“MILLED FIT FOR TROWSERS”:

TOWARD A FULLER[’S] UNDERSTANDING OF CLOTH FINISHING

IN THE MID-ATLANTIC FROM 1790 TO 1830

by

Eliza West

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Arts in American Material Culture.

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This project began in January of 2018, with a call for papers for the Textile History Forum in Marshfield, Vermont. As yet unsure of my thesis topic, but dead set on the fact that it would have something to do with mills, I wrote a proposal for a study of fulling mills on the Brandywine River in Delaware. I quickly realized that this was the perfect thesis topic for me. I am grateful to the organizers—Rabbit Goody and Kate Smith—and attendees of the Forum, which took place in July of that year. They embraced my enthusiasm, and responded in kind, with suggestions, sources, and encouragement that have fueled me throughout the rest of this project.

As I carried out my research that summer and fall, I benefitted from conversations with Tony Shahan about the mills of Delaware and south-eastern Pennsylvania, and with Mark Hutter and Mike McCarty of the Colonial Williamsburg tailor's shop, who shared their perspective on woolen textiles and brainstormed with me. I also want to thank Tom Kelleher, for letting me spend a day at Old Sturbridge Village, learning what it was like to work inside a water-powered mill.

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topic, and always had at her fingertips just the book or article I needed. In particular I am grateful to her for her encouragement of my adventures in fulling, and her insistence on their importance to the text of my thesis.

My biggest thanks go to my friend Justin Squizzero, the wonderful weaver without whom this project would never have happened. Not only did Justin field hundreds of small, textile-related, queries over the past year, his beautiful historic reproduction textiles are also what inspired me to move beyond manuscripts and old coats and to use making as a way of knowing. His craft knowledge has contributed to this project in countless ways, not the least of which was the thirty beautiful yards of cloth which he wove for me. I also owe a debt of gratitude to the Center for Craft, Creativity, and Design, who so generously funded the creation of that textile by awarding me a grant through their Craft Research Fund. Likewise, I would like to thank the Society of Winterthur Fellows and the University of Delaware's Center for Material Culture Studies, who further funded this project and in so doing helped to support both an artisan and an academic.

From beginning to end, this thesis has been a tremendously enjoyable project, and I am truly grateful for the opportunities afforded me at Winterthur, where Catharine Dann Roeber, Tom Guiler, Emily Guthrie, Jeanne Solenski, and Ritchie Garrison were always willing to help with each new endeavor I undertook. I am glad also of my glorious and eccentric classmates—for their good humor and their tolerance of mine—and my friends and family who supported and kept up with me while I was far away.

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ABSTRACT

Woolen cloth was a staple in the wardrobes of late-eighteenth- and early-nineteenth-century Americans. Whether imported or domestically produced, this cloth went through a series of finishing processes after it was woven, to give it the properties desirable for garments or other uses. During this period in the mid-Atlantic, cloth finishing was typically carried out by craftspeople known as fullers at water-powered fulling mills. The trade of cloth finishing makes use of the inherent properties of wool fiber and can transform both the look and function of woolen cloth in a wide variety of ways. This thesis places the work of fullers into physical, social, and technological context. It explores the role of fulling in the production of cloth and the skills and knowledge which belonged to American country fullers. Throughout, it forefronts the challenges historians face in seeking to understand deeply tactile crafts such as woolen finishing, and posits a solution to this problem in the form of making. This thesis explains the changes which finishing produced in woolen cloth and demonstrates that the knowledge which fullers possessed in both their hands and their minds allowed them to transform cloth into a wide range of different functional textiles.

INTRODUCTION

For much of the eighteenth and nineteenth century, a small country fulling mill operated on the banks of a stream called Broad Run, thirty miles west of Philadelphia, in West Bradford Township, Pennsylvania. In the early nineteenth century, fulling mills were common on the American landscape and, in fact, there was more than one fulling mill in West Bradford. Essential for the home production of woolen cloth, these water-powered mills first appeared in America shortly after British colonists arrived in the seventeenth century. Inside them, fullers monitored heavy water-driven fulling stocks, which pounded cloth, causing it to shrink and felt in a process known as fulling or milling. They also practiced a variety of other textile finishing crafts, to transform webs of cloth brought to them by local weavers into fabric suitable for diverse uses.

The tasks which fullers performed in fulling mills, such as the one on Broad Run, fundamentally transformed woolen cloth. Fullers could make cloth thicker and denser; they could also make it soft or firm. Some textiles left the fulling mill impervious to rain and wind and ready for use in men's overcoats. Others gained a smooth, velvet-like finish which made them suitable for fine apparel. Blanketing gained the loft needed to trap air and insulate. Fullers often also colored cloth in dye houses adjoining their mills. These businesses took in fabric brought to them by small-scale home textile producers or by professional weavers and, for a fee, transformed that cloth, improving its utility and increasing its visual appeal.

Fulling mills were present on the American landscape wherever both water power and domestic woolen production were present. At the end of the eighteenth century, as the nascent United States government began to consider the country's domestic industries, the role and importance of fullers was recorded in treatises on the national economy. In the following decades, renewed conflict with Britain stimulated the promotion of American-made goods and new textile factories began to appear on the landscape. Concurrently, both British and American innovators began to experiment with ways to mechanize the finishing processes which had once been done by hand. Even as the tools of the trade began to change, fullers in both factories and country mills carried out largely the same work, despite differences is business organization.

This thesis tells the story of the work done in small country fulling mills in the mid-Atlantic states, like the mill on Broad Run, in the four decades between 1790 and 1830, when both America and woolen manufacturing were undergoing significant change. Its goal is to explore the role which finishing plays in defining woolen textiles. In particular this thesis looks at how the skills of the fuller were applied to pieces of cloth, giving them specific useful qualities for certain functions, and capping the long series of tasks involved in cloth production. To do this, it highlights woolen finishing as a craft *process*, and demonstrates that it is best understood through a combination of historical research and hands-on experimentation. It aims to show that the finishing work done in American fulling mills played a major role in the material landscape of early America. This story has never been fully unraveled.

Background

Tench Coxe, in his introduction to the 1810 Census of Art and Manufactures, estimated that in 1812, Americans would consume twenty-two million pounds of wool. He also stated the importance of the woolen industry to the comfort and health of Americans:

> Of all the raw materials, none is capable of conversion into manufacturers so favorable to health as wool. It is extensively and indispensably necessary to the enjoyment of that blessing [health]... *There is no other good and safe material for carpets:* no other *capable* material *for common hats and winter stockings*: no other which preserves, in the human body, that constant and equitable insensible perspiration, the want of which brings early pain disease and death.

Coxe's goal was to encourage domestic production within the new nation, in order to supplement and ideally supplant imports from Britain and Europe. To that end he also wrote that

> Nice skill, in using the fulling machinery, is of the greatest importance to the success of the woolen branch. This skill is wanting in many places. It is very desirable to awaken the most particular attention of the manufacturers to the fulling operations and mill.[1]

Skillful finishing was necessary for the production of high-quality woolens, and it was in the production of this high-grade cloth where America struggled to compete with Britain.

This was not a new story in the 1810s. Back in 1789, George Washington had grappled with the sartorial politics involved in selecting a textile for his inauguration suit. The best men's suits were made of fine British broadcloth, but the first president

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[1] Tench Coxe, *A Statement of the Arts and Manufactures of the United States of America, for the Year 1810* (Philadelphia: Printed by A. Cornman, 1814), xxx–xxxi, http://tinyurl.galegroup.com.udel.idm.oclc.org/tinyurl/9MqTz2.

of the newly independent nation could hardly wear British wool on this occasion. Instead Washington wore a suit of brown broadcloth manufactured at Jerimiah Wadsworth's Hartford Woolen Manufactory. The cloth was described by Henry Knox as comparable to *second* best British broadcloth. Though not equal to the best of British manufactures, it was still much finer than most cloth produced in America. Unfortunately, it fooled Washington's audience, who believed him to be wearing imported cloth (figure 1).[2]

The story of Washington's coat is a worthy starting place for this study because it brings together concerns of quality, domestic manufacturing, and trade. These themes underlie discussions of woolen cloth for the period of this study. In the second half of the eighteenth-century, Americans imported between 15 and 50 percent of woolen cloth produced in England, depending on the year.[3] By the early nineteenth century, American relations with Britain again became bellicose, and politicians eagerly promoted domestic manufacturing in hopes of lessening America's dependence on imported goods. Trade embargoes instituted in 1807 and again in 1809 sought to limit imports to protect the domestic market. But it was the War of 1812 which had a much more profound effect on American's access to British wool. During

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[2] Linzy A Brekke, "Fashioning America: Clothing, Consumerism, and the Politics of Appearance in the Early Republic" (PhD diss., Harvard University, 2007), 31–33. Brekke's work is an excellent exploration of the political meaning of cloth and dress. She also goes into wonderful detail on the political messaging associated with the Hartford woolen manufactory. Technical information on the factory can be found in Elizabeth Hitz, "A Technical and Business Revolution: American Woolens to 1832" (PhD diss., New York University, 1978. New York: Garland Pub., 1986), 101–12.

[3] Hitz, "A Technical and Business Revolution," 65–67.

Figure 1 George Washington was sworn in as President in 1789 wearing this coat. Today parts of the coat are missing, and the fabric is largely threadbare. Despite this, the high quality of the fabric is still apparent. The textile is thin and firm, with a thread count of 38 ends x 40 picks. The material holds a cut edge, indicating a high degree of fulling, and in areas where the surface is not degraded, it is clear that the cloth was napped and sheared. Coat. Mount Vernon Ladies' Association. Accession number: W-1063. *Courtesy of Mount Vernon Ladies' Association.*

the years of 1813 and 1814, British imports dropped by as much as 90% from what they had been between 1805 and 1807.[4]

During these first decades of the nineteenth century, the push for better domestic manufactures was aided by the importation of Spanish Merino sheep into America. The increased and improved wool supply was processed with new, and rapidly improving, technology for everything from carding fleece to finishing cloth. Tench Coxe summed up the situation, saying that the manufacture of wool

> Is very considerably aided by the new carding and spinning machinery, by the introduction of the Barbary, Merino and long woolled sheep, by improvements in the breeding and tending of the general flocks of the country, by superior care of the growing fleece, by the increase of the value of the carcass or mutton, by the sorting of wool, by improvements in the stocking and cloth looms, by the acquisition of *the fly shuttle*, and of machinery to dress and finish cloths, by increased skill in the workmen and by improvements in the arts and business of fulling and dy[e]ing, to acquire which great exertion and expense are applied.[5]

In addition to rapid improvements in the individual steps of cloth production, factories were opening which combined every stage of producing cloth from sheep to finishing, under the auspices of a single business. This, then, was the exciting and industrious environment in which country fulling mills continued to operate as the nineteenth century progressed. Studying small service-provider finishing businesses at this moment in history is an opportunity to understand the fulling trade at a time when it

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[4] Hitz, 154.

[5] Coxe, *A Statement of the Arts and Manufactures of the United States of America, for the Year 1810*, xxix.

straddled the line between long-standing craft traditions and rapidly-evolving industrial innovations.

Historiography and Methodology:

This thesis is a focused look at the relationship between craftspeople and their products based on a careful examination of primary sources – both written and material. To make this study meaningful, however, I contextualize the cloth finishing trades by looking at their role in both social and economic history, and in the history of technology. The economic and business historians of the twentieth century have made this examination of fulling as a craft possible by establishing a strong understanding of the economic significance of the textile industry, and the changes it underwent in the nineteenth century due to industrialization. First among these authors is unquestionably Arthur H. Cole, whose 1926 text *The American Wool Manufacture* remains the preeminent compendium of information on this industry.[6] Though Cole's comprehensive work has yet to be surpassed, his role as a Harvard professor of business economics means that his book focuses on large scale economic impact, and only touches briefly on the end products of the mills and craftspeople it discusses.

Much of the energy devoted to the study of textiles in America has been lavished on New England, where mill towns like Lowell and Lawrence, and Samuel Slater's Rhode Island cotton mill, have been seen as preeminent examples of American industrialism. Though southern states play a major role in the story of cotton, they, in general, neither produced large quantities of wool nor made extensive

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[6] Arthur Harrison Cole, *The American Wool Manufacture*, vol. 1 (Cambridge: Harvard University Press, 1926).

use of water power. In contrast to that, the Brandywine River in Delaware and south-eastern Pennsylvania had ideal conditions for water powered milling. The region also boasted domestic woolen production and, later, woolen mills. For this reason, this study takes this region as its geographic center, and reaches out from there to contextualize it within the middle Atlantic states and the United States.

The strength of the literature focused on textile production in the Northeast, however, makes it an important site of comparison. For example, Gail Mohanty and Barbara Tucker's work on labor in New England cotton mills has contributed to a broader understanding of American labor.[7] Similarly, exploring American industrialism requires casting a net which encompasses the innovation hotbeds of New England and New York.

By the early nineteenth century, communication up and down the eastern seaboard meant that equipment produced in Vermont could easily be found in factories in Maryland. These patterns of communication, as well as transatlantic exchanges of knowledge, have been written about extensively by David Jeremy.[8] His work has been essential for a deeper understanding of the technical changes that the textile industry was undergoing during my period of study.

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[7] Gail Fowler Mohanty, *Labor and Laborers of the Loom: Mechanization and Handloom Weavers, 1780-1840* (New York: Routledge, 2006); Barbara M. Tucker, "Liberty Is Exploitation: The Force of Tradition in Early Manufacturing," *OAH Magazine of History* 19, no. 3 (2005): 21–24.

[8] David J. Jeremy, "British Textile Technology Transmission to the United States: The Philadelphia Region Experience, 1770-1820," *The Business History Review* 47, no. 1 (1973): 24–52, https://doi.org/10.2307/3113602; David J Jeremy, "Immigrant Textile Machine Makers along the Brandywine 1810-1820," *Textile History* 13 (1982): 225–48.

Several scholars working in the 1960s produced articles and research reports which focused on the woolen industry in certain regions. Barnes Riznik's "New England Wool-Carding and Finishing Mills, 1790-1840," prepared as part of Old Sturbridge Village's research efforts on the carding mill which was moved to the museum from Maine in 1963, parallels much of my work on understanding the social and technical operations of fulling mills in the mid-Atlantic.[9] It has provided clarity about regional similarities and differences. George H. Gibson and Carrol Pursell both produced works on the textile mills of the Brandywine Valley through research at the Hagley Museum and Library, which has extensive collections relating to the industrial history of that region. Both scholars aggregated large bodies of financial, labor, and equipment-related data on specific sites around the region of this study, in particular the Madison Factory on Delaware's Red Clay Creek. Gibson's and Pursell's writings provide a stepping stone for this thesis' exploration of how those same sites processed fiber and textiles.[10]

Since the rise of social history and material culture studies, historical perspectives have zoomed in to explore relationships between people, and between people and objects. Adrienne Hood's *The Weaver's Craft* is one such work. Hood's book is a history of cloth production in colonial Chester County, Pennsylvania. One of

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[9] Barnes Riznik, "New England Wool-Carding and Finishing Mills, 1790-1840" (Sturbridge, Massachusetts: Old Strubridge Village Research Department, 1964).

[10] George H Gibson, "Fullers, Carders, and Manufacturers of Woolen Goods in Delaware.," *Delaware History* XII (1966): 25–53; George H Gibson, "The Delaware Woolen Industry," *Delaware History* XII (1966): 83–120; Carroll W Pursell, *Two Mills on Red Clay Creek in the 19th Century: The Faulkland Spice Mill and the Greenbank Mill, New Castle County, Delaware.* (Wilmington, Del.: Historic Red Clay Valley, 1964).

its greatest achievements is to push back against the dominant narrative of New England textile production. Laurel Thatcher Ulrich has explained that in New England, by the second half of the eighteenth century, domestic textile production had transitioned away from European models of male artisan labor to women's work carried out informally in the home. In part because of a continuing influx of male European artisan weavers, this transition never took place in Pennsylvania.[11] For the purposes of this study, Hood's work is invaluable because it sets the groundwork for a study of woolen finishing in the same region. More than that, however, *The Weaver's Craft* describes textile production not only as an aspect of the economy, but also as a craft. A weaver herself, Hood sets an example for incorporating discussions of craft skill and material culture into works of History.

While Hood's book has proved essential for this study, it touches only briefly on woolen finishing. In this regard, *The Weaver's Craft* echoes the majority of works on textile history: in almost all scholarship on textile production, woolen finishing is described in less detail than the processes which proceed it. This thesis aims to help fill that gap.

Though textile scholarship is sparse on the subject of fulling, a great deal of excellent work exists concerning cloth after it has been transformed into garments. Dress history has the ability to draw out the significance of cloth, not only as the end product of a variety of skilled craftspeople, but also as the site of politics and personal

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[11] Laurel Thatcher Ulrich, "Wheels, Looms, and the Gender Division of Labor in Eighteenth-Century New England," *The William and Mary Quarterly* 55, no. 1 (1998): 3–16, https://doi.org/10.2307/2674321; Adrienne D Hood, *The Weaver's Craft: Cloth, Commerce, and Industry in Early Pennsylvania.* (Philadelphia: University of Pennsylvania Press, Inc., 2003), 106, 141–42.

display. Linzy Brekke's Harvard dissertation, "Fashioning America: Clothing, Consumerism, and the Politics of Appearance in the Early Republic," is an excellent example, and one which addresses not *how*, but *why* woolen cloth was being made in post-Revolution America.[12] Her work on George Washington's inauguration suit is just one example of how woolen cloth was a site of not only craft, but also politics and identity.

In discussing textile history, I must also mention Florence Montgomery's *Textiles in America, 1650-1870*.[13] This glossary of historical textile names, with period definitions, and illustrated with photographs of textile samples, provides guidance when it comes to identifying extant textiles or written descriptions of textiles. *Textiles in America* serves as a translator's dictionary between the written word and the material world. Without it, it would be all too easy to brush off *bearskin* and *satinette* as impenetrable lingo, rather than terms with specific significance to both manufacturers and consumers in the Early Republic. My work continues Montgomery's project of developing definitions for period textiles and linking those words to extant objects and period craft practices.

The significance of woolen finishing during the period of this study is reflected in the number of primary sources which discuss the craft. In this work, a grouping of six period textile production and dye manuals, written between 1769 and 1844, serve

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[12] Brekke, "Fashioning America."

[13] Florence M Montgomery, *Textiles in America, 1650-1870: A Dictionary Based on Original Documents : Prints and Paintings, Commercial Records, American Merchants' Papers, Shopkeepers' Advertisements, and Pattern Books with Original Swatches of Cloth* (New York: Norton, 1984).

as a foundation for understanding how Americans in that period understood and valued fulling and other finishing processes. While they provide generalities regarding the craft of cloth finishing, newspaper advertisements and account books help to fill in specific details. By examining the language used by fullers to describe their own work—for themselves in their account books and for others in advertisements—I have been able to explore how they thought about their skills and their agency as craftspeople, as well as how they interacted with their customers. To understand the mechanics and inventors who built tools and developed new technology for textile craftspeople, I also look at early patent records. During this project I have worked closely with documents in the collection of the Hagley Museum, of Winterthur's own manuscript collection, and in particular, with the holdings of the Chester County Historical Society.

A variety of images have allowed me to understand the physical environment inhabited by cloth finishers. Period illustrations and technical diagrams of mills and machinery were essential for understanding period descriptions. They have also allowed me to comprehend objects, tools, and structures which have survived to the present, but now lack essential components, or knowledgeable users who might demonstrate their function. Through a focus on material culture, this thesis also interacts with those objects directly, teasing out their uses, and what those uses might signify for the craftspeople who used them. Just as importantly, it also looks at how the nature of these tools and spaces effected the textiles themselves.

The true heart of this thesis is the woolen textiles which were created by American craftspeople in the late eighteenth and early nineteenth centuries, and the transformation which those same textiles underwent while being finished. That

transformation is what allowed some of those textiles to be made into garments, which individuals then interacted with, wore, and wore out. The vast majority of woolen textiles used in America and dating from before 1830 do not survive today. Even fewer can be firmly identified as having been manufactured in America. Despite this, I have been able to examine a handful of American-made garments and textile swatches. I also studied a variety of British-made woolens, which serve as useful points of comparison. The nature of studying woolen finishing means that the ability not only to examine, but also to feel the surface of these textiles, has been essential to my understanding.

Written, visual, and material sources are used together in this thesis to craft an understanding of the work done by American cloth finishers in the Early Republic. However, this thesis also makes use of an additional type of source: craft practice itself. Adhering to the philosophy that making is knowing, I undertook to recreate some of the cloth finishing work done at the Broad Run Fulling Mill, in order better understand this craft. This project was inspired by the growing awareness that the act of making can provide researchers with invaluable information to support written documents and surviving objects.[14] Tim Ingold argues that researchers can move beyond observation through acts of creation. He states that the study of material culture is too focused on finished objects, an obsession which should be balanced by

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[14] Pamela H. Smith, "Historians in the Laboratory: Reconstruction of Renaissance Art and Technology in the Making and Knowing Project," *Art History* 39, no. 2 (2016): 215, https://doi.org/10.1111/1467-8365.12235.

an exploration of the process of creation.[15] The protocols for this project draw inspiration from Jane Malcolm-Davies' Knitting in Early Modern England project, in which she has used experimental archeology to recreate a series of knitted textiles like those used in sixteenth-century caps to better understand the properties of the wool used to make them.[16] My own project builds on Ingold's concept of making as a way of knowing and incorporates methodology from Malcolm-Davies' experiments.

Reproducing two pieces of heavily finished woolen cloth was an opportunity to enact craft practices described in textile manuals, while attempting to achieve results described in fullers' account books. In carrying out this project, I was forced to address each aspect of making a piece of cloth before I was able to move on to the next. This required me to understand how each craft process or material choice affected the end result. This project also brought me into communication with three master weavers, Norman Kennedy, Kate Smith, and Justin Squizzero, all of whom have contributed knowledge to this project. Most importantly, this project has allowed me to demonstrate in concrete terms how finishing techniques affect textiles.

A true craft, woolen finishing is nearly impossible to understand without a connection to the materials. Simply put, without touching finished textiles, we cannot hope to truly comprehend them. Because of the central importance of touch for developing an understanding of woolen finishing, samples of the textiles created

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[15] Tim Ingold, *Making: Anthropology, Archaeology, Art and Architecture* (London; New York: Routledge, 2013), 6–7.

[16] Jane Malcolm-Davies, "An Early Modern Mystery: A Pilot Study of Knitting, Napping and Capping," *Archaeological Textile Review*, no. 58 (2016): 65–74.

during this project can be found in Appendix B of the bound copy of this thesis which resides in the Winterthur Library.[17]

Overview of Chapters

This thesis addresses the craft of woolen finishing in several sections. The first chapter describes the physical and social structures in which fullers worked. It explores what there is to be known about the structures of early fulling mills, and the landscapes in which they operated. As industrialization came to America, finishing operations existed not only in the form of service-providers, but also as part of larger woolen manufactories. Comparing these larger businesses to country fulling mills illustrates a range of different forms of business organization, and types of employment, which went on in the cloth finishing trade. This chapter also examines the relationships between fullers and their customers. In it I explore how customers specified their requests to fullers, and how the fullers tracked and recorded that information. These interactions illustrate the significance of finishing in the lives of every-day people, as garments and use-specific textiles were described in the pages of account books.

Chapter two lays out the individual craft processes necessary to make and finish woolen cloth. To do this, it explores how contemporary writers described finishing processes in instructional manuals. This chapter explains how each of these

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[17] Samples can also be found at the Center for Craft, Creativity, and Design, in Ashville, North Carolina, which generously funded this aspect of my research through their graduate research fund, at the Marshfield School of Weaving in Marshfield, Vermont, and at Fort Ticonderoga in Ticonderoga, New York, and Colonial Williamsburg.

processes affects woolen cloth, providing an explanation of finishing processes which can be linked to extant historical textiles.

Chapter three examines the changes which occurred in the textile industry during early-nineteenth-century industrialization. Its focus is on new technologies which were developed during this time. This chapter shows that new technologies reflected the shortage of expert cloth finishers in America at a time when the new nation was seeking financial independence from Britain.

This thesis concludes by exploring fullers' own understanding of their craft. In the final chapter I detail my efforts to recreate two lengths of flannel for men's and women's wear which were finished at the Broad Run fulling mill in 1822. I lay out the choices I made during the process of recreation as both an exploration of how this craft was practiced on the ground, and to share the mechanical details of the process with both scholars and craftspeople. Throughout my thesis, this project has helped me to understand the practical realities of this craft. At the end of this thesis, it serves as a lens though which to examine what it meant to be a fuller in America between 1790 and 1830.

Chapter 1

THE FULL PICTURE: MILLS IN CONTEXT

In the colonial period, large scale textile production was largely unheard of in America; most textile needs were met by importation. A degree of small-scale or home cloth production did take place, however. Woolen cloth made in rural American homes and workshops, as well as that which was produced by the English and Europeans for export, needed to go through a combination of different finishing processes to render it useful for clothing or other applications. In Britain, these various finishing processes were separate trades, and they often took place in different workshops. In American, however, the small scale of cloth production meant that fullers and fulling mills united the various branches of cloth finishing into one craft performed at a single locale: the fulling mill.

In the first decades of the nineteenth century, some fulling mills expanded, taking over other steps of cloth production which could easily be incorporated into their businesses. Other fulling mills were built as part of larger cloth manufacturing establishments. While country fulling mills were not infrequently owned and operated by the same individuals, or had only a few employees, woolen manufactories could be much larger. These bigger businesses were also more likely to struggle to find skilled craftsmen, since the were often started by entrepreneurs rather than craftspeople, and therefore relied on finding and retaining expert artisans who were already in short supply in America.

