>
<tr>
<td>Bible Part II</td>
<td>XII</td>
<td>Corpus Christi College, Christ Church</td>
<td></td>
<td>533</td>
<td>357</td>
<td>0.67</td>
</tr>
<tr>
<td>Bible Part I</td>
<td>XII</td>
<td>Lambeth Place Library, Canterbury</td>
<td></td>
<td>520</td>
<td>311</td>
<td>0.60</td>
</tr>
<tr>
<td>Bible Part II</td>
<td>XII</td>
<td>Maidstone Art Gallery, Canterbury</td>
<td></td>
<td>500</td>
<td>357</td>
<td>0.71</td>
</tr>
<tr>
<td>Florence and John of Chrysostom</td>
<td>XII</td>
<td>Corpus Christi College, Worcester (?)</td>
<td></td>
<td>330</td>
<td>248</td>
<td>0.75</td>
</tr>
<tr>
<td>St. Aug. Commentary</td>
<td>XII</td>
<td>Bodleian Library, English</td>
<td></td>
<td>425</td>
<td>302</td>
<td>0.71</td>
</tr>
<tr>
<td>Bede: Commentary on Chrysostom</td>
<td>XII</td>
<td>St. John's College, Ramsey Abbey</td>
<td></td>
<td>270</td>
<td>178</td>
<td>0.66</td>
</tr>
<tr>
<td>Astronomical</td>
<td>XII</td>
<td>Bodleian Library, English</td>
<td></td>
<td>206</td>
<td>146</td>
<td>0.71</td>
</tr>
<tr>
<td>Terence</td>
<td>XII</td>
<td>Bodleian Library, St. Albans (?)</td>
<td></td>
<td>285</td>
<td>215</td>
<td>0.75</td>
</tr>
<tr>
<td>Glossed Psalter</td>
<td>XII</td>
<td>Hereford Cathedral, Hereford (?)</td>
<td></td>
<td>267</td>
<td>178</td>
<td>0.67</td>
</tr>
<tr>
<td>Boethius</td>
<td>XII</td>
<td>Bodleian Library, Hereford (?)</td>
<td></td>
<td>194</td>
<td>121</td>
<td>0.62</td>
</tr>
<tr>
<td>St. John Chrysostom</td>
<td>XII</td>
<td>Hereford Cathedral, Hereford (?)</td>
<td></td>
<td>273</td>
<td>165</td>
<td>0.60</td>
</tr>
<tr>
<td>Gospels</td>
<td>XII</td>
<td>Hereford Cathedral, Hereford (?)</td>
<td></td>
<td>235</td>
<td>165</td>
<td>0.70</td>
</tr>
<tr>
<td>Bible Part IV</td>
<td>XII</td>
<td>Dean and Chapter of Winchester</td>
<td></td>
<td>597</td>
<td>406</td>
<td>0.68</td>
</tr>
<tr>
<td>Psalter</td>
<td>XII</td>
<td>University of Glasgow, York</td>
<td></td>
<td>292</td>
<td>184</td>
<td>0.63</td>
</tr>
<tr>
<td>Bible Part III</td>
<td>XII</td>
<td>Dean and Chapter of Winchester</td>
<td></td>
<td>476</td>
<td>329</td>
<td>0.69</td>
</tr>
<tr>
<td>Epistles of St. Paul</td>
<td>XII</td>
<td>Church of St. Peter, English</td>
<td></td>
<td>368</td>
<td>260</td>
<td>0.71</td>
</tr>
<tr>
<td>Bestiary</td>
<td>XII</td>
<td>Corpus Christi College, English</td>
<td></td>
<td>375</td>
<td>254</td>
<td>0.68</td>
</tr>
<tr>
<td>Bestiary</td>
<td>XII</td>
<td>Cambridge University, English</td>
<td></td>
<td>298</td>
<td>203</td>
<td>0.68</td>
</tr>
<tr>
<td>Bestiary</td>
<td>XII</td>
<td>Bodleian Library, English</td>
<td></td>
<td>279</td>
<td>184</td>
<td>0.66</td>
</tr>
<tr>
<td>Bestiary</td>
<td>XII</td>
<td>Aberdeen University, English</td>
<td></td>
<td>305</td>
<td>210</td>
<td>0.69</td>
</tr>
<tr>
<td>Domesday Book</td>
<td>XII</td>
<td>Society of Antiquaries, Winchester</td>
<td></td>
<td>250</td>
<td>180</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Height : 0.68 Width
## Byzantine Manuscript Dimensions

<table>
<thead>
<tr>
<th>Name</th>
<th>Century</th>
<th>Location</th>
<th>Original Location</th>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burney 20</td>
<td>XIII</td>
<td>British Library</td>
<td>Constantinople</td>
<td>190</td>
<td>155</td>
<td>0.82</td>
</tr>
<tr>
<td>Burney 21</td>
<td>XIII</td>
<td>British Library</td>
<td>Thessalonica</td>
<td>340</td>
<td>240</td>
<td>0.71</td>
</tr>
<tr>
<td>Egerton 1139</td>
<td>XII</td>
<td>British Library</td>
<td>Jerusalem</td>
<td>215</td>
<td>145</td>
<td>0.67</td>
</tr>
<tr>
<td>Egerton 2902</td>
<td>XIII</td>
<td>British Library</td>
<td>Jerusalem or Acre</td>
<td>300</td>
<td>215</td>
<td>0.72</td>
</tr>
<tr>
<td>Egerton 2610</td>
<td>XI</td>
<td>British Library</td>
<td>Constantinople</td>
<td>150</td>
<td>115</td>
<td>0.77</td>
</tr>
<tr>
<td>Arundel 524</td>
<td>XII</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>170</td>
<td>130</td>
<td>0.76</td>
</tr>
<tr>
<td>Arundel 529</td>
<td>XII</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>140</td>
<td>110</td>
<td>0.79</td>
</tr>
<tr>
<td>Arundel 536</td>
<td>XII</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>235</td>
<td>150</td>
<td>0.64</td>
</tr>
<tr>
<td>Arundel 543</td>
<td>XI</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>355</td>
<td>255</td>
<td>0.72</td>
</tr>
<tr>
<td>Arundel 549</td>
<td>XI</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>340</td>
<td>240</td>
<td>0.71</td>
</tr>
<tr>
<td>Burney 23</td>
<td>XII</td>
<td>British Library</td>
<td>Eastern Mediterranean</td>
<td>195</td>
<td>145</td>
<td>0.74</td>
</tr>
<tr>
<td>MS 187</td>
<td>XIII</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>215</td>
<td>161</td>
<td>0.75</td>
</tr>
<tr>
<td>MS 150</td>
<td>XI</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>172</td>
<td>139</td>
<td>0.81</td>
</tr>
<tr>
<td>MS 237</td>
<td>XII/XIII</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>130</td>
<td>98</td>
<td>0.75</td>
</tr>
<tr>
<td>MS 275</td>
<td>XII/XIII</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>315</td>
<td>231</td>
<td>0.73</td>
</tr>
<tr>
<td>MS 263</td>
<td>XIII</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>275</td>
<td>195</td>
<td>0.71</td>
</tr>
<tr>
<td>MS 308</td>
<td>XIII</td>
<td>Beinecke</td>
<td>Byzantium</td>
<td>205</td>
<td>156</td>
<td>0.76</td>
</tr>
<tr>
<td>Arundel 516</td>
<td>XIII</td>
<td>British Library</td>
<td>Greece</td>
<td>217</td>
<td>170</td>
<td>0.78</td>
</tr>
<tr>
<td>Burney 44</td>
<td>XII</td>
<td>British Library</td>
<td>Greece</td>
<td>275</td>
<td>215</td>
<td>0.78</td>
</tr>
<tr>
<td>Burney 46</td>
<td>XI</td>
<td>British Library</td>
<td>Greece</td>
<td>310</td>
<td>235</td>
<td>0.76</td>
</tr>
<tr>
<td>Burney 47</td>
<td>XI</td>
<td>British Library</td>
<td>Greece</td>
<td>350</td>
<td>255</td>
<td>0.73</td>
</tr>
<tr>
<td>Burney 48</td>
<td>XI</td>
<td>British Library</td>
<td>Greece</td>
<td>380</td>
<td>255</td>
<td>0.67</td>
</tr>
<tr>
<td>Burney 52</td>
<td>XII</td>
<td>British Library</td>
<td>Greece</td>
<td>310</td>
<td>245</td>
<td>0.79</td>
</tr>
<tr>
<td>2007.286</td>
<td>XI</td>
<td>Metropolitan Museum of Art</td>
<td>Constantinople</td>
<td>368</td>
<td>296</td>
<td>0.80</td>
</tr>
<tr>
<td>1991.232.15</td>
<td>XII</td>
<td>Metropolitan Museum of Art</td>
<td>Meteora, Greece</td>
<td>203</td>
<td>160</td>
<td>0.79</td>
</tr>
<tr>
<td>2001.73</td>
<td>XII</td>
<td>Metropolitan Museum of Art</td>
<td>Byzantine</td>
<td>207</td>
<td>149</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Height : 0.75 Weight
## Byzantine Manuscript Dimensions Without Extended Endbands