The location of both types of businesses was constrained by the necessity of access to flowing water to power fulling stocks and, increasingly, other machinery as well. Various other cloth finishing processes also had specific requirements: some

tasks required light and others heat, while yet others necessitated segregated spaces because of the lint they generated. For example, fulling mills were typically accompanied by dye houses, since dyeing was often done in between other steps of cloth finishing but required its own dedicated space. Understanding the various spaces which made up a cloth finishing operation is the first step toward understanding the work which went on inside of them.

The fullers who operated country fulling mills were service providers, receiving cloth from individual customers, and finishing it for a fee, typically charging by the yard. Because the location of mills was dictated by access to water power, rather than by convenience, customers' cloth had to be transported to the mill, often accompanied by nothing more than a note to describe the type of finish it would receive. From there, fullers interpreted their customer's requests, and used the tools and spaces of their mills, along with their specific knowledge of cloth finishing, to carry out their customers' orders. This chapter explores the social and spatial relationships which existed in and around mid-Atlantic fulling mills, and fulling operations in woolen manufactories. In doing so, it provides a framework for a closer look at fulling as a craft.

Fulling Mills in the Landscape

Before the age of steam, water provided power for mills, which housed the large-scale machinery which simplified some of the more the challenging and tedious tasks of daily life. In early America, the most common types of mills ground grain and sawed lumber into planks and boards. Fulling mills, though far less common than grist or saw mills were still one of the most common users of water power. All of these mills provided essential services to their communities and were considered to be

public utilities. Rather than being large operations, these businesses were useful because they were small and appeared frequently on the landscape, so that each community might have its own service providers.[18]

At a fulling mill, a flowing stream provided water to clean and moisten the cloth and powered a water wheel which raised the massive wooden hammers of the fulling stocks. As these hammers fell, they made impact with several yards of wet and soapy woolen cloth, which lay in a specially shaped trough. This repeatedly compressed and agitated the cloth, the primary action required for fulling. Prior to the thirteenth-century when the first fulling mills were erected in England,[19] and in parts of the world where access to water power was not available, fulling was performed using other methods, including tromping with feet, or the Scottish tradition of pounding and passing a piece of wet cloth around a table by hand, known as waulking.[20] Mechanical fulling eliminated the need for large numbers of people to perform this monotonous task. It was also more forceful, allowing for the production

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[18] Louis C. Hunter, *A History of Industrial Power in the United States, 1780-1930,* vol. 1 (Charlottesville: Published for the Eleutherian Mills-Hagley Foundation by the University Press of Virginia, 1979), 21–22, 34, 37.

[19] M. J Dickenson, "Fulling in the West Riding Woollen Cloth Industry 1689–1770," *Textile History* 10, no. 1 (1979): 127–28.

[20] For a brief history of fulling traditions from around the globe see Beverly Gordon, *The Final Steps: Traditional Methods and Contemporary Applications for Finishing Cloth by Hand* (Loveland, Colo.: Interweave Press, 1982), 1–7. Many of these traditions have been lost. However, wool waulkings are still carried out occasionally. This tradition includes songs which are used to keep time as the cloth is passed between a group of people, seated around the perimeter of a table. Norman Kennedy, who grew up in Aberdeen, Scotland, in the 1940s, has preserved many of these songs and the fiber tradition they accompany, and still waulks cloth occasionally at the Marshfield School of Weaving in Marshfield, Vermont.

of more heavily fulled textiles. Into the eighteenth century, fulling was almost the only stage of cloth production which relied on a power source. As industrialization struck, however, nearly every other step in woolen production was mechanized as well. Eventually woolen mills, or manufactories, used water power for not just fulling but also carding, spinning, weaving, napping, and shearing.

Mills of all sorts were powered by water either flowing over the wheel or pushing it from below. The former design is more efficient but relies on a greater change in elevation; the larger the drop, the more power is available to the mill. If the stream dries up in the summer, however, the mill's capacity is hindered. Therefore, the ideal mill seat is located along a "never failing stream." Landscapes in which streams and small rivers fall many feet over relatively short distances frequently boasted large groupings of mills. Brandywine Creek is an excellent example of this. A 1793 article published in the *American Daily Advertiser* and the *Delaware Gazette* explained that in the thirty miles of river between Chester County, Pennsylvania, and Wilmington Delaware, the water fell a total of three hundred feet and there were fifty "perches," or mill seats, housing almost 120 mills (figure 2).[21] The vast majority of these were merchant grist mills, grinding flour for re-sale, or saw mills, but the creek was also home to seven fulling mills. If the fulling mills along that stretch of the Brandywine were evenly spaced, each mill was only four or five miles from the next, indicating exactly how common, and how accessible, these mills were.

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[21] Proposal for a canal along the Brandywine, *Delaware Gazette*, January 26, 1793, American's Historical Newspapers.

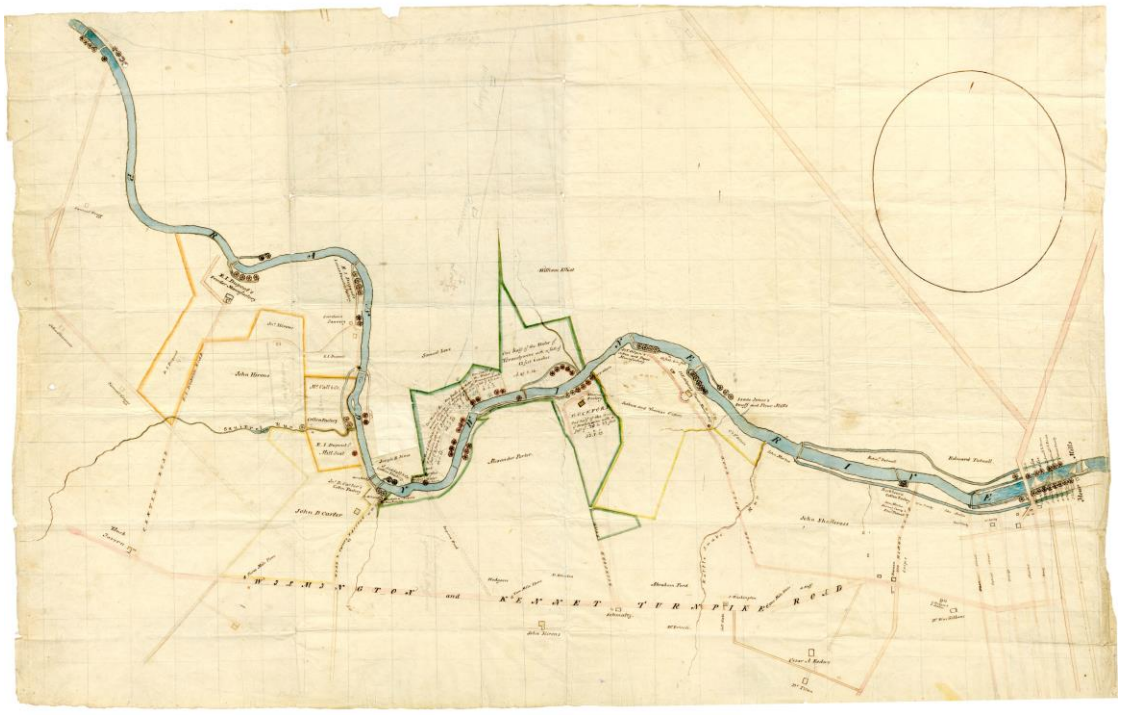

Figure 2 This map shows the sites of fifty-nine mills along the Brandywine River in 1816. Another 27 sites, marked in orange, indicate possible future mill locations with available water power. *Mill seats on the Brandywine River*, c.1816, Longwood Manuscripts, Group 9, Series C, Map Drawer 5, Manuscripts and Archives Department, Hagley Museum and Library, Wilmington, Delaware. *Courtesy of Hagley Museum and Library.*

Fulling mills were an important enough part of the economy to have their own listing in the 1810 industrial census. The census recorded the numbers of fulling mills and woolen manufactories in each state. These early census records were often flawed, but they nonetheless give a general sense of how pervasive fulling mills were in the landscape. While New York State had almost double as many fulling mills as any other state at 427, Pennsylvania had 213, 29 of which were in Chester County. New

Jersey's returns list 52 fulling mills, while Maryland had 21 and Delaware a mere 8. [22] When looking at why some states had more fulling mills than others, there are several factors to consider, including terrain—flat landscapes, and those which lack reliable streams cannot support water-based milling operations—and climate. Ninety percent of the nation's fulling mills were located in either New England or the Mid-Atlantic, since much of the south lacked both the terrain for mills and the climate for sheep-rearing.[23]

Fulling mills were not constants on the landscape either. A mill site's most valuable resource was its water power. It was both common and relatively easy for a mill owner to adapt the structure and mechanism of their mill to a different function. Mill owners did this to suit the changing needs of the community or changing financial opportunities. A notice in the *Delaware Gazette* from June 23rd, 1792, advertised two grist mills for rent in Kent County Maryland. The mills had previously been a saw mill and a fulling mill, and the advertisement states that they could be altered back to those functions if desired. Other millers added new mills of different functions onto their properties. Around 1811, Robert Philips built an addition onto his grist mill on Red Clay Creek in Delaware. Known as the Madison Factory, this structure was designed to be a woolen cloth manufactory. In 1822, an advertisement explained that the property had two water wheels, one of which drove the woolen mill,

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[22] Coxe, *A Statement of the Arts and Manufactures of the United States of America, for the Year 1810*, 7. By 1820, when the next census was conducted, the questionnaire recorded the products of manufacturing but had eliminated service-providers like fulling mills.

[23] Hitz, "A Technical and Business Revolution," 164–65.

while the other powered the grist mill's equipment.[24] Philips clearly saw an advantage in adapting his mill seat to a new use.

The Physical Structure of Fulling Mills

Whether adapted from another use or built specifically to house fulling stocks, the structures of the mills themselves, and the various outbuildings associated with them, can provide another layer of groundwork for understanding this craft. To the best of my knowledge there are no intact fulling mills in America, but fulling and early woolen mill structures occasionally survive, as do descriptions and depictions. Because of the similarities between them, this section looks at both types of mills to assess the physical structures where cloth finishing took place in the Early Republic. The factory which Robert Philips built around 1811 included a fulling mill and was also the base-of-operations for a larger woolen manufacturing business. The building survived into the twentieth century before burning down in 1969 and subsequently being re-built (figure 3).[25] It is constructed of stone, 45 feet long by 25 feet wide and three stories high and is attached to the 50 by 39-foot timber frame grist mill. Another addition at one end was described in 1822 as "28 feet long and 24 wide, one and a half story high, with 2 large sheds, and a shear shop," a space which was clearly also part of the Philips's woolen finishing business. The property also contained a stone house

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[24] Pursell, *Two Mills on Red Clay Creek in the 19th Century*, 25.

[25] "History & Restoration," Greenbank Mills, accessed March 7, 2019, http://greenbankmill.com/home/history.

Figure 3 The Madison Woolen Factory and Greenbank Mill, Wilmington, Delaware. The left-hand portion of the structure built in stone is the reconstructed Madison Factory. *Photo by the author.*

and kitchen, a barn and "six tenements for families to live in." An earlier advertisement describes the existence of a dye house on the property as well. [26]

Though the factory was established as a woolen mill, which could produce cloth from start to finish, it is likely that the stone mill building primarily held the finishing operations. While the Philipses owned several looms, they may have operated in another structure, or even off site. This means that the Madison Factory

[26] Pursell, *Two Mills on Red Clay Creek in the 19th Century*, 25.; Advertisement, *American Watchman*, Wilmington, Delaware, January 9, 1816, America's Historical Newspapers.

can serve as a useful corollary to understand the physical spaces of fulling mills. The thorough description provided in advertisements helps to frame a sense of the physical spaces used in cloth finishing. In addition to a mill structure, the property included specific spaces for dyeing and shearing.

Despite the fact that the Madison Factory did significantly more than finishing, it appears to have been about the same size as many contemporary fulling mills. In 1819 and 1820, Elijah Davis advertised the sale of his fulling mill in West Bradford, Pennsylvania. He states that "the buildings are a good Stone House, a good Barn, [and] a Stone Fulling Mill, forty feet in length, with a large dam, where the business has been carried out for several years."[27] Though the Broad Run fulling mill no longer stands, a raised area of ground indicating its location remains. Using the dimensions of that area as evidence, the mill was likely also about 40 feet in length, or a little longer, suggesting a roughly standard size.

Images of fulling mills like the two in West Bradford are scarce, but woolen mills such as the Madison Factory were occasionally depicted. The billhead of Joshua and Thomas Gilpin's Brandywine Woollen Manufactory shows a mill in the background, which may be the main structure of the mill, though it may well also depict another mill belonging to the Gilpin brothers (figure 4). A sketch done by Eluthera du Pont in the early 1810s depicts her family's woolen venture, the Louviers Mill, which was also on Brandywine Creek in Delaware (figure 5). Both are large four-story structures and show a variety of small outbuildings nearby.

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[27] Advertisement, *Village Record, or Chester and Delaware Federalist*, West Chester, Pennsylvania, January 6, 1819, America's Historical Newspapers.

Both country fulling mills and more fully integrated woolen mills with cloth finishing capacity were designed to house a range of finishing equipment. First and foremost, this meant the fulling stocks themselves. Fulling stocks were massive pieces of machinery made largely of wood. They could easily be taller than a man, as illustrated in the billhead (figure 4), where fulling stocks can be seen on the left of the image.[28] The mechanism consisted of two large hammers on long arms which were raised by protruding tappets fixed to a rotating shaft. The shaft was fixed directly to the water wheel, so that as water pushed the wheel, the shaft rotated, and the tappets alternately raised the hammers. As the hammers dropped, they swung down into a shaped trough holding the wet cloth.

Workers inside the mill contended with the noise and vibration of the fulling stocks. Water powered mills are part building, part machine, and standing inside an operating mill often feels as though you are within the machine itself. There would not be anywhere in the building, or likely within several hundred feet of it, where the sound of the fulling stocks would not be audible. Given that cloth often ran in the fulling mill for hours at a time, the constant noise would have affected anyone inside the mill, as well as others nearby.

By the 1810's, many fulling mills housed carding machines. Carding was a natural pairing with fulling, since it was easy to hook the machinery up to a fulling mill's power supply, and carding could easily be provided as a service, just as fulling

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[28] Oliver Evans and Thomas Ellicott, *The Young Mill-Wright & Miller's Guide* (Wallingford, Pa.: Oliver Evans Press, 1990), 87, plate XII.

Figure 4 *Brandywine Woolen Mill Billhead.* Etching: Brandywine Woollen Mill by Joseph Cone, James John Barralet, 1814-1815, Philadelphia, PA, Ink, Wove paper, Laid paper, Bequest of Henry Francis du Pont, 1959.2089. Courtesy, Winterthur Museum.

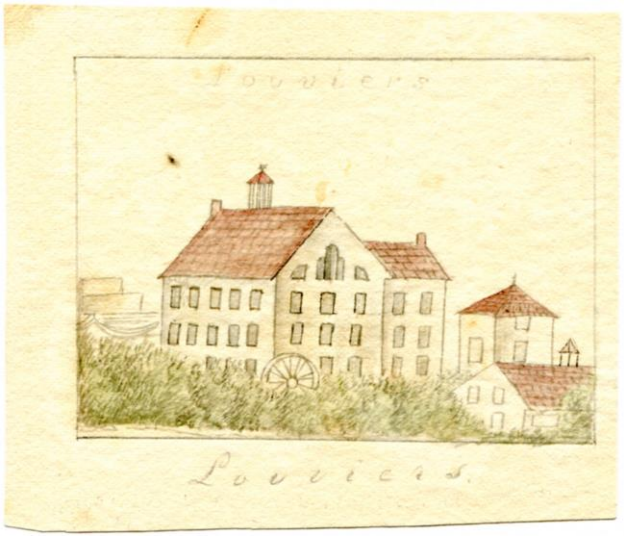

Figure 5 *Drawing of Louviers Mill* by Eluthera du Pont Smith, c.1811-12. Winterthur Manuscripts, Group 6, Box 30, Manuscripts and Archives Department, Hagley Museum and Library, Wilmington, Delaware. *Courtesy of Hagley Museum and Library.*

was. Increasingly as the nineteenth century progressed, fulling mills also contained a series of other technological innovations. While fulling stocks were built into the structure of the mill itself, these other machines were instead driven by belts which connected to drive shafts powered by a water wheel (figure 6). These machines needed to be located within the mill building itself, because of their power requirements.

Figure 6 Tom Kelleher, Historian and Curator of Mechanical Arts at Old Sturbridge Village, adjusting the leather drive belt powering one of the museum's nineteenth-century carding machines. *Image by the author.*

Other work may also have been performed inside fulling mill structures, but the noise and vibrations of the fulling stocks likely impeded many other tasks. The processes of pressing and dyeing both required a heat source. The later often happened in a designated dye house. Both preparing the cloth for shearing, and inspecting it afterwards required good light. Napping necessitated a large frame or table. These tasks may well have taken place on the upper floors of these mills. Shearing created large amounts of lint and so at least at the Madison factory this task was done in a separate shed. Outdoors, tenter frames, for stretching the drying cloth, required open space. The need for multiple structure and open ground is another reason why fullers were happy to set up business in rural locations. Less populous areas also meant that the water which powered these mills was cleaner, and therefore better for both fulling and dyeing.

At fulling mills operated by a single person, or just a few people, individuals would have had to move between spaces in the mill to finish a length of cloth. They would have moved inside and out and between levels, working with water, heat, and a variety of tools which required frequent maintenance. Some tasks took constant attention, like shearing, while others, like the fulling itself, meant keeping half your mind on the sound of the mill, monitoring the equipment with your ears and through the soles of your shoes while mentally calculating when the cloth would need to be checked. The more efficiently the fuller balanced these tasks, the faster the work would be accomplished, and the more money made.

Without an extant American fulling mill with its original equipment still in place, or a floorplan of how that equipment was originally positioned, it is impossible to accurately recreate the patterns which fullers' feet wore into the ground as they

moved between machines and processes to accomplish the several tasks of which their trade consisted. However, understanding the equipment and the space in which it was used is a first step towards recreating the physical environment of a fulling mill. With a sense of place, we can begin to imagine what it meant for a fuller to accomplish the work of finishing cloth. That work consisted of not only the labor of their craft, but also the moments spent moving between spaces and tasks, enduring the constant sound of the equipment, and worrying over the supply of water which made the work itself possible.

Owners, Craftspeople, and Laborers

The skills of cloth finishing resided in the hands and minds of individuals, but the workers who used tools and ran machinery and who processed the cloth brought to fulling mills carried out their craft within broader social networks. These networks included mill owners and operators, craftspeople, and laborers. Some mills were owned and operated by the same person. Others were rented out or run by skilled craftspeople hired by the owner. Fullers also employed apprentices, journeymen and laborers to work with them in their mills. Small fulling mills such as the mill on Broad Run appear to have been run by only one or two individuals, while woolen manufactories which included finishing departments had larger and more diverse workforces.

Mill operations became much more complex in the early years of the nineteenth century. The technological revolution which was underway at that time meant that fulling mills expanded their operations. The first major change was the addition of carding machines. Mechanical carding was a good fit for fullers's business models, since customers could simply drop off their raw wool and pay by the pound

for it to be carded.[29] The mechanical carding machine was many times faster than carding by hand and meant that more yarn could be spun, and cloth woven, and eventually finished. In this way it benefitted the miller twice over.

Though carding machines were by far the most common addition to fulling mills, more integrated woolen manufactories also began to emerge in this period. They not only carded and fulled material, but also took control of the spinning and weaving process, and often also used mechanized napping and shearing equipment. These businesses produced woolen cloth for sale, but often also continued to finish locally made cloth.[30] They employed many more people than small, service-provider fulling mills. Because of the growing degree of mechanization and the related de-skilling of textile processes, many of these employees came from populations perceived to have less skill or ability, and requiring less pay, such as women and children.

Staffing the Pre-Industrial Fulling Mill

Mills which began operations long before mechanization were often run by one individual. A fulling mill could also be a seasonal occupation. The mill on Broad Run was originally built around 1730. By 1789, it was operated by Calvin Cooper, who bought the mill from his father in 1801,[31] and continued to run it until his death in 1818. Cooper was a farmer as well as a fuller, a fact which correlates with the seasonal

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[29] Laurence F. Gross, "Wool Carding: A Study of Skills and Technology," *Technology and Culture* 28, no. 4 (1987): 808, https://doi.org/10.2307/3105183.

[30] Cole, *The American Wool Manufacture*, 1:182.

[31] "Library Record: Book - Ledger and Daybook, 1789-1815," accessed March 13, 2019, https://chestercohistorical.pastperfectonline.com/library/5095DEDF-D1BF-4DF9-B6B5-796204625100.

pattern of his fulling work (figure 7). [32] The fulling business was busiest in the middle of winter, with Cooper averaging more than fifty jobs a month in December and January. From May to August, however, the mill was virtually silent. An 1823 advertisement for Abel Thomas's Chester County fulling operation states that he accepted work between November to the beginning of March, corroborating evidence of the seasonality of this work found in Cooper's accounts.[33] At least at Calvin Cooper's mill, fulling work took place at times of year when the farm was quiet and when streams were less likely to run dry. Many other artisans in this period, including local weavers, split their year between agriculture and craft production as well.[34]

While Cooper recorded little about his farm in his accounts, he did occasionally mention hiring help. In two of Cooper's day books he recorded the employment of individuals for unspecified labor. In 1801, Cooper employed Levi Nichols from April to January of the following year. He paid him in both schooling and cash, which was occasionally given to Nichols' father, suggesting that this arrangement may have approximated apprenticeship. In 1809 he hired Phillip, a man who he describes parenthetically as "blackman"—presumably referring to his race—for a period of 8 months beginning in March. In 1812 he hired Benjamin for nine

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[32] Catherine Quillman, *Between the Brandywines: A History of West Bradford* (Downington, Pa: West Bradford Press, 2005), 235–36.

[33] Calvin Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* 5 vols. West Bradford Township Business Houses, Township Files, Chester County Historical Society Library, West Chester, PA.; Village Record, October 29, 1823, Newspaper Clippings Collection: Industry: Fulling Mills, Chester County Historical Society Library, West Chester, PA.

[34] Hood, *The Weaver's Craft*, 38.

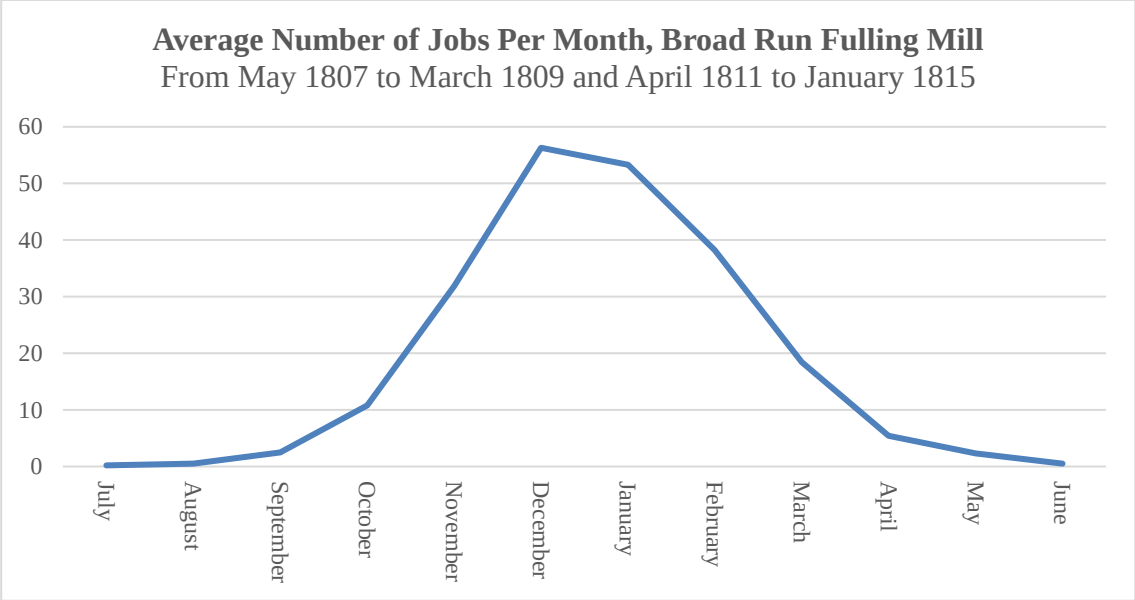

Figure 7 Average number of jobs per month at the Broad Run fulling mill from May 1807 to March 1809 and April 1811 to January 1815. Data from Calvin Cooper's account books at the Chester County Historical Society Library, West Chester, Pennsylvania.

months, again starting in March. In each case, the employment begins in spring, and runs through the end of the year. This suggests that Cooper employed these individuals largely to help with agricultural work, though likely they also assisted in the mill as the year waned.[35] Aside from this part-time and occasional assistance, it seems likely that Cooper ran the fulling operation by himself, or with the help of family members who were not remunerated in cash.

While some mill owners worked as fullers, others rented out their fulling mills. This allowed individuals with a good deal of capital to invest in mill real estate and

[35] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* vols 1-3.

those with the necessary craft skills to create what was hopefully a profitable business for both. An advertisement from 1810 listed a grouping of mills for rent in Queen Ann County Maryland, which included a fulling mill. According to the ad, the fulling mill could be rented with the others, or separately.[36] This advertisement suggest that landlords were ready to facilitate whatever skilled mill operators might be interested in renting their property.

It was also possible for a miller to maintain ownership of a business while hiring someone to run it in their name. When Calvin Cooper died in 1818, the Broad Run mill was bought by Andrew and Hannah Wilson, who added a carding machine to the business. When Andrew died in 1821, Hannah took over ownership of the mill. Andrew's death is marked in the Broad Run Mill's accounts by a change of handwriting in the mill's ledger book in early June of 1821. A day book for the mill beginning in September of 1821 also survives. It is in Hannah's name, though it also bears the name of David Harry, Hannah's brother,[37] who worked for her in the mill. The sibling's names are written on the tops of two opposing pages, in the middle of the day book (figure 8). The left-hand side reads "Hannah Wilson's Carding Book For the year of our Lord eighteenth hundred and twenty two." The facing page is inscribed

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[36] Advertisement, *Delaware Gazette*, June 23, 1792, America's Historical Newspapers; Advertisement, *American Watchman*, Wilmington, Delaware, October, 20, 1810, America's Historical Newspapers.

[37] Gilbert Cope, *Genealogy of the Baily Family of Bromham, Wiltshire, England: And More Particularly of the Descendants of Joel Baily, Who Came from Bromham about 1682 and Settled in Chester County, Pa.* (Lancaster, Pa.: Wickersham Printing Co., 1912), 208.

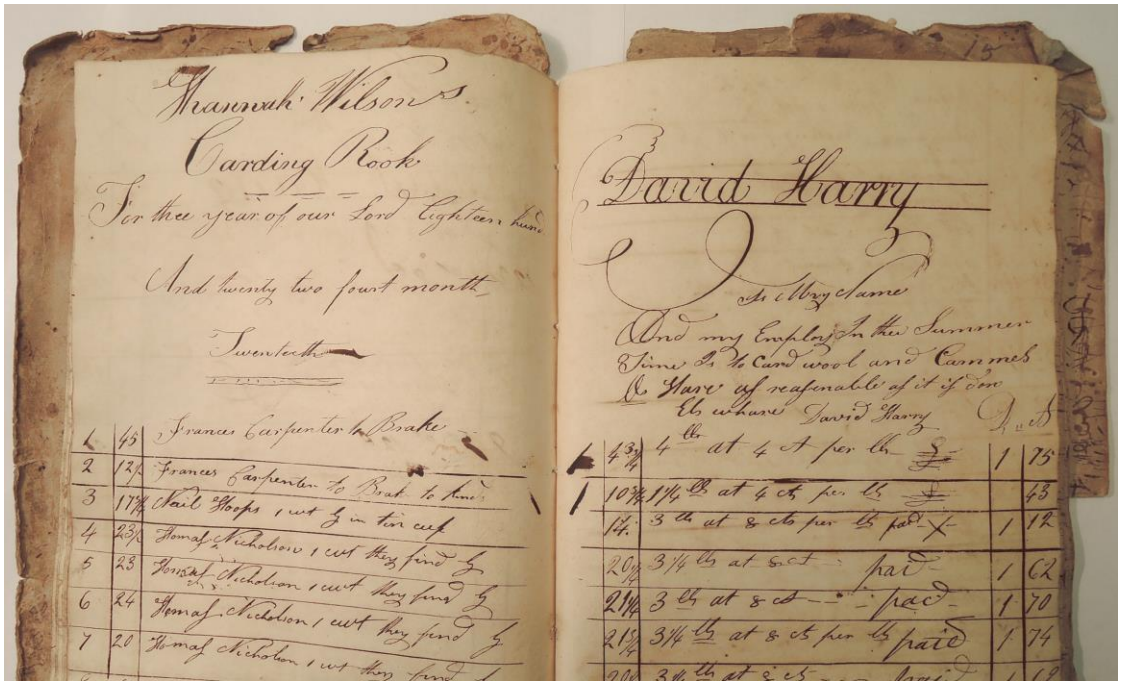

Figure 8 Page headings in Hannah Wilson's day book for the Broad Run fulling and carding mill from 1821-1823 with inscriptions by Hannah Wilson, who owned the mill, and David Harry, who operated it. *Courtesy of Chester County Historical Society Library, West Chester, Pennsylvania. Photo by the author.*

"David Harry is my name and my employ in the summer time is to card wool..."[38]

The use of the first person in David's passage suggests that he was the one who set the words on the page.[39] His assertion of his role in the work of the mill is especially

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[38] Hannah Wilson, *Daybook, 1821–1823*, West Bradford Township Business Houses, Township Files, Chester County Historical Society Library, West Chester, PA.

[39] It is also worth noting Harry's mention of the season, suggesting that under Hannah Wilson's ownership, the mill also operated in the summertime. Additionally both Wilson and Harry describe their work as carding, though the day book shows that the mill was still finishing significant amounts of cloth.

interesting in counterpoint to his sister's clear ownership of the business, expressed on the previous page. The handwriting throughout the day book in consistent and is also consistent with the hand which takes over Andrew Wilson's place in the mill ledger in 1821, suggesting that David was with the mill not just in the summer of 1822, but was actually running it the entire time that it was in Hannah's ownership.

On September 12th, 1821, Wilson advertised in the *Village Record* for "A Journeyman who is a good workman at the fulling business, and can come well recommended," stating that he would "find constant employment" at her mill.[40] Harry was clearly already working in the Broad Run mill in June. Wilson might have been advertising for a replacement who never materialized, or possibly for a second set of hands to aid her brother. In either case, while David Harry was keeping the mill's accounts, all the paperwork associated with the business, newspaper ads included, was in Wilson's name. Hannah Wilson inherited her husband's business after his death, and the business continued in her name until at least 1823, when the day book and ledger both end.

While fulling mills were not always operated by their owners, the records suggest that the responsibility for operating the mill typically fell to one individual. Though many fullers may have hired help some or all of the time, the burden of understanding the gamut of woolen finishing processes belonged to a skilled specialist. In some cases, such as that of Calvin Cooper, a fuller had a lifetime's worth of experience and a steady, reliable business. Despite this, many fullers' skills must have fallen short. Treatises on woolen manufacturing frequently emphasis that it took

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[40] Village Record, September 12, 1821, Newspaper Clippings Collection: Personal Name Files, Chester County Historical Society Library, West Chester, PA.

years of apprenticeship and training to acquire the skills needed to be a competent finisher.[41] Despite the challenges inherent in mastering one, let alone all of the branches of woolen finishing, American fullers often portrayed themselves as renaissance men of cloth finishing. Thomas and Stephan Staples exemplify this in as advertisement from 1814:

> The Subscribers inform their neighbors and the public in general, that they are establishing as their new Fulling Mill, the dying, fulling, and finishing of superfine and coarse, broad and narrow cloths, and solicits a portion of their patronage; particularly those that wish to have their work finished handsomely and with dispatch.
>
> The subscribers trust that they will be able to give satisfaction, as they will have good workmen, and every convenience for finishing cloth at the shortest notice, in the best manner, and on the most reasonable terms.[42]

The Stapleses were confident in their ability to finish every type of cloth which they might be presented with, and to do so in the best manner, but there is no confirmation of the truth of the brothers' claim. The quality of that work depended largely on the skill and experiences of the "good workmen" whom the Stapleses employed.

Country fulling mills were small sites of industry which followed a long-standing business model. One mill might be operated for a lifetime by a single individual or be sold or rented out. Owners might be craftspeople, canny investors, or

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[41] John Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax* (Williamsburg, Va: Colonial Williamsburg Foundation, 1981), 17–18; Asa Ellis, *The Country Dyer's Assistant* (Brookfield, (Massachusetts): Printed by E. Merriam & Co. for the author, 1798), 104, 114, 122–23.

[42] Advertisement, *Delaware Gazette*, November 29, 1814, America's Historical Newspapers.

family members who had inherited a business. Because mills were thick on the ground, especially in places with easy access to water power such as Chester County, Pennsylvania, local cloth producers could choose what mill they patronized.

The Madison Factory and the Structure of Early Woolen Mills

Early woolen mills typically operated on a different business structure than service-provider fulling mills. However, they often performed similar work, and the distinctions between the two types of businesses were not always clear-cut. An examination of the Madison Woolen Factory helps to illustrate the range of business models which performed cloth finishing work in the early-nineteenth-century mid-Atlantic. Constructed next to Greenbank Grist Mill on Red Clay Creek in Delaware, the Madison Factory was owned, if not always operated, by Robert Philips and his son John in the 1810s and 1820s. The nature of this business, which at times included a flock of sheep, spinning, and weaving, in addition to cloth finishing, was more varied and variable than small fulling operations such as the Broad Run mill. The Madison Factory had to deal with multiple textile processes and many employees, on top of the complexities of the early-nineteenth-century American economy. Because the Philipses were not themselves skilled in cloth-making, their business also illustrates the challenges of finding and retaining skilled craftspeople. The machinery with which the Madison Factory was equipped, and the unskilled and often young laborers who operated it, also help to demonstrate how technology facilitated de-skilling in the woolen finishing industry.[43]

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[43] Other scholars have written histories of several early woolen mills. See Pursell, *Two Mills on Red Clay Creek in the 19th Century* for in depth information on the Madison factory, as well as Gibson, "Fullers, Carders, and Manufacturers of Woolen Goods in

The history of the Madison factory emerges from a series of newspaper advertisements. First was John Philips' 1811 advertisement for someone to take care of a flock of sheep. Right away, this presents a different type of business than the country fulling mill. By owning a source of raw materials, the Philipses were clearly aiming to establish a manufactory. They were participating in a culture of entrepreneurship which was popular at that time in the Brandywine Valley. Enterprising persons such as E.I. du Pont, William Young, and Peter Bauduy, all of whom were engaged in several different types of business, likely inspired the Philipses in their purchase of merino sheep and building of a new woolen mill next to Green Bank Gristmill. Philips and his father appear to have bought a flock and built a mill as a business venture.[44] The nature of the Philipses' new business meant that they required skilled employees to operate their mill, much as Hannah Wilson did after the death of her husband, though on a larger scale. In 1814, they advertised for families with children who could be employed in the mill, as well as for a dyer and several finishers.[45] Advertising for unskilled child labor is an important clue to the changing nature of cloth production around this date.

By 1815 the Philipses had "taken into partnership John M. Butler and Charles Briggs, experienced workmen in the fulling, dying, and finishing department of his

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Delaware."; and Gibson, "The Delaware Woolen Industry." Hitz, "A Technical and Business Revolution," should also be consulted for detailed economic and technological histories of several early American woolen mills.

[44] Pursell, *Two Mills on Red Clay Creek in the 19th Century*, 22–23.

[45] Pursell, 22, citing advertisements in the American Watchman, March 23, 1814 and July 2, 1814.

Woollen Manufactory," and John Philips announced that the business would be carried out under the name of John M. Butler, and Co. Though the business was no longer in the Philipses' name, the younger Philips continued to be responsible for the newspaper advertisements. By January of 1816, the mill was for rent. The timing here suggests that the end of the War of 1812 caused the business to struggle. Finally, in 1818, John Philips advertised that the mill was once again open, this time under the name of ROBERT PHILLIPS, SON & CO. The most recent manager, Mr. Barber, had returned to England, but the Philipses were employing John Aldridge, who the younger Philips took pains to point out was also English.[46]

The Philipses were not engaging in the safe and centuries old trade of running a country fulling mill, and additionally, they themselves did not possess the craft skills needed to manufacture cloth. Instead, they hired skilled help, and when necessary allowed those employees to operate the business under their own names. When expedient, they advertised that their workmen had training in English woolen manufacturing, in a clear attempt to reassure customers of the quality of their cloth. William Partridge's 1823 *Treatise on Dy[e]ing* addresses this subject head on, helping to emphasis its significance. He states that at least in the early years of a woolen manufactory, it was necessary to employ European workmen. (However, a second generation of native workmen should be trained up within a few years.)[47]

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[46] Advertisement, *Delaware Gazette*, March 7, 1815, America's Historical Newspapers; Advertisements, *American Watchman*, Wilmington, Delaware, January 9, 1816 and September 9, 1818, America's Historical Newspapers.

[47]William Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere: Including the Most Improved Methods Pursued in the West of England, in Which the Various Manipulations Are Accurately Delineated.: Also, a Correct Description of Sulphuring Woollens, and*

The other woolen factories in Northern Delaware, including Louviers, owned by the du Ponts, William Young's factory at Rockland, the Gilpin's Brandywine Woollen Mill, and Mordacai McKinney's mill, faced the same challenges regarding employment. When available, these Brandywine entrepreneurs hired English and European craftsmen. Du Pont received letters from French, Swiss and English immigrants offering their skills. They also placed newspaper advertisements for local skilled craftsmen. According to George Gibson, these ads were designed to "lure dyers, weavers, fullers, and finishers to their factories and away from independent businesses devoted to assisting household manufacturing."[48] Following more traditional means of acquiring skilled craftspeople, these businesses also sought out apprentices. However, as mechanization took over, mill owners also looked for unskilled labor. Many mills followed the model of Samuel Slater's Rhode Island cotton mill by hiring whole families and employing women and children alongside men. In 1820 there were 250 woolen factories across the New England and Mid-Atlantic states, each employing an average of 15 people. The work force was typically fifty percent men, thirty percent children, and twenty percent women.[49] As mechanization progressed further in the second decade of the nineteenth-century, the proportion of men to women and children employed decreased and the size of the

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Chemical Bleaching of Cottons (New-York: Published by H. Wallis & Co. for the author. J.W. Bell, printer, 70 Bowery, 1823), 27.

[48] Gibson, "Fullers, Carders, and Manufacturers of Woolen Goods in Delaware.," 33–41; Gibson, "The Delaware Woolen Industry," 108–9.

[49] Hitz, "A Technical and Business Revolution," 164–65.

mills increased. By 1830, most of the mills on the Brandywine had dozens of employees.[50]

Even with this relatively large staff, only a small number of people were likely involved in the finishing work at the Madison factory. Fulling was specialized work, and one fuller or "millman" could easily oversee several sets of stocks. According to William Partridge, "the millman, with a lad of sixteen, and a boy of ten or twelve, will do all the work of two pairs of stocks, and raise the nap of the cloth fulled in them.[51]

The Madison Factory placed advertisements at various times for workers, including one seeking entire families, for men to train in finishing and in weaving, for young women to work in the spinning operation, and for boys to be trained as apprentices.[52] These advertisements suggest that the Philipses employed up to a dozen people at times. The Philipses' mill lay somewhere in between these large manufacturers and small country fulling mills. A number of other mills also took up this middle ground, doing custom carding, spinning, weaving, and finishing, but also happy to buy up wool and manufacture it into yard goods for sale.[53] This scale of

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[50] Tucker, "Liberty Is Exploitation," 22; Gibson, "The Delaware Woolen Industry," 109–11.

[51] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 107.

[52] Pursell, *Two Mills on Red Clay Creek in the 19th Century*, 22–23.

[53] *Village Record*, October 29, 1823, Newspaper Clippings Collection: Industry Files: Fulling, Chester County Historical Society Library, West Chester, PA; *American Republican*, May 12, 1818 and *Village Record*, May 2, 1827, Newspaper Clippings Collection: Industry Files: Wool Carding, Chester County Historical Society Library, West Chester, PA; Cole, *The American Wool Manufacture*, 181.

business, as well as the fact that these businesses happily placed newspaper advertisements all year round, suggest that they were full-time operations, rather than seasonal businesses.

By the second decade of the nineteenth century, a true spectrum of businesses which engaged in fulling existed in south-eastern Pennsylvania and northern Delaware. These ranged from small fulling businesses, run seasonally by individuals, to large-scale factories with immigrant master craftsmen, and young children operating machines designed to negate craft skill. As industrialization progressed, the spectrum tilted towards the latter. Despite this, some small, independent fulling mills remained to finish homemade textiles.

Mill Customers

Whether performed in a factory or in a country mill, cloth finishing took place where water power was available, and not necessarily in a location convenient to customers. To solve this problem, many fullers advertised that cloth could be dropped off at local shops, from whence it would be taken to the mill, finished, and returned. However, the range of finishing services which a fuller could provide meant that the cloth had to be accompanied by a note describing the work to be done. The fuller then needed to keep track of whose cloth was whose, perform the work in a timely manner, and return it to the customer. The range of standard language used in fullers' accounts to describe the work they carried out indicates not only how their customers understood the services they were hiring, but also how those requests translated into standard tasks at the fulling mill. Descriptions of length, color, and markings indicate how fullers tracked different textiles once they arrived at the mill. Exploring fullers' relationships with their customers through the language found in their accounts allows

us to examine not only how woolen cloth was finished, but also how that process was experienced by those who hired the fullers.

Fulling advertisements placed in newspapers often included information about intermediaries or agents who would take in cloth for delivery to the mill. Andrew Wilson advertised for customers interested in fulling or dyeing work "to send their work to Townsend and Hoops Store in Westchester, with written orders,"[54] while John Philips announced that the Madison Factory's agent "Mr. George Jones, Merchant Taylor, No. 80 Market street, Wilmington… will receive all kinds of goods for finish and deliver the same when finished, with the additional expense only of a reasonable compensation to the agent."[55] Abel Thomas advertised that fulling and dressing work for his Doe-Run Woollen Mill in rural Chester Country could be dropped off at any of four different locations within ten miles of the mill, including two stores, a weaving shop and a mill (likely a grist mill).[56] This delivery system allowed both customers and fullers to spend less time traveling, and more time producing textiles.

Allowing cloth to be dropped off at convenient locations eliminated face to face interactions between customers and craftspeople. Instead, customers had to send a note along with their cloth to explain the services they were requesting. Abel Thomas described the different types of finishing services that he offered in his advertisement,

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[54] Advertisement, *Village Record*, West Chester, Pennsylvania, November 1, 1820, America's Historical Newspapers.

[55] Advertisement, *Delaware Gazette*, March 7, 1815, America's Historical Newspapers.

[56] *Village Record*, October 29, 1823, Newspaper Clippings Collection: Industry Files: Fulling, Chester County Historical Society Library, West Chester, PA.

no doubt hoping that his customers would follow his lead and specify exactly what service they were requesting. He stated that he carried out "fulling, dying and dressing of Cloth, Blanketting, Flannel, Lindsey, Sattinet, &c."[57] While the list of textiles in part described the range of fabrics which he was used to working with, it also to some extent described different types of finishes. The finish which was standard on cloth (here "cloth" likely refers specifically to a dense textile used for men's clothing) was different from that used for blankets. The first was meant to be firm and dense, requiring long fulling and a close shearing, while the latter was finished to make it as light and fluffy as possible (see appendix A). With his list, Thomas implicitly states that he is aware of the proper finish for each of these textiles.

Fullers translated the information which they received in their customer's notes into their own records. Entries in fulling mill account books record not only customer name, date, and cost, but also what each job consisted of. Not all record keepers wrote with equal degrees of detail, and not all jobs required as much description. In some cases, it was clear enough to name the fabric, and the proper finishing was implied. In other instances, modifiers were used to clarify details, or the fabric's final use was added, to suggest a specific finish. The accounts of the Grandin mill in Raritan, New Jersey which operated in the 1770s and 1780s, are particularly rich in descriptive detail. A single page from November of 1780 contains three entries for cloth "made coating for great coats," and a fourth for cloth "made very rough as can for great coats." The finishing required for great coats was clearly relatively standard, so when a customer asked for a variation on that—in this case for the cloth to be rough, perhaps

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[57] *Village Record*, October 29, 1823, Newspaper Clippings Collection: Industry Files: Fulling, Chester County Historical Society Library, West Chester, PA.

meaning with a shaggy, un-sheared nap like the swatches of bearskin cloth in figure 9, the fuller made a note of it relative to their standard for great coat finishing.[58]

Account books also contain examples of cloth finished for other specific functions, including fabric to be "milled [fulled] fit for trowsers."[59] Perhaps the most common use-specific reference found in the account books examined for this study was cloth finished either for men's or women's wear, a description which references the differences in textiles found in male and female clothing. Some entries provide more information to the modern reader, such as one made by Calvin Cooper for cloth "milled half thick."[60] The implication of this entry is that Cooper would full the cloth about half as much as he normally would. Perhaps this was a direct quote from his customer, or, more likely, it was the craftsman's translation of his customer's wants. Fundamentally, fulling mill clients relied on the expertise of craftsmen to translate their requests into discrete finishing processes and produce the most suitable end-product.

On top of performing the correct finishing processes on each piece of cloth, fullers also had to keep track of which cloth belonged to which customer. Each entry in the Grandin fulling mill account book illustrates a sigil, or pair of initials, noting where they were marked or embroidered into the cloth. Similar patterns of initials can be seen on a scrap of paper interleaved into a New Hampshire woolen mill book from

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[58] "Grandin Fulling Mill Day Book" (1774-1791), Hunderton County Historical Society.

[59] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815*, vol. 2.

[60] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* vol. 1.

Figure 9 Samples of the thick, heavily napped cloth known as bearskin, from the papers of Philadelphia merchant Nathan Trotter, circa 1805-1810. Winterthur Library: Downs Collection, Col 325, Series VII, folder 27. *Courtesy, the Winterthur Library: Joseph Downs Collection of Manuscripts and Printed Ephemera.*

the 1810s, while Calvin Cooper used a less scientific method and marked either the corner or the middle of a piece with Xs or Os. These individualized marking systems helped fullers track textiles throughout the finishing process.[61]

Many of the textiles finished in these mills would have taken multiple days to process. Most of the finishing processes took time, and cloth often had to be rinsed, stretched, and dried between steps. Few account books give a reasonable sense of how long customers waited to receive their finished cloth, but the day books kept by Calvin Cooper are an exception. On average, two weeks pass between Cooper's initial entry, taking the cloth into the mill, and the corresponding entry discussing the final cost of the work, which was added to the day book when the job was complete. Sometimes this period is as short as a few days, though that is more common with dye orders than with milling or dressing orders. At other times, the period is as long as a month or more.[62] This set of accounts, therefore, gives us a rough sense of how long at least one fuller took to complete finishing work. When the job was done, fullers returned textiles to their customers, and collected payment. Finishing services were charged for by the yard. Those which were more heavily fulled cost more. Elizabeth Hitz states that at the time of the 1820 census, fullers typically charged between 14 and 25 cents

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[61] "Grandin Fulling Mill Day Book"; Edmund Mooers, *Account book, 1812-1816,* Doc. 579, Downs Collections, Winterthur Museum, Library, and Garden, Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* vol. 2.

[62] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* vols. 2-5.

per yard, though around that same date Hannah Wilson charged only seven cents a yard for finishing women's wear, and nine cents a yard for men's wear.[63]

The goal of this chapter has been to paint a picture of what it meant to work at an American fulling mill or to hire a fuller to finish a piece of cloth. Woolen cloth was essential to the lives of Americans throughout the eighteenth and into the nineteenth century. During that period, much of the demand was met through imported cloth, but fabric was also produced domestically. Whether made at home, or, as was increasingly the case over time, in a factory, woolen cloth needed to be finished to some degree to make it useable. That finishing required fulling machinery, which was powered by water. It also required craftspeople with the skills to translate customer's wishes into functional textiles. Fulling mills required the right geography, infrastructure investment in a mill and dam, industrious neighbors who saw home production of woolen textiles as a worthwhile use of their time, and a skilled workforce. Understanding the physical and social structures behind cloth finishing provides a necessary framework for understanding the craft skills which fullers performed for their customers by means of their businesses.

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[63] Wilson, *Daybook, 1821–1823,* Hitz, "A Technical and Business Revolution," 160–61.

Chapter 2

FROM FLEECE TO FABRIC: THE STAGES OF MAKING AND FINISHING WOOLEN CLOTH

In 1822, William Guthrie brought two lengths of cloth to the Broad Run fulling mill. His order in Hannah Wilson's day book records that twelve and a half yards of flannel was to be finished for men's wear, and another twelve and a half yards for women's wear.[64] Likely these two lengths were in fact two halves of the same web, or piece of un-finished cloth fresh from a weaver's loom. Almost certainly Guthrie, or whoever wove the cloth for him, had in mind the end function of the textile as they carded, spun, and wove the wool which would eventually be delivered to the fulling mill. This meant that from the beginning they intended that the cloth would be divided and one part transformed into a thin, lightly-finished, textile suitable for a garment such as a women's petticoat or gown (figure 10), while the rest became a thicker, studier, cloth which could be made into a man's waistcoat or jacket (figure 11). This chapter explores how such transformations were possible.

Every step in the process of transforming sheep's fleece into cloth suitable for garments and other uses requires unique craft expertise. It also necessitates foresight regarding the cloth's final form. To that end, this chapter explores every step in the production of cloth, beginning with the raising of sheep, before focusing more specifically on the final finishing processes of fulling, napping, shearing, tentering, and pressing. Six American cloth-making and finishing manuals, written between 1769 and 1844, provide the bulk of the source material for this chapter. Each of these

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[64] Wilson, *Daybook, 1821–1823.*

manuals seeks to walk its readers through the essential skills of cloth production. Despite this, all of the authors are self-conscious of the challenges of conveying through text a set of skills which reside as much in craftsperson's hands as their minds. Because the objective of this thesis is to attempt to access craft skill, or the knowledge which resides in that space between hand and mind, these written primary

Figure 10 This image depicts a woman in a high-waisted gown typical of the early nineteenth-century. The gown's skirts fall in pleats, made possible by the use of thin, drapey cloth. If such a garment were made of woolen fabric, it would need to have been only lightly fulled. *Woman Pressing and Folding Laundry*, by John Lewis Krimmel, c.1819-1820. Winterthur Library Downs Collection, 59x5.5 page 18. *Courtesy, the Winterthur Library: Joseph Downs Collection of Manuscripts and Printed Ephemera.*

Figure 11 This image shows a man dressed in coat, waistcoat, and trousers. These garments may well have been made of woolen cloth. Tailored garments like this benefited from the structural properties of stiff, heavily fulled woolens. *Man Seated at a Table*, by John Lewis Krimmel, 1811. Winterthur Library: Downs Collection, 59x5.4, page 44. *Courtesy, the Winterthur Library: Joseph Downs Collection of Manuscripts and Printed Ephemera.*

sources are supplemented by my personal understanding of cloth finishing, acquired through my own fulling experiments.