<table>
<thead>
<tr>
<th>Name</th>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>Height – 10mm</th>
<th>New Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burney 20</td>
<td>190</td>
<td>155</td>
<td>180</td>
<td>0.82</td>
</tr>
<tr>
<td>Burney 21</td>
<td>340</td>
<td>240</td>
<td>330</td>
<td>0.71</td>
</tr>
<tr>
<td>Egerton 1139</td>
<td>215</td>
<td>145</td>
<td>205</td>
<td>0.67</td>
</tr>
<tr>
<td>Egerton 2902</td>
<td>300</td>
<td>215</td>
<td>290</td>
<td>0.72</td>
</tr>
<tr>
<td>Egerton 2610</td>
<td>150</td>
<td>115</td>
<td>140</td>
<td>0.77</td>
</tr>
<tr>
<td>Arundel 524</td>
<td>170</td>
<td>130</td>
<td>160</td>
<td>0.76</td>
</tr>
<tr>
<td>Arundel 529</td>
<td>140</td>
<td>110</td>
<td>130</td>
<td>0.79</td>
</tr>
<tr>
<td>Arundel 536</td>
<td>235</td>
<td>150</td>
<td>225</td>
<td>0.64</td>
</tr>
<tr>
<td>Arundel 543</td>
<td>355</td>
<td>255</td>
<td>345</td>
<td>0.72</td>
</tr>
<tr>
<td>Arundel 549</td>
<td>340</td>
<td>240</td>
<td>330</td>
<td>0.71</td>
</tr>
<tr>
<td>Burney 23</td>
<td>195</td>
<td>145</td>
<td>185</td>
<td>0.74</td>
</tr>
<tr>
<td>MS 187</td>
<td>215</td>
<td>161</td>
<td>205</td>
<td>0.75</td>
</tr>
<tr>
<td>MS 150</td>
<td>172</td>
<td>139</td>
<td>162</td>
<td>0.81</td>
</tr>
<tr>
<td>MS 237</td>
<td>130</td>
<td>98</td>
<td>120</td>
<td>0.75</td>
</tr>
<tr>
<td>MS 275</td>
<td>315</td>
<td>231</td>
<td>305</td>
<td>0.73</td>
</tr>
<tr>
<td>MS 263</td>
<td>275</td>
<td>195</td>
<td>265</td>
<td>0.71</td>
</tr>
<tr>
<td>MS 308</td>
<td>205</td>
<td>156</td>
<td>195</td>
<td>0.76</td>
</tr>
<tr>
<td>Arundel 516</td>
<td>217</td>
<td>170</td>
<td>207</td>
<td>0.78</td>
</tr>
<tr>
<td>Burney 44</td>
<td>275</td>
<td>215</td>
<td>265</td>
<td>0.78</td>
</tr>
<tr>
<td>Burney 46</td>
<td>310</td>
<td>235</td>
<td>300</td>
<td>0.76</td>
</tr>
<tr>
<td>Burney 47</td>
<td>350</td>
<td>255</td>
<td>340</td>
<td>0.73</td>
</tr>
<tr>
<td>Burney 48</td>
<td>380</td>
<td>255</td>
<td>370</td>
<td>0.67</td>
</tr>
<tr>
<td>Burney 52</td>
<td>310</td>
<td>245</td>
<td>300</td>
<td>0.79</td>
</tr>
<tr>
<td>2007.286</td>
<td>368</td>
<td>296</td>
<td>358</td>
<td>0.80</td>
</tr>
<tr>
<td>1991.232.15</td>
<td>203</td>
<td>160</td>
<td>193</td>
<td>0.79</td>
</tr>
<tr>
<td>2001.73</td>
<td>207</td>
<td>149</td>
<td>197</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Byzantine MS Without Endbands