The first of the manuals on which this chapter draws is John Wily's *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, published in Virginia in 1769. Wily's pamphlet was intended to provide guidelines for textile production, from sheep breeding to tips on stretching a quantity of wool by mixing it with cotton. The publication was an attempt to bolster domestic production in the strained economy of Virginia in the decade prior to the Revolutionary War.[65] Asa Ellis's 1798 *The Country Dyer's Assistant* and Elijah Bemiss's 1815 *The Dyer's Companion* are primarily dye manuals. Ellis's work also contains a careful and detailed description of the proper preparation of fiber, spinning, weaving, and cloth finishing, while Bemiss includes a shorter description of cloth finishing, occasionally directly plagiarizing Ellis.[66] J. and R. Bronsons' 1817 *The Domestic Manufacturer's Assistant and Family Directory in the Arts of Weaving and Dyeing* focuses on dye recipes and weaving drafts, but also describes the basic steps of woolen production from sheep to finished product.[67] William Partridge's 1823 work is part dye manual, part treatise on the manufacturing of high-end woolens in America. Much more so than any other work references in this chapter, Partridge is focused on

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[65] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 3, 4, 14.

[66] Ellis, *The Country Dyer's Assistant*; Elijah Bemiss, *The Dyer's Companion.* (New York: Dover Publications, 1973).

[67] J Bronson and R Bronson, *Early American Weaving and Dyeing: The Domestic Manufacturer's Assistant and Family Directory in the Arts of Weaving and Dyeing* (New York: Dover Publications, 1977).

large-scale manufacturing with an emphasis on competing with British woolens.[68] Matthew Atkinson's 1844 *Family Director* is described on the title page as "designed as a help to those, who are supplying themselves, in whole or in part, with woollen goods of their own manufacture."[69] Discounting Partridge, and with the exception of fulling itself, the other five manuals primarily describe traditional, un-mechanized, finishing techniques. The Bronsons and Atkinson, however, include descriptions of mechanized carding and spinning, an indication of the slow shift towards industrialization taking place during this period.

Studied together, these texts grant a glimpse into the popular understanding of woolen cloth production and finishing from the mid-eighteenth to mid-nineteenth centuries. The steps of woolen cloth making, as described in these manuals and elaborated below, are as follows: the propagation of sheep, sheep shearing, washing and sorting of fleece, greasing and carding fleece, spinning, weaving, scouring and dyeing, fulling, napping, cloth shearing, tentering, and pressing. These manuals do not always agree with each other. Additionally, they are a record of how work ought to be done, rather than a record of how it was done. Where able, I have corroborated these descriptions through evidence found in extant textiles and through my own experimentation. The goal of the following descriptions is to illustrate the effect of

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[68] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*.

[69] Matthew Atkinson, *The Family Director: Designed as a Help to Those Who Are Supplying Themselves, in Whole or in Part, with Woolen Goods of Their Own Manufacture ; Containing Plain Directions for Washing Wool, Colouring Wool, Woolen Yarn and Flannel and Mixing of Colours ; Also, Directions for Carding, Spinning, Weaving, Fulling and Finishing* (Carrollton [Ohio]: Printed by John Hudson, 1844), title page.

each of the steps on cloth finishing rather than to give an exhaustive description of all elements of each process.

Making Woolen Cloth

Wool is produced by sheep, and the first concern in the production of woolen cloth is acquiring fiber. A sheep's life is reflected in its wool; from its breed, to the climate where it lives, to its diet—many factors affect its fleece.[70] Careful breeding and a managed diet can control the quality of the wool to some degree. In the eighteenth century, however, few Americas prioritized wool when making decisions about their flocks. As the century waned and Americas strove to be more self-sufficient, this changed. To improve the quality of sheep's fleece, John Wily encouraged selective breeding, providing day-time shade for the Virginia summers, and sowing winter crops for sheep to pasture on in colder months. Asa Ellis recommended that sheep not be pastured with cattle, and that they be fed out of a rack constructed so that no materials dirty their fleeces while they eat. Likewise, they should be plump, or "in good flesh" so "that the wool may be lively." Sheep were typically sheared once or twice a year, at which point their fleeces, whether "lively" or not, were ready to be processed into cloth. The first step in that process was separating the wool of each fleece based on the fineness of the fiber. [71]

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[70] Conversation with Michael Hampton, master knitter and owner of Hampton Fiber Mill, Richmond, Vermont.

[71] Hood, *The Weaver's Craft*, 57–58; Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 5–7; Ellis, *The Country Dyer's Assistant*, 118–19.

At this point it is important to note that not all wool became woolen cloth. "Woolen" refers specifically to short crimpy fibers which have been carded, a process which deliberately tangles the fibers to create bouncy yarn. That yarn makes soft and fuzzy cloth which actively felts in the fulling process. Longer, smoother wool fibers are processed to make worsteds. That process involves combing and straightening the fiber and produces a yarn which is much smoother in appearance and feel and is less apt to felt.

Sorting the wool can have a significant impact on the final product. In involves breaking up the fleece into different grades or qualities of fiber. Each grade, generally designated by where the fleece grew on the animal, varies in staple length and fineness. Different grades also feel different to the hand and react differently in the fulling process. If not properly sorted, wool of different grades might cause a piece of cloth to cockle as it is fulled, shrinking more in some areas than others, and causing the whole piece to ripple and warp.

A fleece could be sorted into as many as seven grades or as few as three. Each grade of wool was suitable for a different project, from fine fashion textiles down to coarse blankets.[72] Sorting was also the stage where wool to be combed for worsted textiles was separated from that destined for woolens. Once sorted, the fleece was washed to remove lanolin, the sheep's natural oil; too harsh a washing at this stage, however, could felt the fibers together.[73] Next, the clean fleece was roughly carded, after which new grease, such as olive oil or hog's lard, was introduced to the fiber in

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[72] Ellis, *The Country Dyer's Assistant*, 115, 117; Bronson and Bronson, *Early American Weaving and Dyeing*, 41.

[73] Atkinson, *The Family Director*, 39.

order to lubricate the process of carding and spinning.[74] Though necessary in order to turn the fiber into yarn, the grease impeded dyeing and fulling. Therefore it was eventually washed back out, either before weaving, if the cloth was to be dyed in the yarn, or afterwards, prior to dyeing the cloth.[75]

Once greased, both Ellis and Wily recommend further mixing the wool to create as homogeneous a mix as possible. One method to do this is to take armfuls of the coarsely carded wool and, with a sheet spread on the floor, tear off small handfuls of wool, throwing them down onto the sheet while walking around it.[76] In general, these authors recommend processing wool for one piece of weaving at a time. If there wasn't enough of one grade of wool for the entire project, the best grade was used for the filling, or weft, and the next finest for the warp, or chain.[77] If a single grade of wool was being used, at this point it was divided into two sections for filling and chain.[78] The final step in preparation for spinning was for the wool to be carded again, forming bats which the spinner would stretch out into yarn. Prior to mechanization,

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[74] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 8–9; Ellis, *The Country Dyer's Assistant*, 16–17; Bronson and Bronson, *Early American Weaving and Dyeing*, 43–44; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 53. The Bronsons recommend one quart of oil for every ten pounds of wool, while Ellis suggests one pound of grease for every seven of wool.

[75] Conversation with Justin Squizzero.

[76] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 9–10; Ellis, *The Country Dyer's Assistant*, 116.

[77] Bronson and Bronson, *Early American Weaving and Dyeing*, 41.

[78] Ellis, *The Country Dyer's Assistant*, 116.

carding was done using pairs of hand-held wool cards covered in bent wire teeth which were pulled across each other to break up and recombine clumps of fiber. The Bronsons, Partridge, and Atkinson also describe the use of carding machines.[79]

Wily, Ellis, Partridge, and Atkinson all stress the importance of proper spinning for the best end result; all of the yarn for a single piece, or at least the entirety of the filling or chain, should be spun by one individual or, as described in Partridge's treatise, on a single spinning jenny, in order to guarantee a consistent product.[80] This was because two spinners might put different degrees of twist on their work and "if hard and slack twisted wool be striped together, in a piece of cloth, it will be found to shrink, unequally, in fulling; the soft twist will be narrow, and the hard twist wide, and the cloth will be puckered and spoiled."[81] Partridge refers to cloth with this flaw as being "rowy."[82] This was because the degree of twist on the yarn effected the amount which a textile was able to shrink. Tightly twisted fibers were more closely held in place. Because the fulling process was predicated on woolen fibers being able to move and felt together, a high degree of twist meant less shrinkage in the fulling mill. The opposite was true of loosely twisted fibers, hence the caution about striping yarns with

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[79] Bronson and Bronson, *Early American Weaving and Dyeing*, 44; Atkinson, *The Family Director*, 40.

[80] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 12; Ellis, *The Country Dyer's Assistant*, 116–17; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 63–64. 4

[81] Atkinson, *The Family Director*, 41.

[82] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 64.

different degrees of twist in a textile which was destined to be fulled. For woolen cloth, the yarn should be twisted only as much as is needed to keep is from coming apart, as a loose twist promoted good fulling and "a handsome finish."[83] However, to handle the tension of the loom, the warp needed to be more tightly twisted than the weft.[84] In several ways the manner in which yarn for a piece of cloth was spun effected how it would full.

Finally, the yarn was ready to be put onto the loom. At this point, the quantity of yarn determined the overall dimensions of the piece, according to a weaver's formula. The cloth's width and length were determined, as was its weave structure. The textiles discussed in this thesis are not complicated: they are generally plain weaves, twills, or satin weaves (figure 12). These various weaves, however, reacted differently to fulling. In a plain weave, every weft yarn crosses over and under every warp yarn. This structure has the maximum number of intersections, causing the yarns to be locked in place as tightly as possible. In a twill or satin weave structure, however, the weft yarns may pass over and under more than one warp yarn at a time. The visual effect is a pattern on the surface of the textile created by "float" yarns. Because there are fewer places where the yarns intersect with each other, they have more freedom to move within the cloth. These textiles tended to drape better than

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[83] Atkinson, *The Family Director*, 40; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 70.

[84] Warp and weft should also be twisted in opposite directions during spinning, as this "will occasion the Warp and Filling to mill closer and tighter together" in the fulling process. Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 12; Ellis, *The Country Dyer's Assistant*, 116; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 63.

plain weaves. They also reacted differently to fulling. In a plain-woven textile, the shrinking which takes place in the fulling process caused the textile to become tight and dense. In a twill weave, however, the yarns have more room to move, and so instead of locking the yarns more tightly together, light fulling could have the effect of making the cloth loftier instead.[85]

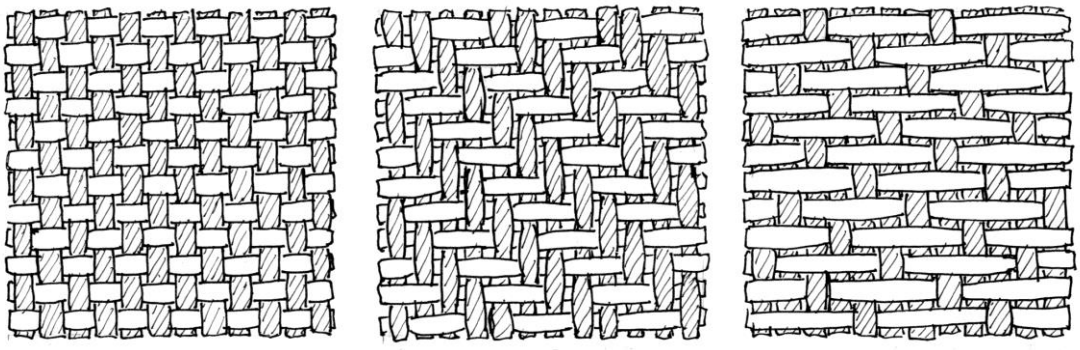

Figure 12 Common textile weave structures. From left to right: plain weave (also known as tabby weave), 2x2 twill, and satin. *Illustration by the author*.

Beyond describing the making of specific textiles, the advice regarding weaving includes warnings about how poor weaving will affect the finished cloth:

> The imperfections and faults, in weaving, may be covered to some extent by the fuller, but they cannot be removed. If woven too thin, the cloth when finished, will be deficient, either in body or in breadth; and if woven unequally, the fulling increases the evil. The cloth will be puckered, and can neither be finished, made up or worn to any degree of decency.[86]

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[85] Discussions on separate occasions with Rob Stone and Norman Kennedy.

[86] Atkinson, *The Family Director*, 41.

This was a common caution, which shows that one attitude towards the creation of woolen cloth was that finishing could cover the wrongs done in earlier stages. While it was indeed the role of fulling to improve the appearance of cloth after it left the loom, it was clearly not the panacea that some hoped it to be.

Further discussing how the weaver's choices manifest in the finished cloth, the Bronsons wrote that "flannels for fulled cloth, should be made as stout as possible by the weaver" by using one quarter more filling than warp, which is to say, by packing the filling more tightly together in weaving. Cloth which was woven thin had to be shrunk more in fulling to create a cloth as dense as that which was woven thick. Thin cloth which relied on fulling to become thick had other flaws as well:

> Domestic made cloth when worn threadbare, the thread has the appearance of a kink; this is owing to the flannel being wove thin, which requires so much fulling before it arrives at a suitable thickness, that the threads become crooked and knotty.[87]

The crooked or kinky yarns described here are indeed present in some American-made woolens in museum collections today. This trait can be seen in a circa 1790 to 1810 American militia light infantry or horse coatee in the collection of Fort Ticonderoga (figures 13 and 14). Contrasting the textile of this coat to that of a contemporaneous British officer's uniform (figures 15 and 16), highlights the degree to which the threads in the cloth of the American uniform appear to travel in drunken, rather than straight and orderly, lines. The comment by the Bronsons demonstrates how weaver's choices and skill affect the finishing process.

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[87] Bronson and Bronson, *Early American Weaving and Dyeing*, 49.

Figure 13 *American Militia Light Infantry or Light Dragoon Coatee*, c. 1790-1810. Fort Ticonderoga Museum Collection, UN-002. Margaret Staudter, photographer/© Fort Ticonderoga

Figure 14 In this detail image of the lapel of an American Militia Light Infantry or Light Dragoon Coatee circa 1790-1810, it is possible to see that the threads appear to wander, rather that forming the regular grid-like structure seen in figure 16. This suggests that the cloth was woven loosely, then heavily fulled to compensate for poor weaving. Fort Ticonderoga Museum Collection, UN-002. © *Fort Ticonderoga. Photo by the author.*

Figure 15 *British Officer's Coatee, 49th Regiment*, c.1812-1814. Fort Ticonderoga Museum Collection, UN-011. *Gavin Ashworth, photographer/© Fort Ticonderoga.*

Figure 16 This detail of the collar and lapel of a British Officer's Coatee of the 49th Regiment, circa 1812-1814, shows the tight, regular grid-slight structure of high-quality, heavily fulled woolen cloth. This is especially evident in the threadbare upper edge of the collar. Fort Ticonderoga Museum Collection, UN-011. *Gavin Ashworth, photographer/© Fort Ticonderoga.*

Finishing Woolen Cloth

Once a piece of woolen cloth was woven, it required some degree of finishing. That might be as minimal as scouring and tentering. Textiles such as broadcloth could also be dyed, heavily fulled, napped, sheared, and finally pressed. Virtually any degree or combination of those processes was also possible, and would produce textiles with different qualities, suited to different functions. (For descriptions of some textile-specific finishes, see appendix A.)

In should be noted here that dyeing was a significant element of cloth finishing. It played a major part in the visual appearance of the finished cloth and was often done in conjunction with fulling, or in spaces adjacent to fulling mills. Though certainly part of the finishing process, dyeing does not significantly alter the physical properties of cloth. Because those physical changes are the primary focus of this study, dyeing is not addressed in any detail in this thesis.[88]

The first steps of finishing can be seen as a transition out of the weaving process. These began with darning and burling, which involved weaving in any repaired warp threads which had been left hanging during the weaving process as well

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[88] A number of wonderful books exist on the history dyeing, from the stories of specific colors or dye stuffs, to natural dye manuals which aim to make traditional dyeing methods available to modern craftspeople. Two examples of the later are: J. N Liles, *The Art and Craft of Natural Dyeing: Traditional Recipes for Modern Use* (Knoxville: University of Tennessee Press, 1990); Dominique Cardon, *Natural dyes: sources, tradition, technology and science* (London: Archetype, 2007). There are also a number of historical dye manuals which have been republished, including Bemiss, *The Dyer's Companion.*; Dominique Cardon, *The Dyer's Handbook: Memoirs of an 18th Century Master Colourist.* (Havertown: Oxbow Books, 2016), http://public.eblib.com/choice/publicfullrecord.aspx?p=4562326.

as "removing all knots, and other defects that would injure the finishing."[89] Because period descriptions of this process all exist within manuals for family textile production, it is challenging to tell whether mending and burling were done by the weaver, or the cloth finisher. Likely, mending was the weaver's responsibility, while burling was specific to fulled and dressed textiles, and so fell under the purview of the fulling mill.

Scouring

Prior to dyeing or fulling, the cloth needed to be scoured, or washed, clean of the grease which was introduced to the fiber to aid in the carding and spinning. At times, cloth was fulled "in the grease," but this was not desirable, since garments made out of cloth thus processed were stiff in the winter and smelly in the summer. They accumulated dirt and were so uncomfortable that they were often thrown away before they wore out.[90] Another reason to scour the cloth was to facilitate dyeing, since dye does not adhere well to greasy wool.[91]

Scouring typically involved a cleaning agent, such as soap or, commonly, stale urine, which is rich in ammonia and was a popular choice because it was cheaper than soap. Since fulling stocks were often used for this washing process, fullers' account books often record entries for cloth which was brought to the mill simply to be

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[89] Atkinson, *The Family Director*, 43.

[90] Atkinson, 42; Ellis, *The Country Dyer's Assistant*, 107.

[91] Yarn might also be scoured before weaving, so that the yarn can be dyed, and the cloth woven in a design such as a stripe or check.

scoured. In addition to bringing woolens to be scoured, home textile producers also took advantage of this vigorous type of washing to help finish worsteds, linen, cotton, and mix-fiber textiles that were not designed to be fulled.[92] In these instances, scouring helped to settle the fibers and clear the cloth from sizing agents used to strengthen the yarns while weaving. After scouring, the cloth was ready for the transformation of the finishing process.

It was important that the cloth should be prevented from fulling while it was being scoured, since cloth was often burled after scouring, which would not be possible if it had already begun to felt. To guarantee this, Partridge stated that the hammers of the fulling stocks should be run slowly, and that a little water should be allowed to run through the stocks during scouring.[93] After scouring and burling, the cloth underwent "a second course of fulling," a phrasing which suggests the close linkage between these two processes.[94] Abraham Rees's *Cyclopaedia*, first published in 1802, includes an illustration of fulling stocks, which includes a note: "these Stocks are for Scouring: for Milling cloth the trough… is differently formed" (figure 17). Though this was probably uncommon in small fulling mills, stocks could be specially designed for scouring or for fulling. For both scouring and fulling the cloth was placed wet into fulling stocks, which mechanically agitated it. For scouring, this meant that

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[92] Kirk Family of Chester County, PA, Miscellany, Microfilm Reel 1, (Acc. 1429) Hagley Museum and Library, Wilmington, DE. This account book, for example, includes references to the scouring and tentering of 12 yards of linsey, the scouring and pressing of 16 yards of damask, and the mill scouring of old blankets.

[93] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 84.

[94] Atkinson, *The Family Director*, 43.

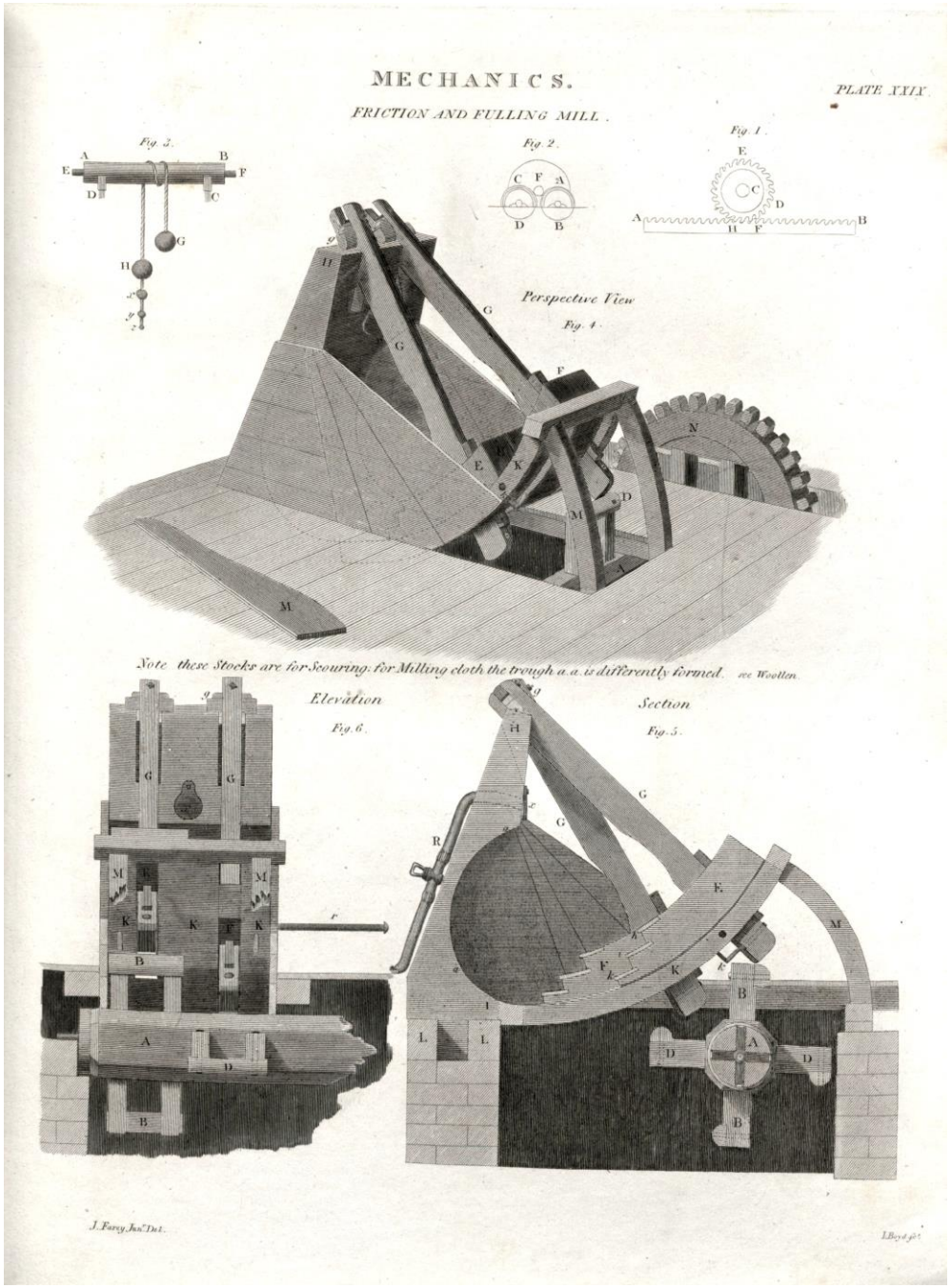

Figure 17 The line of text in the center of this image reads “Note: these Stocks are for Scouring; for Milling the trough a. a. is differently formed.” Mechanics, Plate XXIX, Friction and Fulling Mill, *The Cyclopædia* (Philadelphia: Rees, Abraham, 1802). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

the cleaning agent was able to penetrate the fiber and wash away all grease. When clean, the wool was better able to "close" or "unite… forming that compact and firm texture, that is essential to all well-finished cloth."[95]

Fulling Stocks

Good fulling depended on the cloth being compressed and agitated. While the purpose of scouring was to push water and soap through the fiber to wash it free of grease, fulling itself involved repeatedly subjecting the cloth to pressure. Because of this, most images of fulling stocks show a more confined trough than is illustrated in the plate from Rees's *Cyclopaedia* (figures 18 and 19). The other requirement for achieving the right degree of compression was the weight and drop of the fulling stock hammers. Thomas Ellicott depicts a set of fulling stocks in the 1795 *The Young Mill-Wright and Miller's Guide*. In his illustration (figure 18), the hammer heads are labeled number 21, and the trough in which the cloth is placed is number 24. Ellicott provides dimensions for his illustration which are useful for gaining a sense of scale. Number 23, the stock post, should be seven feet high, while each of the hammers was to be "4 feet 3 inches long, 21 inches wide, and 8 thick."[96] If they were made of oak, the hammer heads could have weighed as much as 275 pounds a piece.[97]

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[95] Atkinson, 43.

[96] Evans and Ellicott, *The Young Mill-Wright & Miller's Guide*, 87.evans, 87

[97] "Densities of Wood Species," The Engineering Toolbox, accessed March 13, 2019, https://www.engineeringtoolbox.com/wood-density-d_40.html.

Both Rees's and Ellicott's illustrations, as well as figures 19 and 20, depict the same style of stocks, known as driving stocks, since the hammers drove toward the cloth at an angle. An illustration from the 1765 French text, *Art de la Draperie*, by Duhamel du Monceau, shows another style of stocks (figure 21) in which the hammers fell straight down on the cloth. Stocks of this style were known as falling stocks. Though references to both appear regularly in literature regarding fulling, driving stocks were more common in American illustrations and descriptions from this period. Elijah Bemiss remarks:

> There are various forms in use [in American], and the most of them badly constructed. I will only remark that the falling mill, rightly constructed, makes the firmest and best cloth, and is the most difficult mill to tend.[98]

Duhamel's illustration of falling stocks clarifies what Bemiss means: in the falling stocks, the hammers delivered the maximum of force to the cloth, but were least able to shift the cloth's position in the trough, meaning that the fuller frequently needed to manually re-arrange the fabric.

The hammers and troughs of driving stocks were designed to move the cloth as it fulled. This prevented the cloth from fulling unevenly, or from felting to itself. Depictions show that the faces of fulling stock hammers were stepped, designed to toss the cloth upwards, against the curved interior of the trough at the same time that it was pounded and compressed (compare the profiles of hammer faces in figures 18 through 21). The hammers worked in tandem, one hitting when the other was raised. This would have created an action almost like kneading dough.

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[98] Bemiss, *The Dyer's Companion.*, 272.

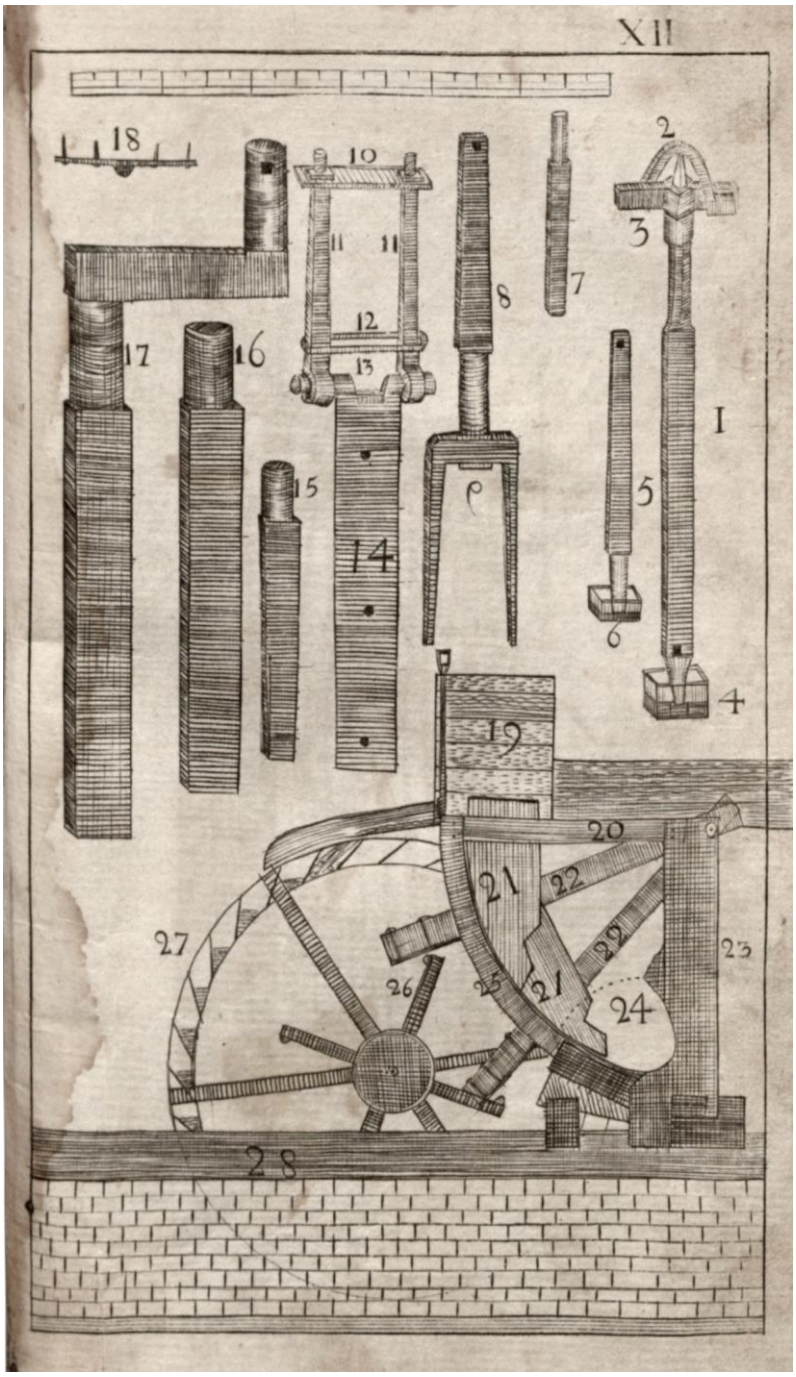

Figure 18 The lower part of this plate (numbers 19-28) illustrates the parts of a pair of fulling stocks. Plate XII, Part Five, *the Young Mill-Wright & Miller's Guide: in five parts, embellished with twenty five plates* (Philadelphia: Evans, Oliver and Thomas Ellicott, 1795). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

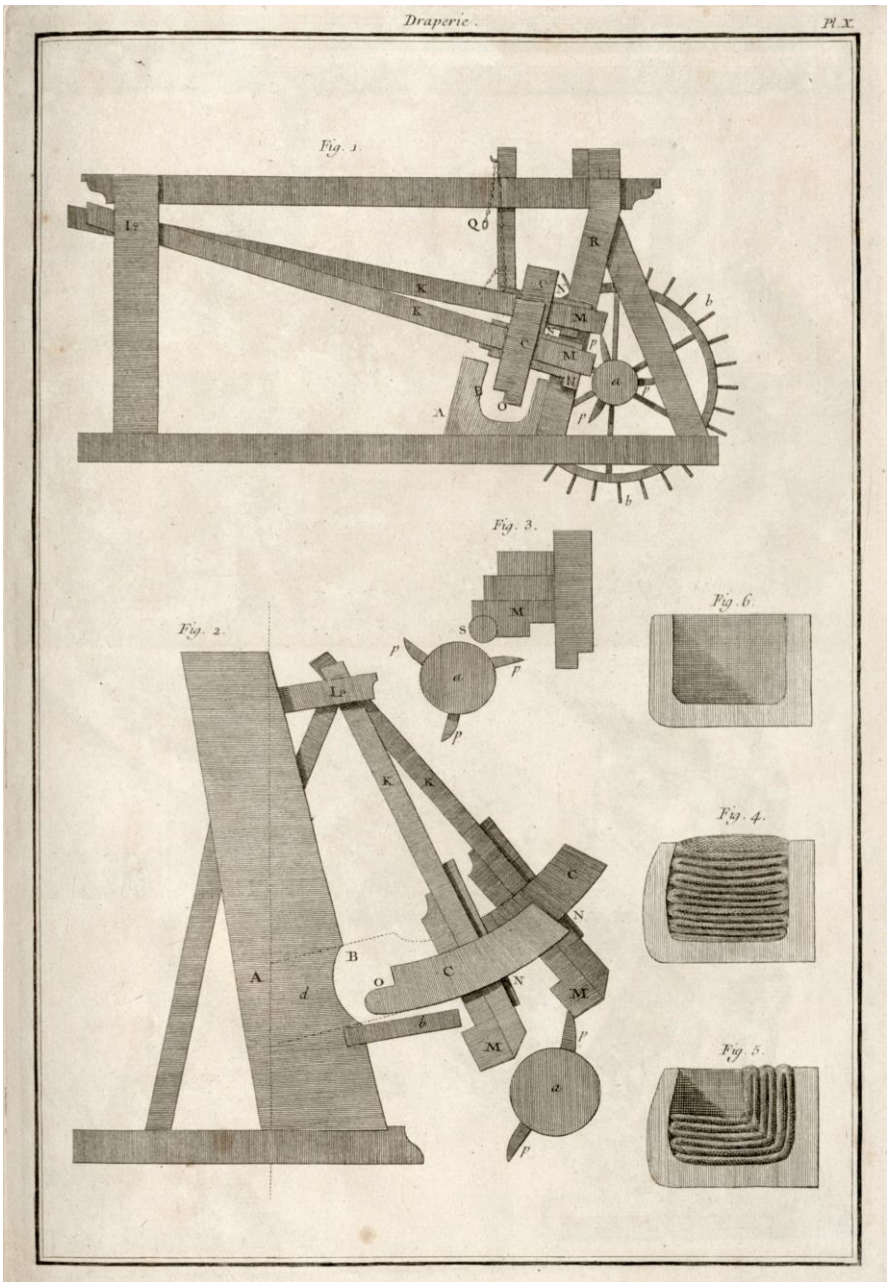

Figure 19 This French illustration from the mid-eighteenth century shows two different styles of fulling stocks (figures 1, 2). Figures 4 and 5 illustrate the arrangement of cloth in the cup or trough of the stocks shown in figure 1. Plate X, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

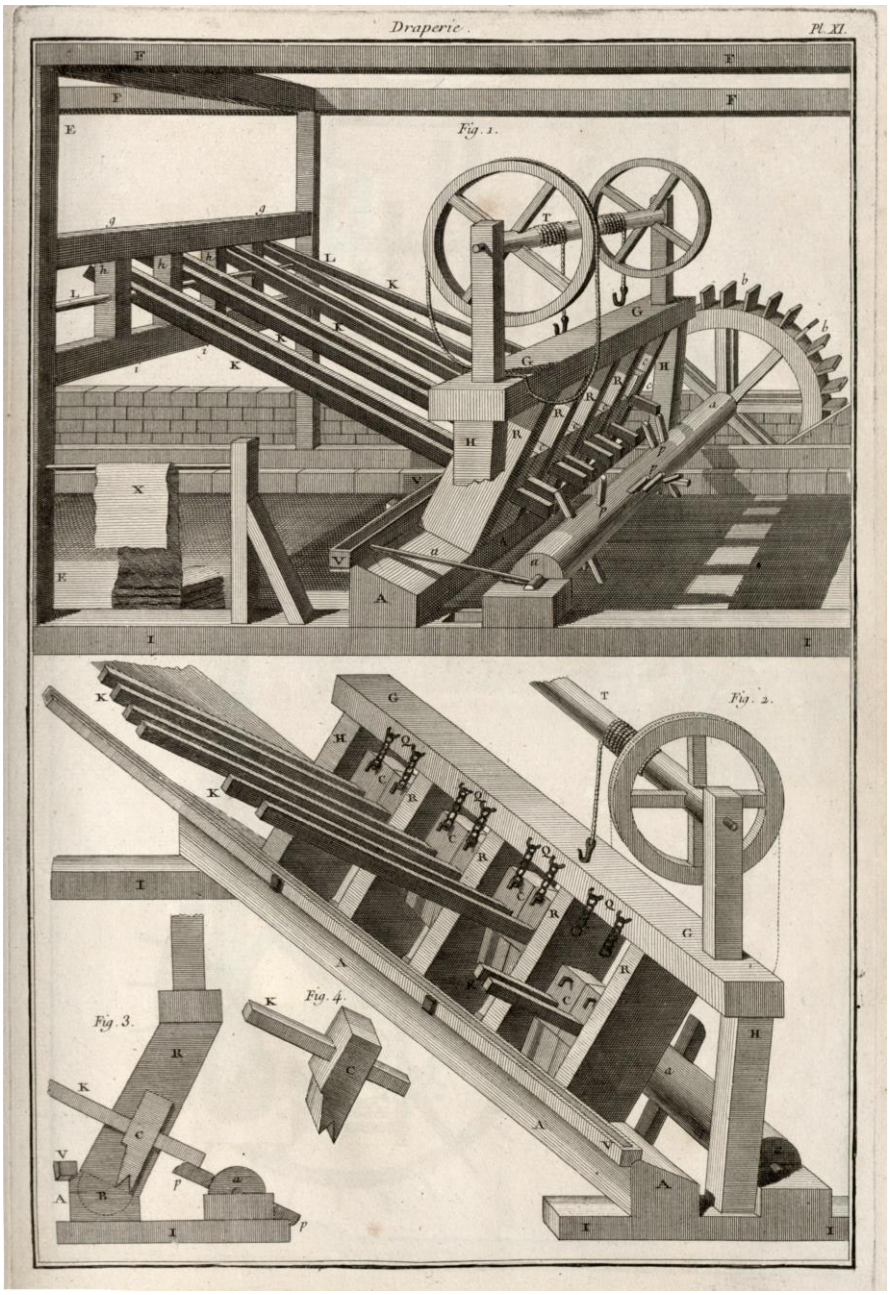

Figure 20 Figures 1 and 2 illustrate multiple set of fulling stocks in operation together. Figure 3 illustrates fulling mallets (c) with sharp "teeth" which Duhamel states are suitable for fulling coarse cloth, but which would damage finer textiles. Plate XI, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

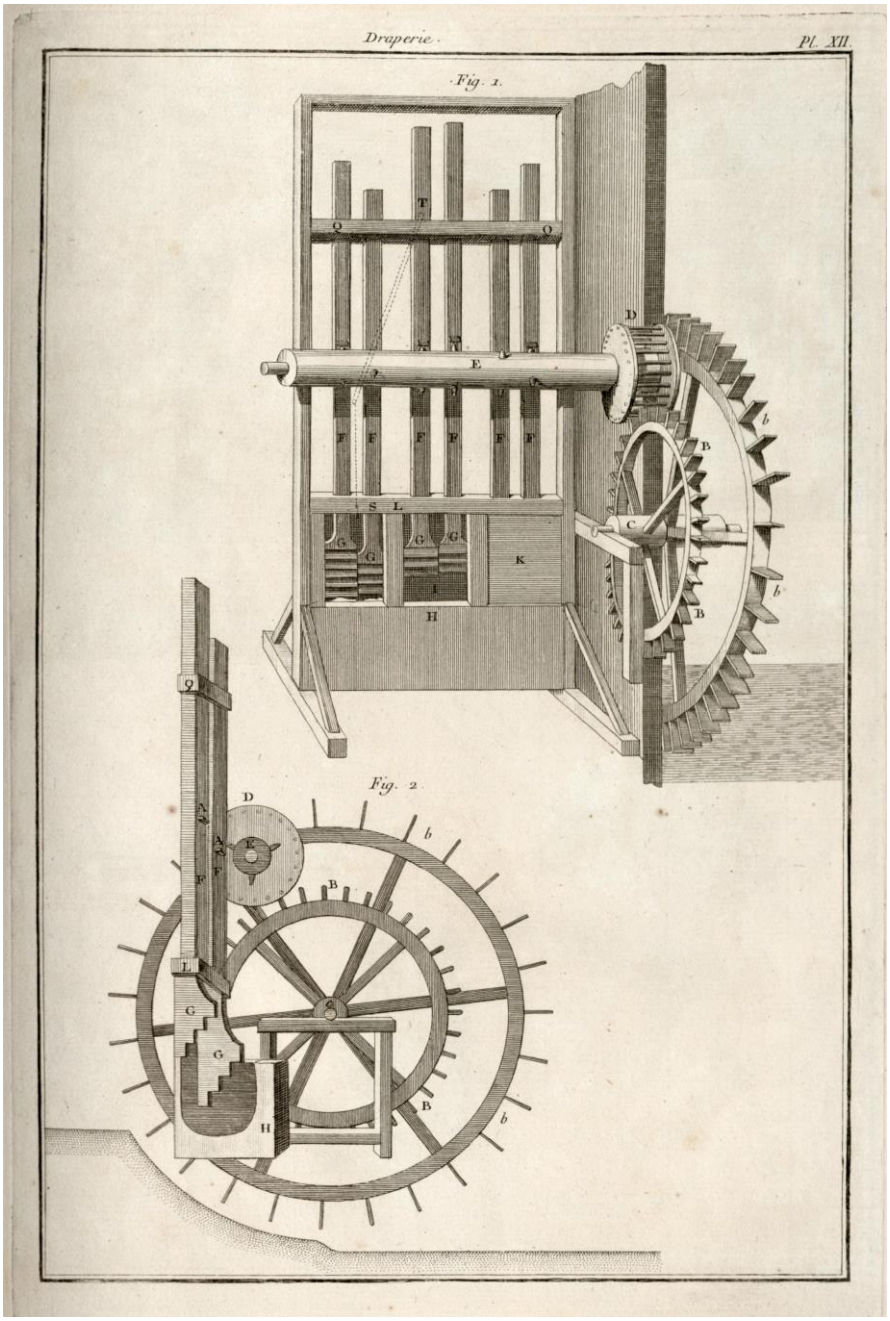

Figure 21 Duhamel's description of this plate states that it depicts a Dutch style of fulling stocks where the mallets fall straight down, rather than at an angle. Plate XII, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

Though massive, the hammers were not designed to drop their entire weight onto the cloth. Instead, a portion of the handle extended through the hammer head. This was the part which was raised by the tappet on the mill's drive shaft. It also arrested the stock's fall before the hammer head could impact the back of the fulling trough. Because of this, the volume of textile in the trough effected the force of the hammers – the more material in the fulling stocks, the more it was compressed by the hammers. In Leeds, England, the woolen manufacturer Benjamin Gott recorded information about fulling stocks at his factory. In 1813 he recorded calculations for determining the size of a set of fulling stocks:

> The width of the Stock from side to side from 15 inches to 15 ½ ins. in proportion to the depth. Stocks are seldom if ever made less than 24 inches deep. A Stock of this description will mill 28 yards of Best Superfine Spanish Broad Cloth—if the depth be ¼ of an inch deeper it will mill 1 yard more & for every quarter of an inch that same.[99]

In this example, the volume of the fulling stocks was carefully engineered to fit a specific quantity of cloth. Doing so would have guaranteed a specific consistent pressure was applied to the cloth at all times. The same effect could be achieved by using false backs, or pieces which were inserted to make the space within the trough smaller, for fulling shorter lengths of cloth. Gott also records the speed of his stocks, stating that his driving stocks made 37 strokes per minute, while his falling stocks

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[99] W. B Crump, Joseph Rogerson, and Benjamin Gott, *The Leeds Woollen Industry 1780-1820* (New York: Johnson Reprint, 1967), 300.

made 24. William Partridge recommends a rate of 30 stroke a minute per hammer, or 60 strokes a minute if counting both hammers. [100]

For fullers in American country fulling mills this level of precision was likely impossible. Because they finished whatever cloth was brought to them, it would not always have been possible to fill the stocks with a specific amount of cloth. Likely they did full multiple pieces of cloth for different customers at the same time. They could also regulate the fulling by controlling the amount of time a piece of cloth stayed in the stocks.

Fulling Process

A careful description of the fulling process itself is provided by John Wily, who, despite stating that fulling should only be done by those who have completed apprenticeships, appears to wish to provide adequate instruction for this craft in a single paragraph:

> First wet [the cloth] with warm Soap Suds or Chamber Lie [urine], then lay the Cloth in the Cup of the Mill, and set the Mill to work. The Cloth should be kept moistened with warm Soap Suds, Chamber Lie, Rye Meal, or Fuller's Earth, mixed with warm Water, to make and keep the Cloth slippery, that it may turn a little at every Stroke the Mallets give it; for if you see the Cloth remain in the same Position for several Strokes together, you may depend the Mill, or Cloth, is not in proper Order. The Cloth should always have a moderate Warmth in it, first raised by the warm Liquid it is moistened with, which Heat is afterwards to be kept up by the hard and quick Strokes of the Mallets, which are ordered or regulated by the Quantity of Water delivered on the wheel[. O]nce in five or six Hours[,] The Cloth should be taken out

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[100] Crump, Rogerson, and Gott, 299; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere,* 90–91.

> of the Mill, and overhauled, beginning at one End and examining it through, to see if it is not united or milled together in Places that ought not to be, which will sometimes happen if the Mill continues working too long at a Time without examining.[101]

Wily's description is best understood through comparison with an image of fulling stocks in use. The billhead for the Brandywine Woolen Factory (see figure 4) provides us with such an image. On the left-hand side, a man pulls a length of cloth from a set of fulling stocks. His stance helps to intimate the strength needed to pull several yards of wet woolen cloth out of the trough of the stocks. The fuller in this image is likely checking the cloth part way through the fulling process. As described by Wily, it was important to monitor the textile to ensure that layers of cloth were not felting to each other, as could happen if the cloth got tangled, or if the hammers failed to shift it into a new position. According to both Ellis and Bemiss, poorly designed stocks which required the workmen to check the cloth frequently were common in America. Ideally the cloth would form a "proper body for milling" in the stocks, which is to say, it would form a mass which moved well as the hammers impacted it. To monitor the fulling process, the finisher could remove the cloth from the stocks and stretch it over a wooden pin, to correct any creases which had begun to form and make sure the cloth was not felting to itself, before returning it for further fulling. This needed to be done every hour and a half to two hours, or whenever the cloth was not turning well.[102] Partridge describes removing the cloth every three to four hours, checking the width,

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[101] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 20–21.

[102] Ellis, *The Country Dyer's Assistant*, 105–6; Bemiss, *The Dyer's Companion.*, 272–74.

and making sure the cloth was still square by tugging at the wide selvages known as lists.[103]

Pulling the cloth from the stocks was also how the fuller checked to see if the cloth was sufficiently fulled, a process which demonstrates the foresight required in the production of woolen cloth. Just as wool sorters, spinners, and weavers had to think ahead to how the cloth would be finished, fullers needed to understand what the clammy, soapy, linty cloth they pulled out of their stocks was going to feel like when it was dry. Visually, they could confirm if the threads were coming together by judging how much of the weave structure was still visible. Most of this judgement had to be made with their hands, though, as they felt how thick, soft, or fuzzy the cloth was becoming (figure 22). At this stage the fuller gauged whether the cloth would in fact be suitable for its intended purpose once it dried. If they removed the cloth too soon, it would need to be returned to the stocks for further fulling. If left to full for too long, it might shrink beyond usefulness. In my own experiments, this stage was one of the most interesting, since the cloth felt nothing like the soft, fuzzy end product I was aiming for. It took the judgement gained through repeated experimentation to make that cognitive leap.

At a microscopic level, the outer layer of wool fibers is covered in small scales. When the fibers are able to slide past each other, they travel in a single direction, but are unable to slide backwards because of that scaled surface. The repeated compression and agitation provided by the fulling stocks aids in this

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[103] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 92–93.

Figure 22 Wet cloth in the process of being fulled. Here the yarns are beginning to come together but are still easily distinguished from each other. *Photo by the author.*

movement. Over time, the fibers become ever-more entangled, and the structure of the woolen cloth becomes denser, a process known as felting. This is the physical alteration which happens to woolen cloth in the fulling process.[104] Visually, the result is that the woven structure of the cloth becomes less apparent, because the fibers

[104] J. Gordon Cook, *Handbook of Textile Fibres*, 3d ed. (Watford, Herts: Merrow Pub. Co, 1964), 100–101, 114–15.

making up different yarns and on the surface of the cloth have matted together. Increased density also makes it harder for light to penetrate the cloth. To the hand, fulled cloth is thicker, and often softer. The regular bumps of the woven structure are transformed into a smooth, fuzzy surface, and the cloth loses some of its drape (see figures 51 to 54, and Winterthur Copy: Appendix B).

Though the mechanical agitation of the stocks was essential to this felting process, it was also facilitated by a number of other elements. Cloth fulls best when it is wet, warm, and lubricated.[105] The lubricant, or fulling agent, could be either soap or stale urine, though soap seems to have been the preferred choice.[106] Elijah Bemiss writes this about monitoring levels of moisture and soap:

> Be cautious and [do] not have [the cloth] too wet as it retards the milling and the cloth will not be as firm: have it so wet that you may easily wring out the soap with the thumb and finger; as it dries and requires soap, add more.[107]

Maintaining this soapy moisture helped the fibers to slide over each other as the cloth was repeatedly compressed in the stocks. Extra soap could also be added selectively, if it became apparent that some areas of the cloth were not fulling as quickly as others.[108] Warmth was produced by the occasional addition of warm water to the

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[105] Don't we all?

[106] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax,* 20. Urine was effective and cheap, but when soap was available and affordable, it was always the first choice.

[107] Bemiss, *The Dyer's Companion.*, 274.

[108] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 92.

stocks, though Wily is not alone is suggesting that the action of the stocks themselves kept the cloth warm.[109]

Despite controlling for a range of factors in order to create an ideal environment for felting, the fulling process took time. According to Partridge, between fourteen and eighteen hours was needed to full a piece of cloth properly.[110] Since Partridge was largely concerned with the production of the high-end textiles broadcloth and cassimere, it is reasonable to assume that timing was for those heavily finished textiles. This means that other fabrics likely fulled for somewhat less time. Nonetheless, fulling a piece of cloth could easily take an entire day.

The cloth was done being fulled when it achieved the degree of felting required for a specific end-use. Woolens could be fulled until they were incredibly dense and firm, as was the case with broadcloth. Fashionable men's coating, which was finely and tightly woven, could shrink a large amount without becoming bulky, because the thin yarns were tightly held in place by the cloth's structure. Cloth like this, when heavily fulled, became smooth and firm to the touch. It was so heavily felted that when it was cut, the yarns didn't even fray. On the other hand, cloth for blanketing would be unpleasant if it was hard and dense. Instead, blankets were woven in a loose structure of heavier yarns. In the fulling process, some fibers escaped from the lightly-twisted yarns, and then tangle together on the surface of the cloth to create a lofty insulating layer, which when viewed under a microscope would appear lively and

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[109] Partridge, 92 see 84-85 For a discussion of chemical reactions causing the wool to become hot during the scouring process known as "braying."