$R^2 = 0.95674$

Height : 0.75 Weight
## North African Islamic Manuscripts from Kairouan

<table>
<thead>
<tr>
<th>Name</th>
<th>Century</th>
<th>Location</th>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>Ratio W:H</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>VI</td>
<td>Kairouan</td>
<td>74</td>
<td>105</td>
<td>1.63</td>
</tr>
<tr>
<td>84</td>
<td>VI</td>
<td>Kairouan</td>
<td>74</td>
<td>105</td>
<td>1.54</td>
</tr>
<tr>
<td>82</td>
<td>VI</td>
<td>Kairouan</td>
<td>74</td>
<td>106</td>
<td>1.57</td>
</tr>
<tr>
<td>87</td>
<td>VI</td>
<td>Kairouan</td>
<td>73</td>
<td>106</td>
<td>1.51</td>
</tr>
<tr>
<td>85</td>
<td>VI</td>
<td>Kairouan</td>
<td>73</td>
<td>107</td>
<td>1.56</td>
</tr>
<tr>
<td>86</td>
<td>VI</td>
<td>Kairouan</td>
<td>74</td>
<td>107</td>
<td>1.52</td>
</tr>
<tr>
<td>88</td>
<td>VI</td>
<td>Kairouan</td>
<td>78</td>
<td>108</td>
<td>1.50</td>
</tr>
<tr>
<td>81</td>
<td>VI</td>
<td>Kairouan</td>
<td>77</td>
<td>121</td>
<td>1.38</td>
</tr>
<tr>
<td>80</td>
<td>VI</td>
<td>Kairouan</td>
<td>76</td>
<td>124</td>
<td>1.45</td>
</tr>
<tr>
<td>102</td>
<td>VI</td>
<td>Kairouan</td>
<td>81</td>
<td>125</td>
<td>1.62</td>
</tr>
<tr>
<td>114</td>
<td>VI</td>
<td>Kairouan</td>
<td>87</td>
<td>136</td>
<td>1.70</td>
</tr>
<tr>
<td>100</td>
<td>VI</td>
<td>Kairouan</td>
<td>94</td>
<td>143</td>
<td>1.55</td>
</tr>
<tr>
<td>124</td>
<td>VI</td>
<td>Kairouan</td>
<td>95</td>
<td>143</td>
<td>1.38</td>
</tr>
<tr>
<td>125</td>
<td>VI</td>
<td>Kairouan</td>
<td>96</td>
<td>144</td>
<td>1.47</td>
</tr>
<tr>
<td>101</td>
<td>VI</td>
<td>Kairouan</td>
<td>106</td>
<td>152</td>
<td>1.52</td>
</tr>
<tr>
<td>103</td>
<td>VI</td>
<td>Kairouan</td>
<td>98</td>
<td>154</td>
<td>1.56</td>
</tr>
<tr>
<td>74</td>
<td>VI</td>
<td>Kairouan</td>
<td>105</td>
<td>157</td>
<td>1.42</td>
</tr>
<tr>
<td>75</td>
<td>VI</td>
<td>Kairouan</td>
<td>103</td>
<td>157</td>
<td>1.42</td>
</tr>
<tr>
<td>107</td>
<td>VI</td>
<td>Kairouan</td>
<td>97</td>
<td>163</td>
<td>1.55</td>
</tr>
<tr>
<td>93</td>
<td>VI</td>
<td>Kairouan</td>
<td>116</td>
<td>164</td>
<td>1.52</td>
</tr>
<tr>
<td>92</td>
<td>VI</td>
<td>Kairouan</td>
<td>113</td>
<td>165</td>
<td>1.50</td>
</tr>
<tr>
<td>90</td>
<td>VI</td>
<td>Kairouan</td>
<td>110</td>
<td>170</td>
<td>1.43</td>
</tr>
<tr>
<td>97</td>
<td>VI</td>
<td>Kairouan</td>
<td>113</td>
<td>170</td>
<td>1.46</td>
</tr>
<tr>
<td>91</td>
<td>VI</td>
<td>Kairouan</td>
<td>110</td>
<td>171</td>
<td>1.57</td>
</tr>
<tr>
<td>120</td>
<td>VI</td>
<td>Kairouan</td>
<td>113</td>
<td>172</td>
<td>1.40</td>
</tr>
<tr>
<td>104</td>
<td>VI</td>
<td>Kairouan</td>
<td>107</td>
<td>173</td>
<td>1.53</td>
</tr>
<tr>
<td>98</td>
<td>VI</td>
<td>Kairouan</td>
<td>113</td>
<td>176</td>
<td>1.55</td>
</tr>
<tr>
<td>119</td>
<td>VI</td>
<td>Kairouan</td>
<td>115</td>
<td>176</td>
<td>1.53</td>
</tr>
<tr>
<td>95</td>
<td>VI</td>
<td>Kairouan</td>
<td>121</td>
<td>177</td>
<td>1.41</td>
</tr>
<tr>
<td>99</td>
<td>VI</td>
<td>Kairouan</td>
<td>114</td>
<td>177</td>
<td>1.50</td>
</tr>
<tr>
<td>105</td>
<td>VI</td>
<td>Kairouan</td>
<td>114</td>
<td>177</td>
<td>1.46</td>
</tr>
<tr>
<td>106</td>
<td>VI</td>
<td>Kairouan</td>
<td>105</td>
<td>178</td>
<td>1.55</td>
</tr>
<tr>
<td>118</td>
<td>VI</td>
<td>Kairouan</td>
<td>130</td>
<td>202</td>
<td>1.55</td>
</tr>
<tr>
<td>121</td>
<td>VI</td>
<td>Kairouan</td>
<td>134</td>
<td>205</td>
<td>1.44</td>
</tr>
<tr>
<td>94</td>
<td>VI</td>
<td>Kairouan</td>
<td>152</td>
<td>213</td>
<td>1.68</td>
</tr>
<tr>
<td>79</td>
<td>VI</td>
<td>Kairouan</td>
<td>149</td>
<td>214</td>
<td>1.47</td>
</tr>
<tr>
<td>77</td>
<td>VI</td>
<td>Kairouan</td>
<td>170</td>
<td>235</td>
<td>1.43</td>
</tr>
<tr>
<td>78</td>
<td>VI</td>
<td>Kairouan</td>
<td>166</td>
<td>244</td>
<td>1.45</td>
</tr>
</tbody>
</table>
Kairouan MS Dimensions