[110] Partridge, 93.

chaotic. A fuller, aware of the textile being processed, and the desires of their customer, might full a cloth to either of these stages, or anywhere in between.

Some numbers exist recording the exact amount which specific textiles shrank during fulling. According to Wily, cloth for men's clothing should be woven at least five quarters of a yard wide, since it lost width as well as length in fulling. If not woven wide, it will be too narrow for use after finishing. David Harry, operating the Board Run mill in 1822, recorded the exact degree to which he shrank cloth for customers. William Guthrie's men's wear flannel was twelve and a half yards long when it entered the mill. When it left, it was only nine and a half yards long, or seventy-six percent of its original length. The cloth likely lost about the same amount in width as well. Guthrie's women's wear flannel shrank to eleven yards, or eighty-eight percent of its original length. In these instances, Harry judged the amount of fulling needed to transform Guthrie's cloth into the finished textiles he had requested.[111]

Napping

As with fulling, whether a cloth was napped at all, and the degree to which it was napped, depended on the desired end product. Often but not always, fulled woolens were napped. Some un-fulled woolens, and non-woolen textiles such as

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[111] Wilson, *Daybook, 1821–1823*; Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 13.

fustian or modern cotton flannel, are also napped (figure 23).[112] The napping process involves brushing up the fibers on the surface of the cloth, which further obscures the weave structure and makes the cloth softer to the touch. Typically this process was done when the cloth was still wet. In the period of this study, "dressing" is often used to mean first napping and then shearing cloth. Asa Ellis states that "cloths designed for handsome dressing, should be plyed with jacks until a fine thick nap rises. Those for common use, will not require so much labour."[113] This illustrates the connection between quality and "handsome" appearance of cloth, and the labor investment in the finishing process.

Wily describes napping as the process of using "Clothier's Cards to make a Grain on the cloth." By "grain" Wily means a directional nap which runs from one end of the cloth to the other. Running your hand one way along the cloth, it would feel smooth; in the other direction, however, the surface was rough and prickly. If a garment such as a coat was cut with the nap all running down towards the ground, it helped rain to flow off the surface, and kept the wearer dry for longer. [114] The nap also created an additional insulating layer. Textiles designed specifically for warmth, like the heavy coating known as bearskin (see figure 9), could be napped on both

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[112] P.A Sykas, "Fustians in Englishmen's Dress: From Cloth to Emblem," *Costume : The Journal of the Costume Society* no. 43 (2009): 2; Montgomery, *Textiles in America, 1650-1870*, 238.

[113] Ellis, *The Country Dyer's Assistant*, 107.

[114] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 23–24.

Figure 23 Sample of cotton and linen fustian with napped finish, Anders Berch Collection, Nordiska Museet, Stockholm, Sweden. Accession number: NM.0017648B:92D. *Photo by Mats Landin, Nordiska Museet. (CC BY-NC-ND 3.0)* https://digitaltmuseum.se/011023328220/tygprovsamling

sides. In other instances, the nap functioned aesthetically; it either created a fluffy, fur-like appearance, or served as the pre-cursor to shearing, which could make the surface of the cloth almost resemble velvet. In these cases, often only the exterior of the cloth was napped.[115]

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[115] Ellis, *The Country Dyer's Assistant*, 108.

The tool traditionally used to nap the surface of cloth was a T-shaped wooden frame which could be fitted with teasels—the spiky heads of a thistle-like plant with barbed tips. An engraving of cloth workers from Yorkshire, England, illustrates a boy whose job it was to set new teasels into the frames as the old ones wore out (figure 24). Clothier's jacks were similar, but more closely resembled wool cards and relied

Figure 24 In this image, a boy cleans wool fiber from teasel heads while two men nap cloth on an angled table. The Preemer Boy, *The Costume of Yorkshire: illustrated by a series of forty engravings, being fac-similes of original drawings. With descriptions in English and French*, (London: Walker, George and R and D Havell, engraver, 1814). *From The New York Public Library. This image is in the public domain.* https://digitalcollections.nypl.org/items/510d47dc-dcab-a3d9-e040-e00a18064a99

on metal teeth which would damage the surface of the cloth. [116] These tools could then be drawn across the surface of the cloth, pulling the ends of fibers free from the yarns and aligning them into a nap.

Because the goal was to nap the entire surface of the cloth, the larger the area which could be worked on at once, the more efficient the process was. When napped by hand, the cloth had to be manually advanced each time a section was completed. According to Wily, the cloth was hung over a frame, and the napper worked standing up, drawing his clothiers' cards down the surface of the cloth.[117] Duhamel's illustration also depicts this method (figure 25), while the Yorkshire engraving shows cloth being napped while spread over an angled board (figure 24). It is worth noting that in 1823 Partridge states that hand napping was prohibitively expensive and so in his text he only describes napping done with the use of a napping machine or "gig mill," which will be discussed in more detail in the following chapter. The objective of napping was to raise up the fibers on the surface of the cloth. Many of these would have become matted down during fulling. Therefore:

> To know when a piece is sufficiently dressed, open the pile and examine the ground of the cloth. If the wool be so cleared out that the upper parts of the chain threads are distinctly seen, unclogged with wool, the it is well raised. [118]

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[116] Ellis, 109; Bemiss, *The Dyer's Companion.*, 274.

[117] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 23–24.

[118] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 99, 105.

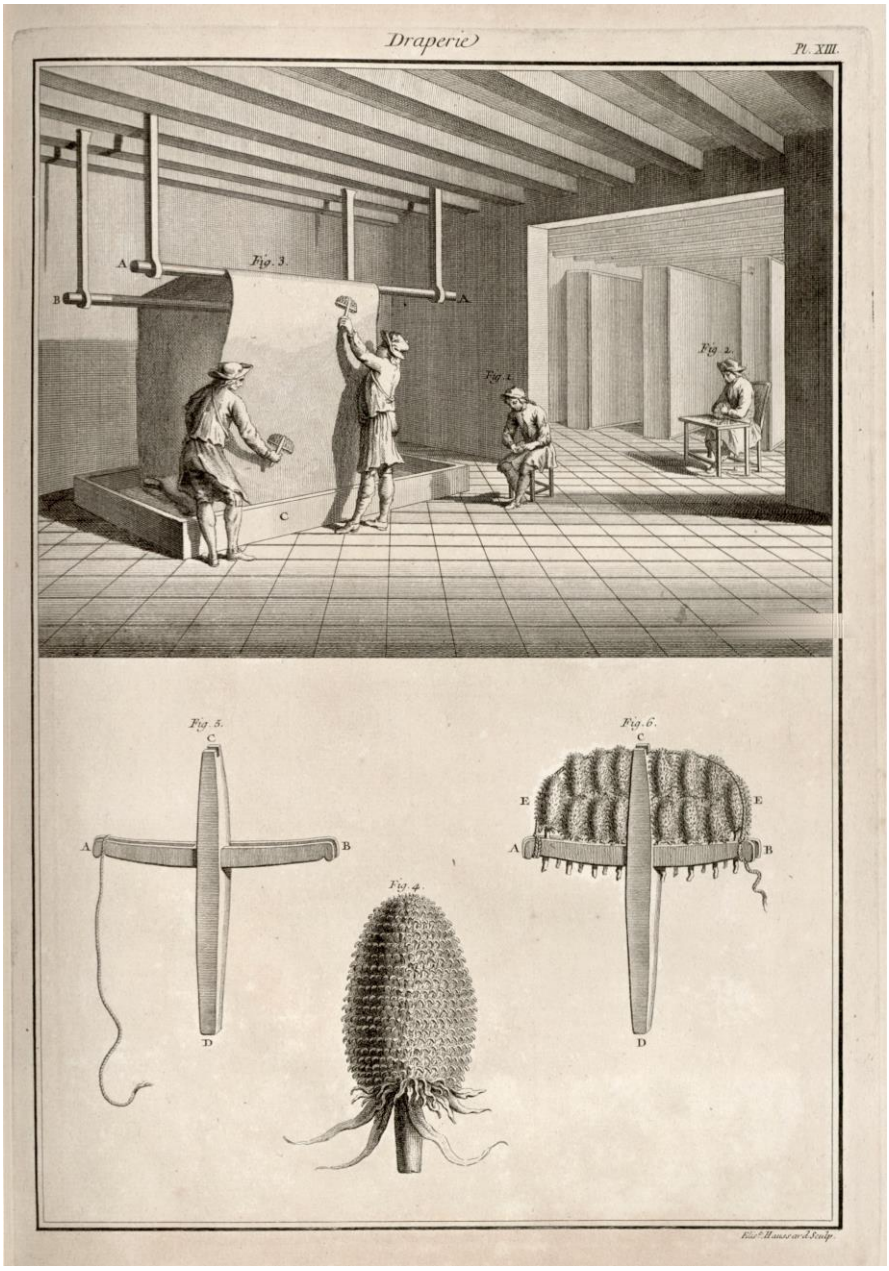

Figure 25 In this plate cloth nappers work at a large standing frame, holding a handle of teasels in one hand, and, according to Duhamel, with another empty handle in their other hand, used from the back of the cloth to provide counter-pressure. The manner of constructing the handles is shown at bottom. Plate XIII, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

Tentering

While the cloth was still wet, it needed to be tentered. Tentering involved stretching the cloth on a frame before allowing it to dry. This helped to guarantee that the cloth dried without wrinkles, and that the final product was a consistent width. It could also correct distortions of the grain which occurred occasionally during fulling. A tentering frame resembled a fence with two rails, generally set up outside near the fulling mill (figure 26). The distance between the rails could be adjusted to equal to the width of the cloth. Closely-set tenter hooks were fixed into each rail. The cloth was first attached to the upper hooks, and then stretched down to the hooks on the lower rail (figure 27). It was typically stretched somewhat at this point, regaining a small amount of the length and width lost in fulling. For example, broadcloth which was designed to be seven quarters of a yard wide when complete might be fulled to six and a half quarters and then stretched to seven on the tentering frame.[119] The hooks fastened into the lists of the cloth. These were wide selvage edges, woven into the cloth to facilitate finishing and dyeing. Examples of eighteenth-century Swedish woolens show contrasting warp threads in the lists (figures 28 and 29).[120]

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[119] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 24–25; Ellis, *The Country Dyer's Assistant*, 109; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 110.

[120] Bemiss, *The Dyer's Companion.*, 272.

Figure 26 *Tenter hooks on a tenter frame at Otterburn Mill*. This tenter frame in Otterburn, Northumberland, in the northeast of England, date to the eighteenth-century. The hooks in the wooden beams were used to secure the cloth. The lower beam could be adjusted in height to put tension on the cloth. *Photo © Russel Wills (cc-by-sa/2.0).* geograph.org.uk/p/5762310

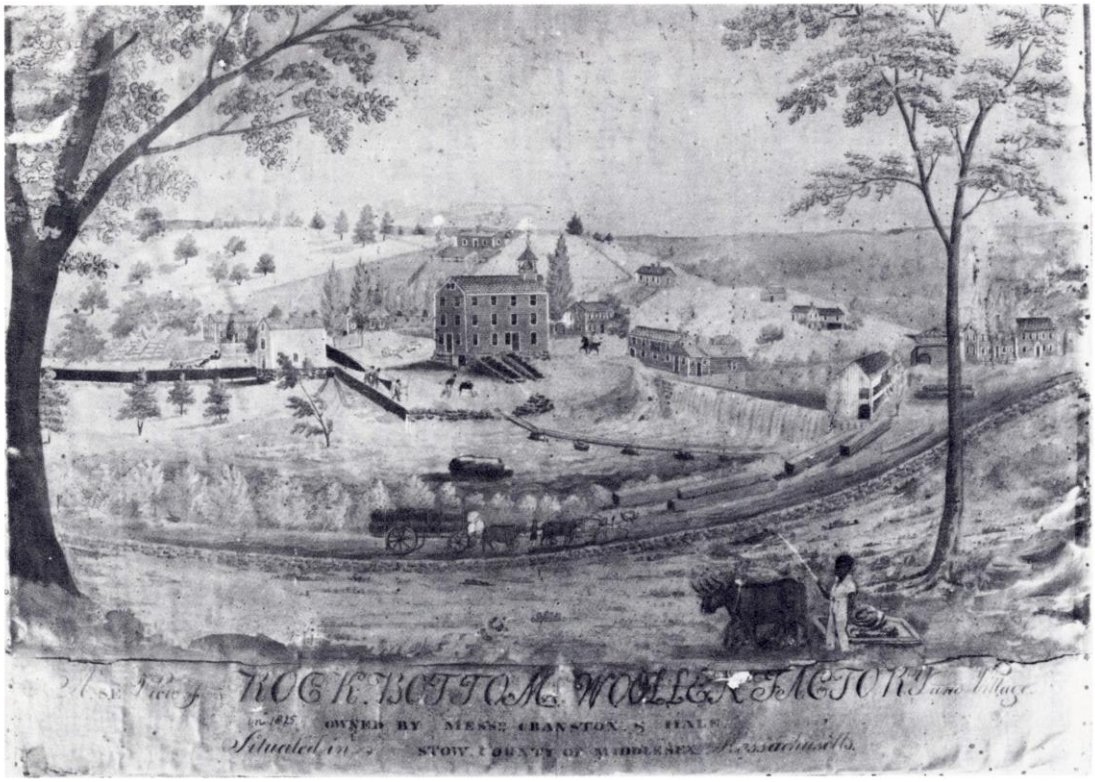

Figure 27 This image includes a rare depiction of woolen cloth being stretched on a tenter frame. Just to the left of the central mill building a group of men can be seen putting cloth onto a frame. *A S.-E. View of Rock Bottom Woollen Factory and Village in 1825 Owned by Messers. Cranston & Hale, Situated in Stow, County of Middlesex Massachusetts*, Old Sturbridge Village Research Library – Landscapes of Change Exhibit, on loan from private collector. In *A Technical and Business Revolution: American Woolens to 1832*. By Elizabeth Hitz, (PhD diss., New York University, 1978. New York: Garland Publishing, Inc., 1986, 176.)

Figure 28 Sample of unfulled woolen cloth with a wide “list” of heavy threads on the left edge of the cloth. Anders Berch Collection, Nordiska Museet, Stockholm, Sweden. Accession number: NM.0017648B:128A. *Photo by Mats Landin, Nordiska Museet. (CC BY-NC-ND 3.0)* https://digitaltmuseum.se/011023321413/tygprov

Figure 29 Sample of fulled woolen cloth. The colorful list threads are visible on the left edge of the cloth. Anders Berch Collection, Nordiska Museet, Stockholm, Sweden. Accession number: NM.0017648B:127A. *Photo by Mats Landin, Nordiska Museet. (CC BY-NC-ND 3.0)* https://digitaltmuseum.se/011023321378/tygprov

Shearing

Finally, with a nap raised on the surface, and tentered free of wrinkles, the cloth could be sheared. In this process, the fibers of the nap were cut to uniform length, much as a mower trims an overgrown lawn. Through shearing, the surface of the cloth became yet smoother and more regular. The objective was to trim the fine woolen fibers to an even length, and to achieve the same finish over the entire surface of the cloth. The traditional solution to this problem involved large shears, much like massive iron scissors with spring hinges, which might weigh forty pounds. An engraving of Yorkshire shearers at work illustrates how the massive blades skimmed across the surface of the cloth (figure 30). The blades were curved, and the cloth was stretched taut over a correspondingly curved shear board. The shear board consisted of a wooden frame, set at about waist height, which was padded with a cushion of cloth or felt and covered in cloth or leather (see bottom of figure 31). When the curve of the board matched the curve of the blade exactly, the full length of the blade (often over two feet) was able to cut evenly.

The cloth was stretched over the shear board with tenter hooks to keep it free of wrinkles, since a blade accidentally cutting into the structure of the cloth would ruin it. The nap pointed towards the craftsperson, and the remainder of the cloth was folded up behind the shear board. The shearer checked the surface for any knots from the weaving process which had been missed during burling. These were picked out or cut off before shearing. Finally, the shears were set on the cloth, and the heavy blades, the lower of which was often further weighted to produce a close cut, were closed using a wooden handle which acted as a lever (figure 31). The shearer worked from one selvage to the other, before advancing the cloth to shear the next length. When the

Figure 30 This image depicts cloth shearers at work and shows several sets of cropping shears hanging on the wall. Below the shears sit several napping frames, for smoothing the nap of the cloth between shearings. The Cloth Dresser, *The Costume of Yorkshire: illustrated by a series of forty engravings, being fac-similes of original drawings. With descriptions in English and French*, (London: Walker, George and R and D Havell, engraver, 1814). *From The New York Public Library.This image is in the public domain.* https://digitalcollections.nypl.org/items/510d47dc-dc9b-a3d9-e040-e00a18064a99

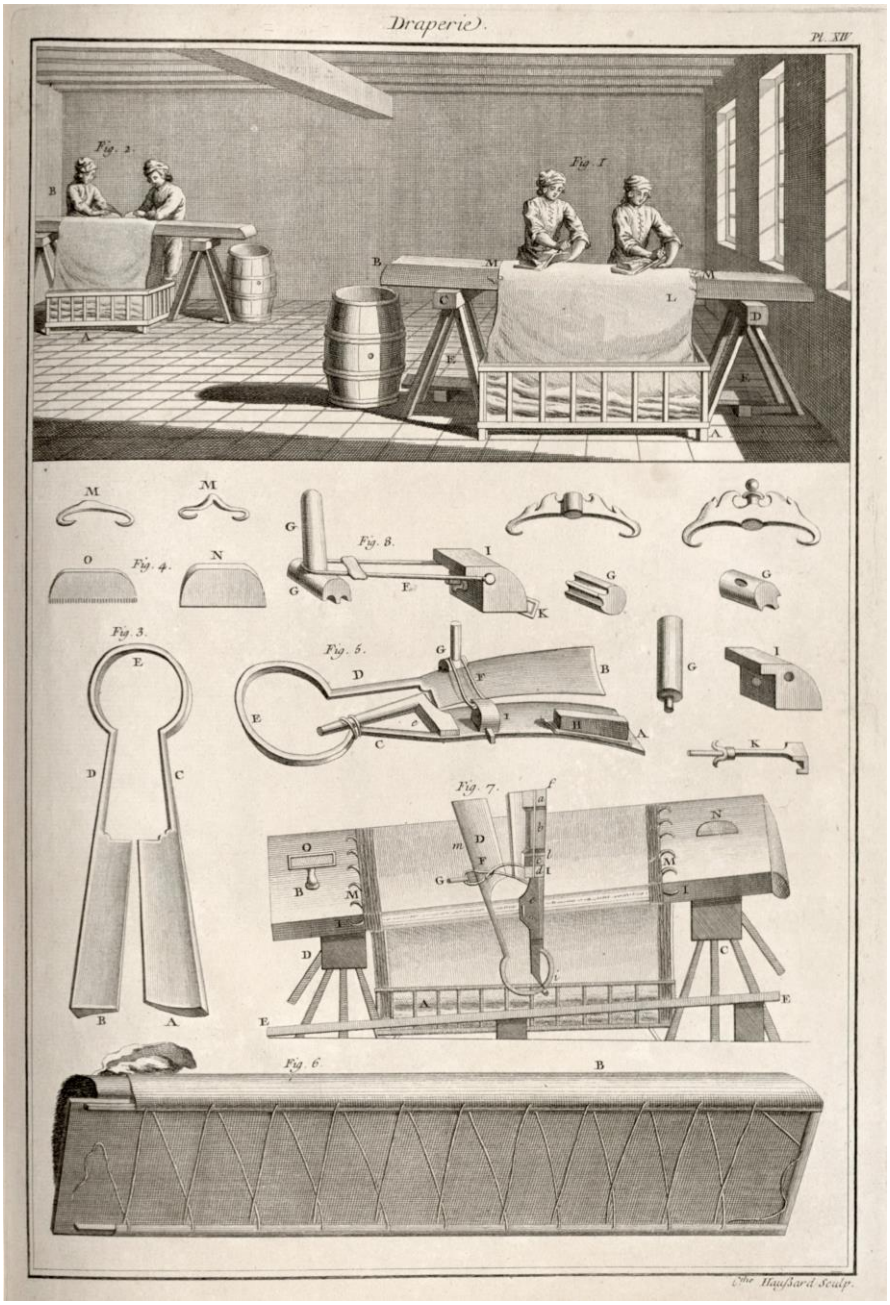

Figure 31 This plate shows cloth shearers at work. In the lower half of the image, Duhamel depicts cloth shears (figure 3) as well as the padded shearing bench (figure 6) and the mechanism used to lever the shears closed (figure 8). Plate XIV, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

shearing was complete, no ridges were left on the surface of the cloth. To achieve this, it was typical to shear the cloth multiple times. Handsome cloth might be sheared upwards of half a dozen times, often alternating with napping, and ending the whole process by napping it one final time to guarantee that the nap was laying smooth in a single direction.[121]

By the time Asa Ellis's *The Country Dyer's Assistant* was published in 1814, machines for both napping and shearing cloth were beginning to be put into use across the country. Despite this, Ellis provides detailed descriptions for the construction of the tools needed for hand napping and shearing cloth. This suggests that in the 1810's, hand processes were very much still in use. In 1823, Partridge did his best to describe the working of a "gig-mill" for napping cloth, but Atkinson's 1844 publication doesn't describe either napping or shearing at all, an indication that by that date these steps were done by machines, and it was not worth explaining their operation to home producers.

Pressing

In his chapter titled "To know when cloth is well dressed," Asa Ellis opens by explaining: "when cloth has received a good dressing, and is finished in a suitable manner, it will be soft and firm. Being shorn even, it will present you a short, thick nap, which lies smooth in one regular direction." On the other hand, "if it be pressed stiff, like buckram; if the nap be irregular, and the face of the cloth be rough, the

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[121] Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 25–26; Ellis, *The Country Dyer's Assistant*, 110–110, 135–37; Bemiss, *The Dyer's Companion.*, 69.

workman has not performed his duty, but he has endeavored to hide his failure, by the press."[122] Pressing was the final step in woolen finishing. Much like a modern iron, it applied heat and pressure to cloth in order to smooth its surface. The quote above indicates that it could also be used at times to obscure shoddy work earlier in the process.

Cloth presses consisted of two large beams fixed into the floor.[123] A small brick fireplace was built at the base, and a large screw press assembled between the two beams. It functioned by heating a two-inch-thick iron plate over the fire until it was just hot enough that you could put your hand on it for a few seconds. On top of this were set a few sheets of pressing paper, which were topped with the cloth which had been carefully folded so there was a piece of paper between each fold of cloth. This whole package was then pressed from above, with pressure applied by a giant screw, until the cloth became warm. Additional pieces of cloth could be added to the bottom of the pile (on top of the stove plate) and separated by planks of wood (figure 32). The warmth of the plate and the pressure applied with the screw mechanism combined to smooth the textile, and, at times, to put a shine on it, though this was less common with woolens than worsteds.[124] Excess heat at this stage could create the buckram-like, over-pressed cloth described above by Ellis.

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[122] Ellis, *The Country Dyer's Assistant*, 120.

[123] Wily states that the main posts of a press should be twelve feet high. Wily, *A Treatise on the Propagation of Sheep, the Manufacture of Wool and the Cultivation and Manufacture of Flax*, 26–27.

[124] Wily, 26–30.

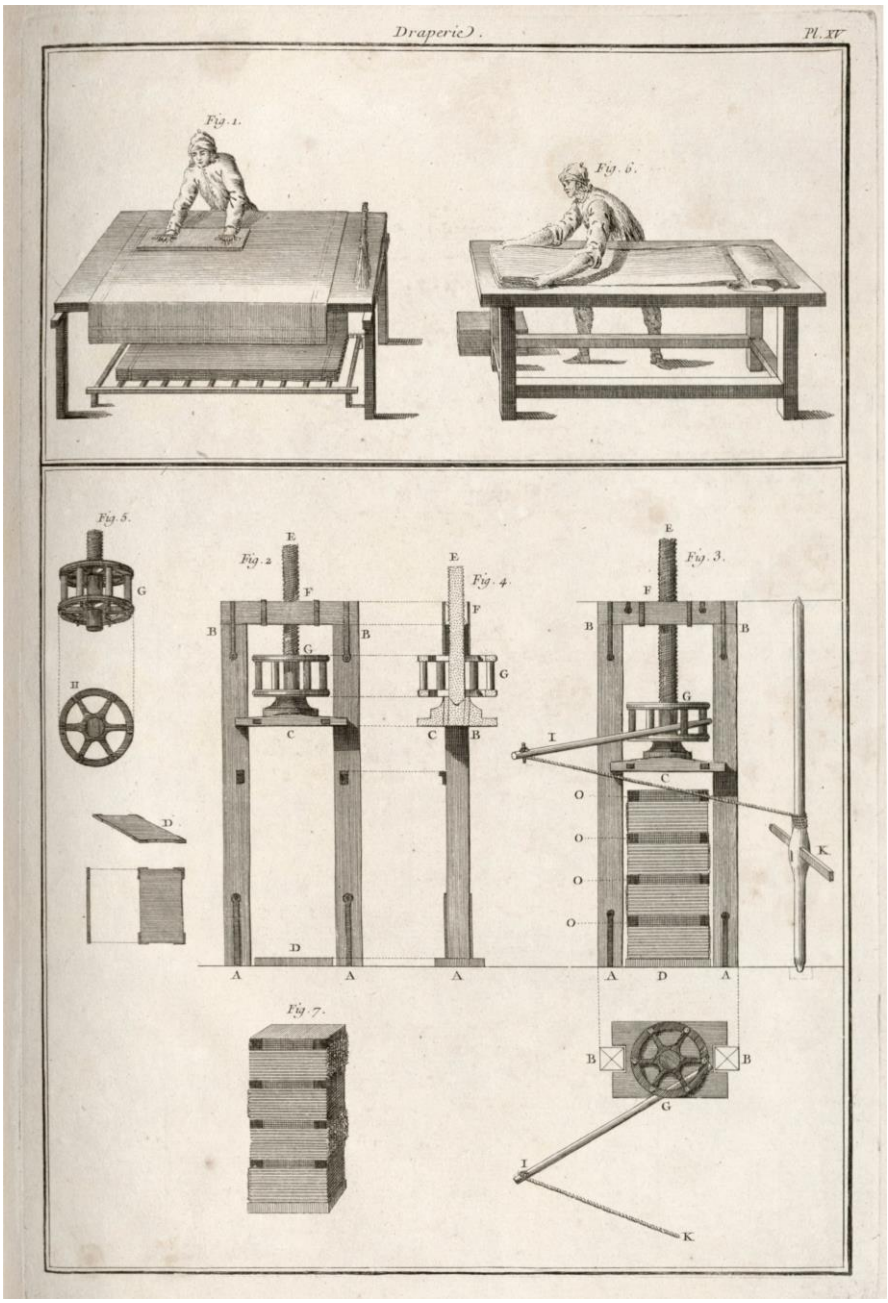

Figure 32 Plate XV illustrates a cloth press, showing how cloth is folded before being layered into the press. This plate also illustrates the screw mechanism used to put pressure on the cloth. Plate XV, *Art de La Draperie: Principalement Pour Ce Qui Regarde Les Draps Fins*, (Paris: Duhamel du Monceau, 1765). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

After pressing, the cloth was ready to be returned to the customer. Receiving it back after the completion of the finishing process, the customer would first feel the finish on the cloth – the fibers of the surface would be compacted together, and smooth to the touch. Over time, as the press wore off, the nap would raise slightly, and the cloth would feel fuzzy, or, if very handsomely finished, like velvet.

Training and Skill of American Cloth Finishers

Together, fulling, napping, shearing, and pressing, as well as dyeing, could transform cloth fresh from the loom into luxurious, beautiful textiles. This was only really possible, however, if the weaver, spinner, carder, and wool sorter had also done their work well. At the same time, poor finishing might leave even well-made cloth unpleasant to wear, unattractive, or unsuitable for the function it was intended to fulfill. This was very much Asa Ellis's attitude when he wrote that "it would greatly promote the interest of the nation, as well as that of individuals, were no person to attempt the dy[e]ing and dressing of cloths, until he has obtained suitable information, by instruction and experience."[125] This problem was referenced repeatedly in the various manuals cited in this chapter. Often this discussion was framed in terms of the differences between the training standards in Britain and Europe, and those in America.

In West Yorkshire, England, fulling and dressing cloth were entirely separate trades, while in America both these trades as well as dyeing were done by the same

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[125] Ellis, *The Country Dyer's Assistant*, 122.

craftspeople.[126] This lack of specialization may have served country fulling mills well, as it meant that cloth finishing businesses didn't need to be large and even small populations could support a fulling mill. The trade off, of course, was one of quantity for quality. American cloth finishers were poorly trained jacks of all trades. Ellis complained of America's amateurish craftspeople, saying "after all, experience is necessary and no person can dress cloths well, until he has served a regular apprenticeship." Even an apprenticeship served with a country fuller, however, didn't result in the degree of specialized knowledge possessed by English craftspeople.

While this generalized finishing education was acceptable for country fulling mills, it was a problem for those who sought to set up any sort of serious domestic manufacturing. This was the audience for whom William Partridge had written his treatise on manufacturing broadcloth and cassimere. Partridge was eager to see American workmen well-trained but believed those efforts were hindered by American business organization. In the United States, the managers of woolen manufactories tended to be capitalists, rather than individuals who had been brought up in the business, as was commonly the case in England. Because they themselves lacked craft understanding, they were not able to hold their craftspeople accountable and demand high-quality work. Partridge wrote that "when the managers shall have obtained a competent judgement in this business and will pay the strict and constant

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[126] Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 37–38; Ellis, *The Country Dyer's Assistant*, 104.

attention which so complicated a manufactory requires, the American workmen will become as expert as any in the world."[127]

Closing this chapter with a discussion of how cloth finishers were trained is particularly relevant because my goal here has been to lay out the skills and knowledge-base required to perform the work of cloth finishing. Despite the use of half a dozen period texts describing the fuller's and cloth dresser's trade, it is hard to escape the fact that these crafts are impossible to truly capture on paper. Because of this, my interpretation of these manuals has been filtered through observations of extant woolen textiles, and through my own cloth finishing experiments. My aim has been to present the various factors which contribute to cloth finishing in order to provide historians with a greater appreciation of this craft, and textile specialists with the ability to recognize certain finishes on historic textiles. The experimental aspects of this thesis have demonstrated the many rewards of bridging the gap between the theoretical and the practical when exploring craft work. My hope is that this chapter has provided tools for others to begin to make new connections with old objects.

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[127] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 25, 28–29.

Chapter 3

THE CHANGING TECHNOLOGY OF WOOLEN FINISHING

The forces at work in the American textile industry after the close of the American War for Independence were many. The conclusion of revolution against British rule made way for a revolution in industry. The American project to increase domestic production of textiles became an opportunity to explore new technologies and forms of business organization. Though cotton has long been the reigning historical example of technological innovation in textile manufacturing, woolen production, and more specifically woolen finishing processes, were also transformed through the development of new technologies in this era. Innovation focused on ways to simplify the more demanding aspects of woolen finishing, such as napping and shearing. The goal of these technologies was to finish woolen textiles faster and at a lower cost. In America, they also helped to compensate for an insufficient pool of skilled finishers.

Fundamentally, cloth finishing machines aimed to replicate the specialized work of craftspeople. This represented a de-skilling of labor, which offered speed and consistency without the need for long years of training. Though the goal was presumably originally to manufacture goods of the same or better quality as those made using traditional craft methods, American manufacturers were never able to establish competitive production of high-grade woolens. Instead, they settled for the uniformity allowed for by mechanization. According to Elizabeth Hitz, woolen producers realized they did not need to produce high-end woolens to be financially

successful.[128] Unable to compete with imports of fabrics such as broadcloth and cassimere, because competitive prices were actually below production costs, American manufacturing shifted to cheaper, more utilitarian fabrics such as flannel and satinette.

This chapter studies early finishing machines, looking at their development and their role in the finishing and woolen industry. This path of inquiry is a backdoor for better understanding the role of cloth finishing in the creation of woolen textiles. For example, the novelty of shearing machines which could continuously progress the textile beneath a shearing blade helps to highlight the intermittent nature of shearing by hand. By examining mechanized shortcuts for shearing and napping, we can triangulate both the primary objectives and the primary challenges of these processes for craftspeople in the Early Republic.

The Mechanization of Cloth Production

The mechanization of woolen finishing was not an entirely new idea by the late eighteenth century. Water powered fulling mills had, after all, been in existence since the middle ages. Additionally, the middle of the eighteenth century saw a blossoming of industrial-scale tools for other types of textile production. Specifically, Richard Arkwright's 1769 water-powered spinning frame and the carding machine, which was developed between 1750 and 1775. [129] These tools, though first conceived of for

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[128] Hitz, "A Technical and Business Revolution," 121, 221.

[129] Julia De L. Mann, "The Textile Industry: Machinery for Cotton, Flax, Wool, 1760-1830," in *A History of Technology. Vol IV, the Industrial Revolution, c. 1750 to c. 1850*, ed. Charles Singer et al. (Oxford; Glasgow; New York; Toronto: Clarendon Press ; Oxford University Press, 1958), 278; Gross, "Wool Carding," 806.

cotton processing, were also adapted for woolen yarns. Together these technologies made it obvious that mechanization of almost any textile process was possible.

The technological landscape in which country fullers ran their businesses allowed further innovation to take root. The standard design of fulling stocks in use in post-Revolution America were not new. Similar mills were probably constructed by early colonists in the seventeenth century, and the design changed very slowly prior to the middle of the ninetieth-century.[130] Because of this established familiarity with mechanized equipment, fullers were already aware of the benefits of using water power in place of man power for hard physical jobs like pounding cloth to full it. By the early nineteenth century, many fulling mills were adding carding machines to their operations as well (figure 33). Carding machines were perfected in England in the third quarter of the eighteenth-century. By the last decade of the century, card cloth—a tricky-to-manufacture material, studded with small, bent wire carding teeth, and an essential element of carding technology—was being manufactured in the United States.[131] It was easy to house carding machines inside an already-standing mill building, and carding was a tedious step in cloth-making which home textile producers were happy to outsource to a mill for a few cents a pound, just as, later in the process, they would pay by the yard for the fuller to finish their cloth. Because carding machines were relatively simple additions to existing structures, and because they

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[130] The first fulling mill in America is said to have been built in Massachusetts in 1643. Harry B Weiss and Grace M Weiss, *The Early Fulling Mills of New Jersey,* (Trenton: New Jersey Agricultural Society, 1957), 9.

[131] Gross, "Wool Carding," 806.

Figure 33 The feed belt and carding cylinders of one of Old Sturbridge Village's nineteenth-century carding machine. *Photo by the author.*

were easily incorporated into country fullers' business models, a large number of fulling mills became *carding and* fulling mills in the early nineteenth century.[132]

[132] In 1818, when the Broad Run mill re-opened under the ownership of Andrew and Hannah Wilson, a carding mill was added to the business. The final day book for the mill is referred to as "Hannah Wilson's Carding Book" suggesting that this work felt

Carding machine technology came early in the industrialization textile production. One reason for this is that mechanized spinning depended on a large and steady supply of carded fiber. This was true not only for wool, but more importantly, also for cotton, which was easier to process mechanically and tended to drive innovation.[133] Though carding machines seem to have been adopted in the United States around the same time that napping and shearing machines were beginning to be available, they were much more common that either of those devices in small, rural fulling mills. The large number of fullers who added carding operations to their businesses suggests that these craftspeople were receptive to changes to what was in many ways a centuries-old business model. The expansion of their work from finishing woolen cloth to also preparing fiber for spinning, and the addition of a second major piece of water-powered equipment, must have made further mechanization of their trade more inevitable and, perhaps, less threatening.[134]

Though wool carding is not directly related to finishing, it is important to understand the role of carding machines in early-nineteenth-century fulling businesses. It is also valuable to briefly note that spinning too was undergoing rapid mechanization in the eighteenth and early nineteenth century. Power weaving, though

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more important to the mill's operators. Fulling mill and woolen mill advertisements routinely advertised both carding and finishing work. Wilson, *Daybook, 1821–1823.*

[133] De L. Mann, "The Textile Industry: Machinery for Cotton, Flax, Wool, 1760-1830," 277.

[134] The well-organized British cloth finishers strongly resisted mechanization on the grounds that it would put skilled craftspeople out of work. No such resistance seems to have occurred in America. Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 39–40; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 32–33.

somewhat behind spinning, was also being prototyped at this time, though primarily for the manufacturing of cotton textiles. Despite these new technologies, finishing was the single biggest area of innovation between 1790 and 1830 in the woolen industry.[135] With fulling mill operators already primed for change through the introduction of mechanical carding, and with the simultaneous paucity of skilled finishers and an increasing push for domestic cloth production, this desire to further mechanize finishing is perhaps unsurprising. A final reason, however, should also be considered. While cotton producers developed technologies for fiber preparation, spinning, and weaving, many of which could and were eventually adapted for wool, woolen cloth required additional physical processing after it left the loom, which the cotton industry could not be expected to prototype. Woolen cloth was for the most part not useable until it had gone through finishing processes. To effectively mechanize woolen production, the craft skills of napping and shearing also needed to be industrialized.

Gig mills for napping cloth had existed in some form for several centuries in England but were banned there in 1551.[136] This technology resurfaced, however, in the waning years of the eighteenth century. Generally, gig mills consisted of large drums fitted with many long and narrow frames of teasels (figure 34). The drum

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[135] David J Jeremy, "Invention in American Textile Technology during the Early Nineteenth Century, 1790-1830," *Working Papers from the Regional Economic Research Center*, no. 5 (1982): 8, table 2.

[136] R. Patterson, "The Textile Industry: Machinery for Cotton, Flax, Wool, 1760-1830," in *A History of Technology. Vol II, from the Rennaissance to the Industrial Revolition c. 1500-c. 1750*, ed. Charles Singer et al. (Oxford; Glasgow; New York; Toronto: Clarendon Press ; Oxford University Press, 1957), 172.

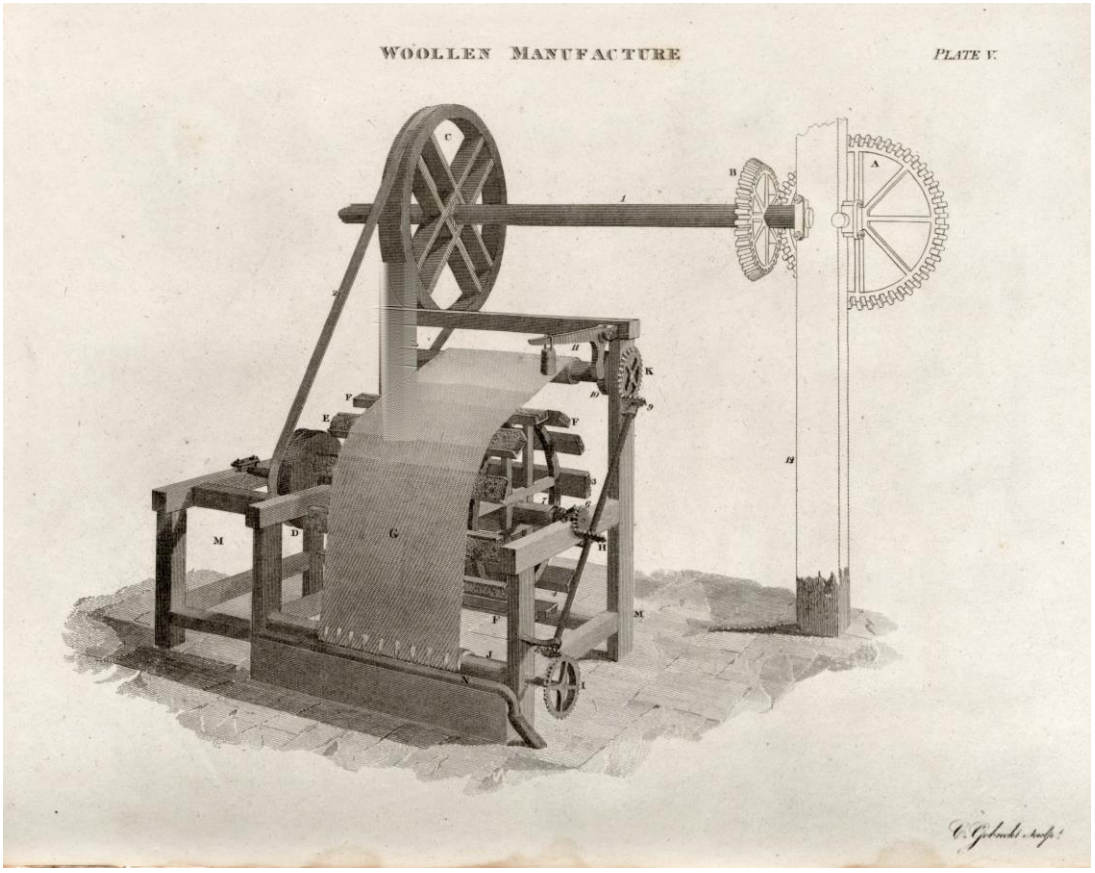

Figure 34 Woolen Manufacture, Plate V, [Gig Mill], *The Cyclopædia* (Philadelphia: Rees, Abraham, 1802). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

turned, and the cloth was drawn over it, causing the teasel heads to brush its surface.[137] As these machines became more commonplace in the early nineteenth century, a variety of new designs and improvements were also patented.

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[137] Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere,* 100–103; Hitz, "A Technical and Business Revolution," 269–70.

Shearing machines were truly an innovation of the early industrial period. They transformed the slow and challenging work of hand shearing cloth into a continuous rotary process in which cloth passed beneath or between blades, which delivered even shearing to their entire surface. Because shearing machine innovation began in America in 1792, the technological progress is well documented through the records of the America patent office, making this machine a particularly good example to look at for understanding the technological progress of woolen finishing in America.

Machine Design

A close examination of the development of the shearing machine enables a variety of points to be made about this particular finishing step. American shearing machine patents help to illustrate how innovators sought to simplify the unique challenges of this process. The first was that hand shearing was slow and discontinuous. The second was that the cutting action itself demanded skill and strength.

Patent records are one way to track innovations, and many patents were granted for shearing machines during the period of this study. Unfortunately, the American patent office, which opened in 1790, burned, along with all of records, in 1836. The patent rolls, which included names of inventors as well as the sometimes-cryptic titles of their patents, were preserved, and descriptions and drawings of those patents deemed most significant were reproduced where possible. The latter category includes the earliest patent for a shearing machine, issued to Samuel Dorr in 1792, as well as at least a dozen other shearing machine patents issued before 1838. A total of

55 patents for cloth shearing machines were issued between 1790 and 1847.[138] The sheer number of inventions indicates that shearing was a problem which people were eager to solve.

The earliest mechanized shearing machines developed in Britain simply consisted of frames which continuously progressed the fabric as traditional shears were operated to cut the nap (figure 35).[139] This solved the first challenge of cloth shearing, making it so the cloth advanced automatically as the shearing took place. While this proved a useful assist to skilled British shear-men, in America a shearing machine needed to effectively mechanize the shearing itself, since there was no ready supply of skilled manual shear operators. Samuel Dorr's 1792 design also advanced the cloth automatically. The action was performed by rollers, which were turned with a crank. That same crank also operated a rotating "wheel of knives," which sat flat on top of the machine, with one half of its arc passing over the cloth and shaving its surface (figures 36 and 37).[140] This design mimics the long blades used in hand shearing, while uniting the motion of the shears and the cloth so that the blades could pass over the continuously moving cloth are regular intervals.

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[138] Barbara Suit Janssen and Smithsonian Institution, *Technology in Miniature: American Textile Patent Models, 1819-1840* (Washington, D.C.: Smithsonian Institution Press, 1988), 95.

[139] Hitz, "A Technical and Business Revolution," 275–77.

[140] Janssen and Smithsonian Institution, *Technology in Miniature*, 52, 95.There is some disagreement about the exact design of this machine. While the reconstructed patent image, based on the original language of the patent, implies a wheel with spoke-like blades, many other scholars have interpreted this as a cylinder of blades instead, much closer to later shearing machine designs.

Despite this move towards fully mechanized shearing, the flaws in Dorr's design are readily apparent. Because of the spoke-like design of the cutting blades, the machine needed to be more than twice the width of the textile being shearing. Additionally, the blades traveled in an arc over the cloth, with the center point on one edge. It must have been almost impossible to register the blades so that they would cut the same on the far edge of the textile as on the near edge. Successive shearing machine designs, possibly included Dorr's own 1793 or 1794 improvement, used a different cutting mechanism. Instead of a wheel rotating over the surface of the cloth,

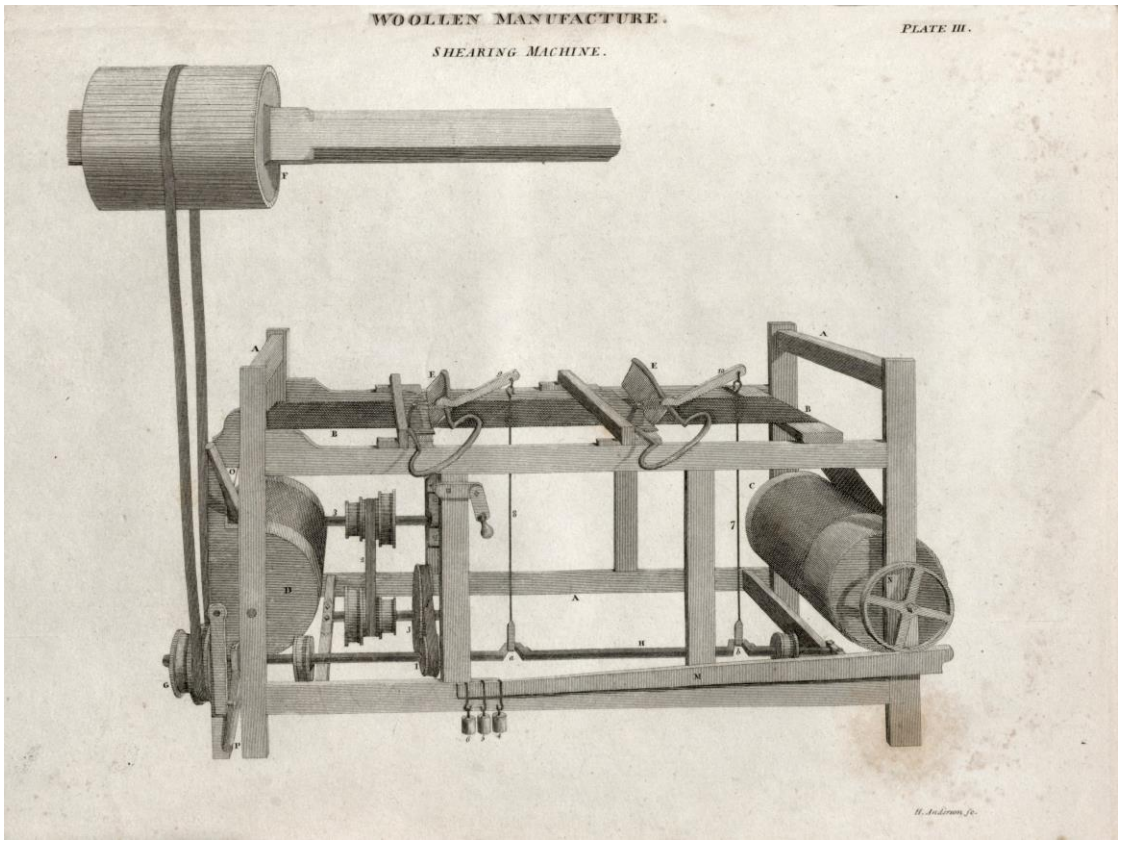

Figure 35 Woolen Manufacture, Plate III, Shearing Machine, *The Cyclopædia* (Philadelphia: Rees, Abraham, 1802). *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

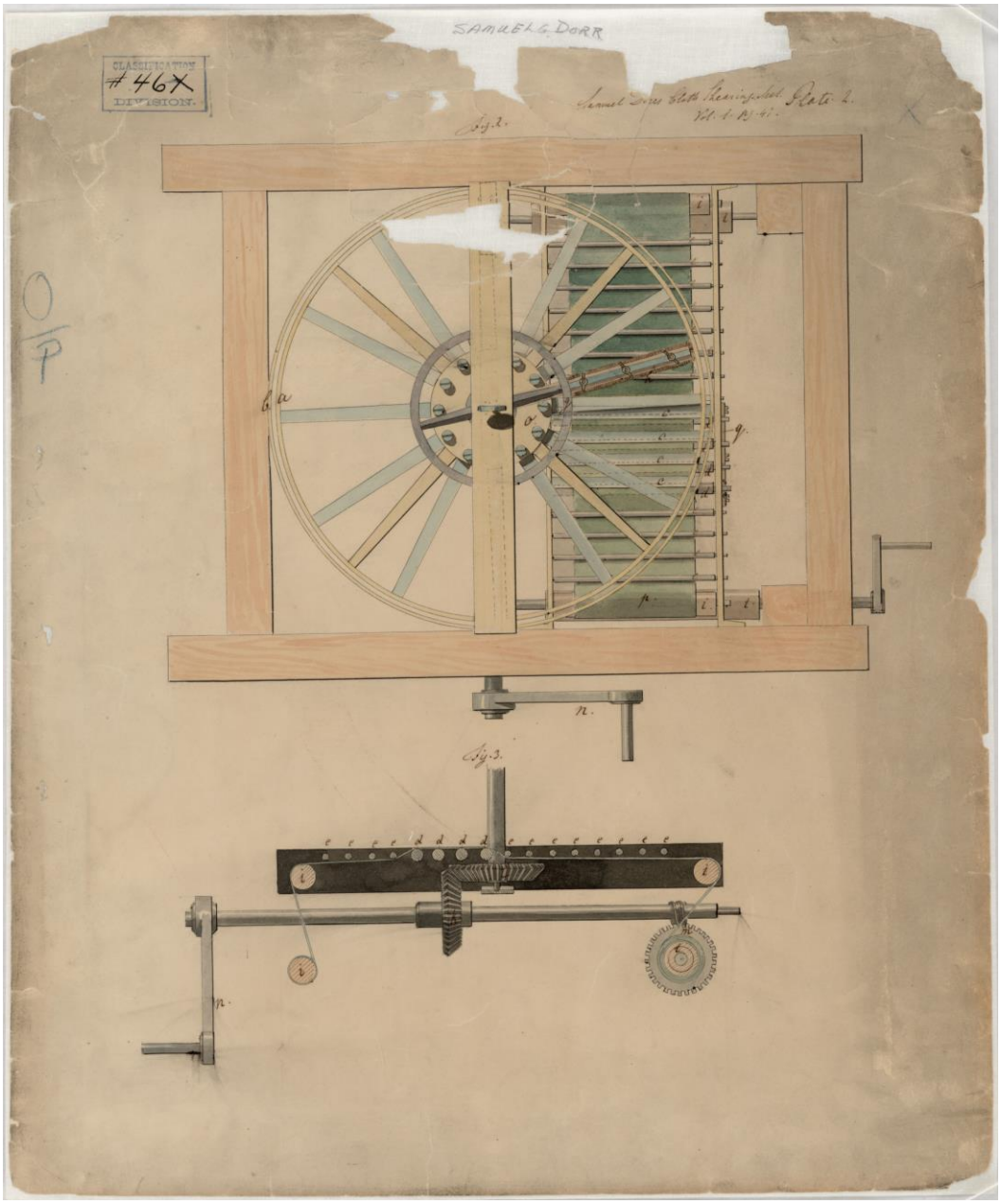

Figure 36 A top view of Dorr's, "wheel of knives," cloth shearing patent. The image shows how the spoke-like blades passed over the cloth. Samuel Dorr's Cloth Shearing. Mch, 10/20/1792 [Architectural and Engineering Drawings]; Restored Patent Drawings, 1837–1847, Record Group 241: Records of the Patent and Trademark Office, 1836–1978; National Archives at College Park, College Park, MD [online version available through the Archival Research Catalog (ARC Identifier: 102278454) at www.archives.gov; March 30, 2019]