\[ R^2 = 0.95394 \]

Height : 1.51 Width
Appendix C

Bookbinding Tools & Materials

General tools
• Paper cutter
• Scissors
• Teflon folder
• Bone folder
• Breakaway knife
• Needle awl
• Curved needle
• Straight needle
• Japanese screw punch
• Rulers
• Nori Paste
• Wheat Starch Paste
• Finishing Press

North African
• Cream Parchment Paper
• Binders Board
• Linen Thread (red)
• Silk Thread (blue, yellow)
• Linen
• Russell’s Oasis goatskin in Terra Cotta
• Scharf-Fix

Byzantine
• Zerkall Cream Vellum Paper 140 gsm
• Poplar
• Linen
• Harmatan goatskin in Maroon

English
• Zerkall Cream Vellum Paper 140 gsm
• Sewing frame
• Alum-tawed calfskin
• Quarter-sawn Oak
• Linen
• Chamois buckskin
References

Abun-Nasr, Jamil M

Ascher, Robert

Atsalos, B.

Bearman, Frederick

Bloom, Jonathan M.

Bosch, Gulnar K.

Bosch, Gulnar K., John Carswell, and Guy Petherbridge

Boudalis, Georgios

Bourdieu, Pierre

Burton, Jane

Cameron, Avery

Carrell, Toni

Clanchy, MT

Clarkson, Christopher

Coles, John M.

Deroche, François
1986 Quelques reliures medievales de provenance damascaine. Revue des études

Di Leo, Jeffrey R.

Diehl, Edith

Diringer, David

Dobres, Marcia-Anne

Ellis, Elsi Vassdal

Frederici, Carlo; Houlis, Kostantinos

Greenfield, Jane, and Jenny Hille

Hegmon, Michelle

Hillenbrand, Robert

Hollenback, Kaey L; Schiffer, Michael Brian

Houlis, Konstantine

Jacobs, David
Middle Eastern bookbinding - The Islamic book.

Johnson, Matthew

Kaegi, Walter

Kireyeva, Vilena
Lamacraft, C. T.
Lindsay, Jen
Lowden, John
Malcyzcki, W. Matt
Marçais, Georges, and Louis Poinssot
Merian, Sylvie L.
Miller, Julia
Monro, Alexander
Mynors, R.A.B; Thomson, R.N.
Naylor, Phillip
Nigosian, S. A.
Oikonomedes, Nikolas
Outram, Alan K.
Parker, Alan B.
Petersen, Theodore C.
1954 Early Islamic Bookbindings and Their Coptic Relations. Ars Orientalis 1:41-64.
Petherbridge, Guy
Pfaffenberger, Bryan
Pickwoad, Nicolas  

Powell, Susan  

Rainie, Lee; Duggan, Maeve  

Renfrew, Colin; Bahn, Paul  

Roberts, Colin; Skeat TC  

Rosen, Christine  

Schiffer, Michael; Skibo, James  

Sillar, B; Tite, MS  

Szirmai, J.A.  

Thackston, Wheeler M.  

Van Regemorter, Berthe  


Wilson  