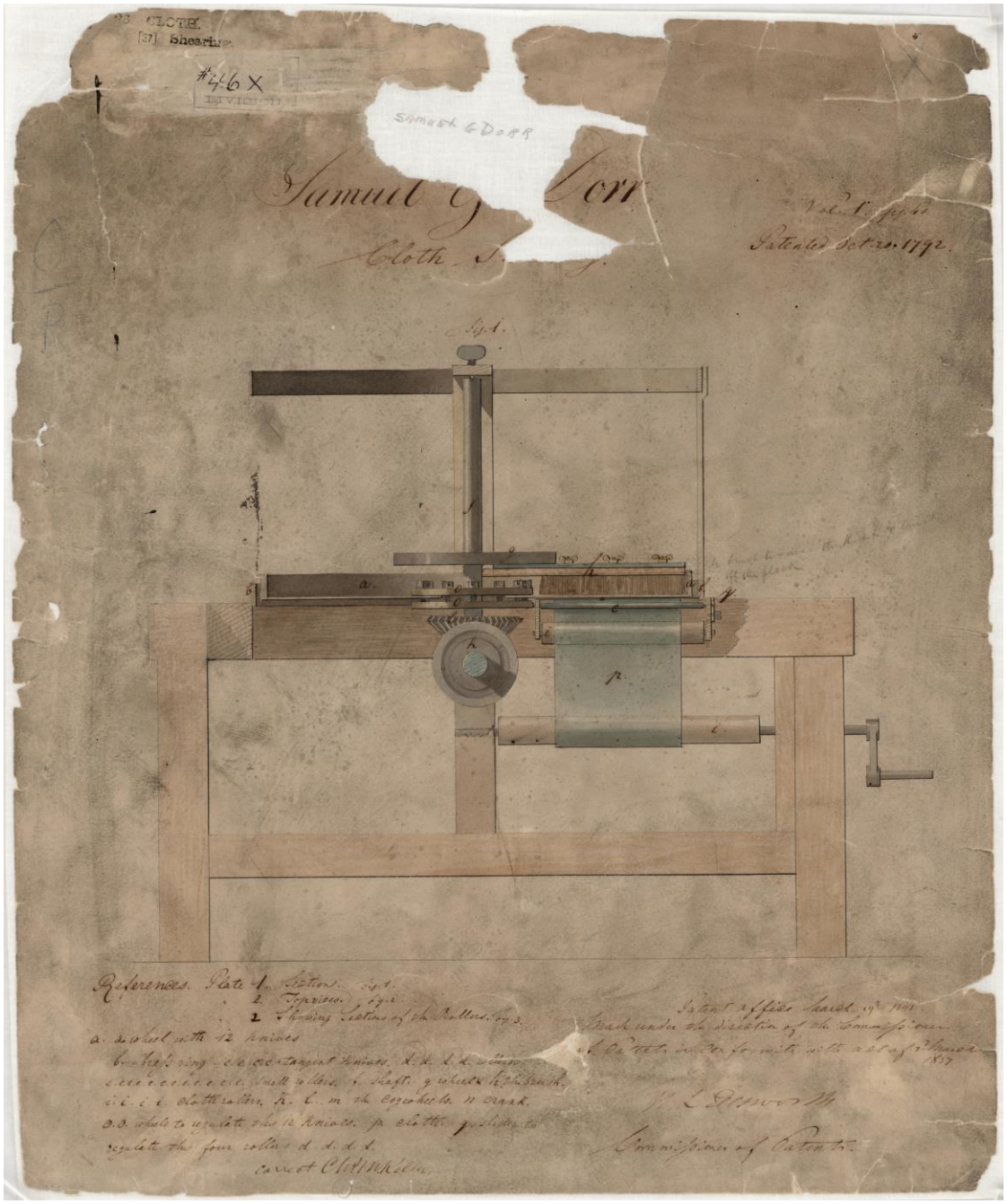

Figure 37 Side View, showing a brush which raised up the nap just prior to shearing. Samuel Dorr's Cloth Shearing. Mch; Restored Patent Drawings, 1837–1847, RG 241; NACP [online version available through the Archival Research Catalog (ARC Identifier: 102278454) at www.archives.gov; March 30, 2019].

blades were fixed to a rotating cylinder, which turned at a different rate than the rollers advancing the cloth, allowing the blades to scrape along the surface, opposed on the other side of the cloth by a stationary ledger blade. Seth Parsons' 1819 patent featured two helical blades, under which the cloth passed as it moved through the machine (figure 38).[141] This design made more even shearing possible and appears to have been the cutting method used by all subsequent surviving shearing machine patents within the period of this study. This technological advance moved further away from the traditional methods of craft finishing and demonstrates a willingness to think outside the box to solve the problem of efficient cloth shearing.

At least two incomplete shearing machines similar to Parson's design survive today. One is in a private collection, and the other resides at the Museum of Power and Industry in Belvedere, Tennessee. Both machines consist of approximately waist-high wooden frames on which are mounted beams for the cloth before and after it is sheared, as well as the shearing mechanism (though the blades are missing on both of these machines), and additional rollers for moving the cloth through the machine and brushing up the nap immediately before shearing (figure 39).

Regardless of the effectiveness of these machines' various features, they shared the common goal of fast and effective shearing. An 1811 announcement in the Washington, Pennsylvania, *Reporter,* advertised shearing machines made by a Mr. Adam Wise which could supposedly shear two hundred yards of cloth a day, in comparison to the fifty yards the advertisement states was the average daily output of

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[141] Janssen and Smithsonian Institution, 50–53.

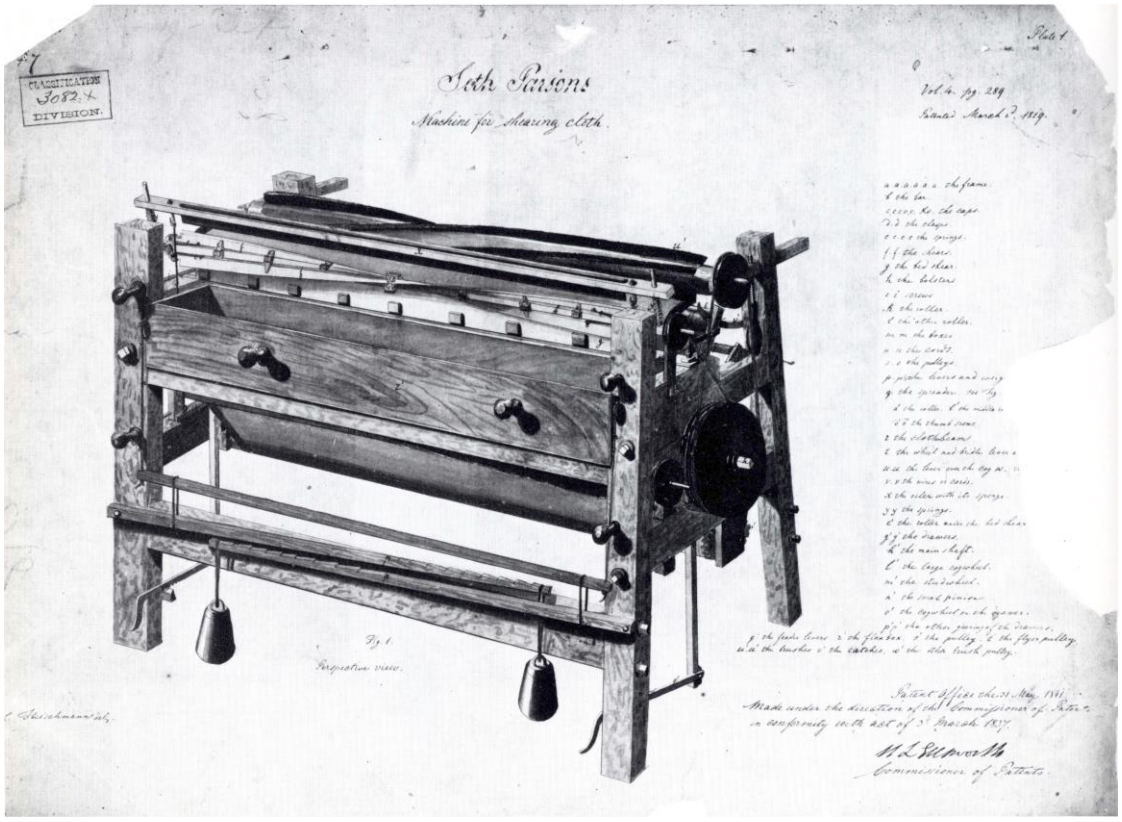

Figure 38 Seth Parsons' 1819 shearing machine patent. The helical shearing blade can be seen at the top front of the machine. Seth Parsons Machine for Shearing Cloth, 3/2/1819, [Architectural and Engineering Drawings]; Restored Patent Drawings, 1837–1847, Record Group 241: Records of the Patent and Trademark Office, 1836–1978; National Archives at College Park, College Park, MD. In *Technology in Miniature*. By Barbara Suit Janssen. (Washington: Smithsonian Institution Press, 1988, 52.)

Figure 39 An early nineteenth-century shearing machine, missing its blade, similar in design to Seth Parson's 1819 patent. *Courtesy of Peggy Hart. Photo by Jean Hosford*

a hand shearer.[142] A similar advertisement for another machine promised a rate of thirty yards per hour.[143] The profit assured by this accelerated rate of work was surely a major motivator for cloth finishers, and therefore also for inventors and machine builders.

The shearing machines patented by Samuel Dorr, Seth Parsons, and others were intended to simplify cloth shearing, which one shearing machine advertisement described as "At best … but a laborious and tedious part of our business to perform."[144] In an ideal world, mechanization allowed woolen cloth to be sheared faster, produced a more consistent result, and required less skill and strength on the part of the operator. By looking at the solutions these innovators came up with, it is possible to better understand the problem they were solving. American fullers and cloth finishers in the late eighteenth and early nineteenth centuries who dressed woolens without the aid of mechanical shearing machines struggled to quickly produce smooth, consistent finishes. Business owners found craftsmen with the necessary skills in short supply. Mechanical solutions to these problems provide us with additional explanations of the skills of pre-industrial craftspeople, and therefor also of the struggles faced by small-scale American fulling mills which sought to finish cloth professionally for their customers. A close examination of early shearing

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[142] Advertisement, *The Reporter*, Washington, Pennsylvania, February 11, 1811, America's Historical Newspapers.

[143] Advertisement, *American Watchman*, Wilmington, Delaware, July 25, 1810, America's Historical Newspapers.

[144] Advertisement, *The Reporter*, Washington, Pennsylvania, February 11, 1811, America's Historical Newspapers.

machine designs illuminates the intersections of craft and entrepreneurship in the Early Republic.

Machine Builders and Buyers

Examining the inventors, makers, and users of innovative textile technologies provides a fuller sense of the environment occupied by professional cloth finishers. The inventors themselves came from a range of backgrounds. Some, like Samuel Dorr, were finishers themselves. Others were mechanics, millwrights, or general inventors.[145] Fullers in the Brandywine Valley and beyond had access to a wide range of cutting-edge textile technology. Both locally made machines, and technology imported from New England, were in use in the region.

A millwright named John Scott, working in Wilmington in 1795, advertised his services in the construction of a wide variety of mills and mill equipment. Scott even stated that he could produce steam engines, if water power was lacking and coal plentiful. Among the dozens of types of equipment the millwright listed was "all that is needful to carry on the woolen cloth manufactory." Unsurprisingly, given the early date, Scott does not mention shearing machines, but he does discuss fulling stocks, carding machines, and "a raising mill to raise [nap] the cloth."[146] Scott is an example of a professional mechanic whose work included textile equipment. While millwrighting was a discreet trade, it is interesting to note the wide range of machines

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[145] Jeremy, "Invention in American Textile Technology during the Early Nineteenth Century, 1790-1830," 20–22.

[146] Advertisement, *Delaware Gazette*, Wilmington, Delaware, March 7, 1795, America's Historical Newspapers.

which this one tradesperson undertook. Adam Wise, whose machine could supposedly shear two hundred yards of cloth a day, also produced several different types of equipment. In addition to mechanical shears, he made "the common kind of fuller['s] shears, mill irons & screws of all descriptions," certainly including those used in cloth presses.[147] Local mechanics catered to a wide range of needs, indicating that the transition from old technology to new was a slow one, and also that the nascent American economy was only just beginning to be able to support specialists of this type in the second decade of the nineteenth century.[148]

Other makers did specialize in certain machines and compensated for their narrow range of products by advertising them widely. A Rhode Island man advertised his shearing machine in a Wilmington newspaper in 1804.[149] In 1810, Brandywine millers Caleb and Samuel Kirk published a testimonial recommending a shearing machine built by Solomon and Justis Beckley in Wilmington, but also available at the shop of Solomon Beckley Jr. in Wethersfield, Connecticut.[150] At his Broad Run mill, Calvin Cooper also toyed with the idea of buying a shearing machine from a New England machine maker. Written three times on the first page of Cooper's day book

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[147] Advertisement, *The Reporter*, Washington, Pennsylvania, February 11, 1811, America's Historical Newspapers.

[148] For a discussion of millwrights' role in the industrialization of textile manufacturing in Britain see Jennifer Tann, "The Textile Millwright in the Early Industrial Revolution," *Textile History* 5, no. 1 (1974): 80–89.

[149] Advertisement, *Mirror Of the Times, & General Advertiser*, Wilmington, Delaware, December 25, 1804, America's Historical Newspapers.

[150] Advertisement, *American Watchman*, Wilmington, Delaware, July 25, 1810, America's Historical Newspapers.

for the years 1811 to 1813, is the line: "John Stanley, [Pou]ltney, County of Rutland. State of Vermont. Shearing Machine Builder."[151] Though there is no sign that Cooper ever bought such a machine, a reference to John Stanley also appears among the records of the Antietam Woolen Manufacturing Company, of Hagerstown, Maryland. In 1815, that business bought one of Stanley's machines for shearing broadcloth.[152] Stanley built machines from the designs of David Dewey, who held an 1809 patent for a shearing machine. An 1815 advertisement in the *Albany Argus* explains that Stanley's arrangement with the inventor was such that he could not sell Dewey's design within New England, much of New York, or Ohio, which helps to explain the far-flung references in Pennsylvania and Maryland.[153] While country fullers like Calvin Cooper may not have considered shearing machines a good investment for their small businesses, Cooper's clear consideration of Stanley's machine indicates how this new technology was beginning to infiltrate the American cloth finishing industry on every level by the second decade of the nineteenth century.

Machine Users

Functional designs and mechanics to build them were not the only considerations necessary for cloth finishers to enthusiastically adopt new technologies. Mechanization meant that work could be performed by progressively less skilled, and

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[151] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815,* vol. 3.

[152] Papers of the Antietam Woolen Manufacturing Co, Hagerstown MD, 1814-1816. (Acc. 1422), Hagley Museum and Library, Wilmington, DE.

[153] Advertisement, *Albany Argus,* Albany, New York, October 24, 1815, America's Historical Newspapers.

therefore cheaper, labor. When it came to shearing machines, advertisements often made claims like this one: "a lad of a dozen years of age, is capable of working them by hand, and can shear as much as three journeymen can do with hand shears, and do it equally as well."[154] Though shearing machines could reputedly be operated by unskilled children, maintaining them, and using them to produce well-finished cloth still required certain specialized skill sets. While an unskilled worker might have been able to operate a well-adjusted machine, a skilled craftsperson of another sort was needed for maintenance and adjustments. Some shearing machine advertisements stated that their machines were simple and easy to maintain. Others demanded that potential buyers visit the maker's shop for a demonstration of the machine and to prove they understood its workings and could operate it prior to purchase.[155]

While it is easy to see the goal of textile innovations in this era as a de-skilling of cloth production, the reality is not quite so straightforward. David Jeremy argues that it would not have been possible to introduce many technologies had the processes being mechanized not been familiar to the craftspeople overseeing their operation. While the mechanisms of cloth finishing evolved, the goals of the process remained the same.[156] Though it might well have been possible to employ young boys to operate mill equipment, to properly finish cloth, it was still necessary to have a skilled

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[154] Advertisement, *Mirror Of the Times, & General Advertiser*, Wilmington, Delaware, December 25, 1804, America's Historical Newspapers.

[155] Advertisement, *American Watchman*, Wilmington, Delaware, July 25, 1810, America's Historical Newspapers; Advertisement, *Albany Argus*, Albany, New York, October 24, 1815, America's Historical Newspapers.

[156] Jeremy is referring specifically to the transfer of British textile technology to America. Jeremy, "British Textile Technology Transmission to the United States," 36.

craftsperson on hand who understood how to use the new tool to achieve traditional results. Likewise, without access to a mechanic, machines could fall out of repair, and become much less efficient than hand processes. The challenges of maintaining equipment in an operable condition are suggested by the 1820 manufacturing census. The census returns listed manufacturing businesses in each state and included both a column for the machinery owned by each factory, as well as a separate column for how much of that equipment was functional.[157]

Former curator of the American Textile History Museum, Laurence Gross's article, "Wool Carding: A Study of Skills and Technology," uses another early nineteenth-century textile technology to explain how the operation of a carding machine was not simply about de-skilling workers. In his own attempts to return a vintage carding machine to operation, Gross proved to himself that diagrams and descriptions were not enough to bring the machine to life. He states that to maintain a machine of this nature, the carder needed a wide range of skills including knowing how to properly oil the wool and distribute it on the machine, as well as the ability to maintain the machine, replacing parts as they wore out, and even make miniscule adjustments as changes in weather caused wooden parts to shrink and swell. While not individually challenging, together these skills were more complex than the simple operation of hand carding.[158] Gross's findings are substantiated by my own experience visiting in the Old Sturbridge Village carding mill. The carding machines were

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[157] United States and Census Office, *Records of the 1820 Census of Manufactures.* (Washington: National Archives, National Archives and Records Service, General Services Administration, 1964).

[158] Gross, "Wool Carding," 804–5, 810.

comparatively easy to run, but still needed attention during the few hours they operated while I was at the site. Tom Kelleher, Old Sturbridge Village's Curator of Mechanical Arts, had to adjust the belts which transferred the mill's power to different parts of the machine, as they had stretched, a task which he did himself, rather than hand it off to a less experienced staff person. While shearing machines certainly had different requirements than carding machines, the variety of skills needed to maintain and operate them is comparable. Experienced fullers, who skillfully monitored and adjusted their fulling stocks, had a similar relationship to those machines. An understanding of the desired result of the machine needed to be paired with sufficient mechanical skill to achieve it.

It would not be possible to understand the post-1790 American textile manufacturing landscape without factoring in the new woolen finishing technologies, as they played an essential role in the rapidly changing manufacturing landscape of the Early Republic. However, for the purposes of understanding cloth finishing, these machines also serve another function. They illustrate the priorities of American woolen manufacturers to improve the quantity, and perhaps also the quality, of woolen cloth finishing in the young country. They also help us to understand the exact nature of the skills required for cloth finishing, by illustrating how those skills were re-created using machines.

Chapter 4

THE CRAFT OF WOOLEN FINISHING

We can seek to understand this craft in many different ways: by exploring the physical and social spaces in which cloth finishing took place, through contemporary texts which describe the various processes involved, through the inventions designed to simplify woolen finishing, and by examining the textiles which had their functions defined by American cloth finishers. Words, images, and even objects which have survived aid us in developing a sense of cloth finishing as a business and a historical reality. To understand cloth finishing as a craft, however, is another thing. Definitions of craft typically make reference to both skill and to work done by hand. Both of these elements of craft effect the finished product; however they reside not in the object itself, but in the process of its creation. It is that skill, contained within the hands of craftsmen whose apprentices have long since ceased to pass down their knowledge, which is so hard to access through either traditional historical research, or even through material culture studies.

Tim Ingold's 2012 book *Making* proposes that the act of doing or making can produce unique knowledge which cannot be found in other sources.[159] Pamela Smith's "Making and Knowing" project through Columbia University has applied similar ideas to the translation of a sixteenth-century manuscript by an anonymous author-practitioner. Smith and her team recreated recipes contained within this manuscript in order to better understand the text itself.[160] This thesis's focus on

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[159] Ingold, *Making*, 6–9.

[160] Smith, "Historians in the Laboratory," 215.

understanding a particular series of craft processes, and the heavy use of period instruction manuals for sources, makes it an excellent candidate for this form of knowledge-gathering.

Textile historians have used this methodology before to explore craft processes of the past. In 1980 Adrienne Hood used her background as a craftsperson to further our understanding of North American textiles by weaving reproductions of a series of historic fabrics, and distributing swatches of those fabrics to a handful of institutions, where other craftspeople and scholars have been able to make use of them.[161] More recently, Jane Malcolm-Davies has crowd-sourced the production of experimental knitting swatches as part of a study aiming to better understand the yarns used in Early Modern British knitwear.[162] In the final chapter of this thesis, I too use making as a means to knowing, in order to access the craft knowledge of early American cloth finishers.

Recreating William Guthrie's Fulling Order

One of this thesis's main objectives is to highlight the importance of finishing, and in particular fulling, in the production of woolen textiles. To explore exactly how defining finishing could be to a cloth's function, I recreated a single fulling order in Hannah Wilson's day book for the Broad Run fulling mill. I chose to recreate William Guthrie's 1822 order in which two, twelve-and-a-half-yard pieces of flannel were

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[161] Adrienne D. Hood, *Reproducing Nineteenth Century Handwoven Fabrics: A Weaver's Technical Guide to Accurate Reproductions* (A. D. Hood, 1980).

[162] Malcolm-Davies, "An Early Modern Mystery: A Pilot Study of Knitting, Napping and Capping," 65–74.

finished for men's wear and for women's wear.[163] I selected this order because both the identical lengths of the two pieces of cloth, and the date on which they were delivered, suggest that these pieces were in fact two halves of the same web of cloth. This meant that the differentiation which, in essence, gendered these two lengths of fabric occurred entirely within the fulling mill.

Though my own background as a craftsperson gave me confidence to undertake this project, I went into it as neither an expert weaver nor particularly practiced in cloth finishing.[164] In order to carry out this project successfully, I worked with master weavers Justin Squizzero, Kate Smith, and Norman Kennedy. While Squizzero reproduced the textile, Smith and Kennedy shared their experienced in cloth finishing and helped me to develop a successful fulling technique.

Defining Flannel

The first challenge of this project was that of understanding exactly what type of cloth David Harry finished for William Guthrie in the winter of 1822 (figure 40). The exact wording of the order is:

> 12 ½ [yards] Wm. Guttry [sic] Brandywine ^manner womens ware
>
> 12 ½ D[itt]o flan[nel] mens ware.

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[163] Wilson, *Daybook, 1821–1823.*

[164] My own academic and professional training as an historical costumer meant that I entered this project with a strong understanding of textiles, as well as an appreciation for craft expertise. My time working as the Head of Costume at the upstate New York living history museum, Fort Ticonderoga, proved to be an invaluable opportunity to explore the connections between the historical record and the recreation and wearing of historical garments. That experience has deeply informed this project.

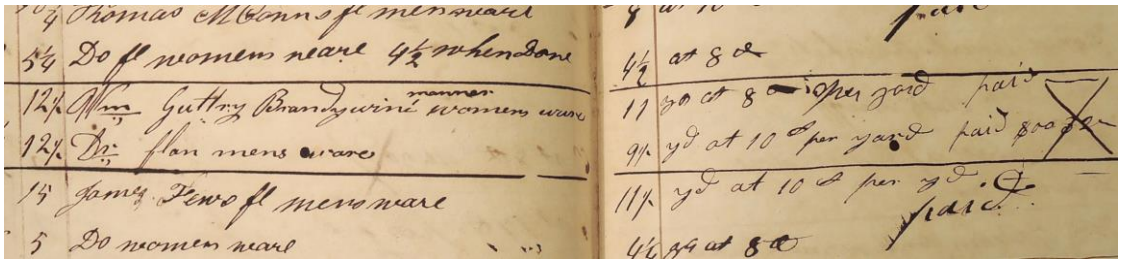

Figure 40 William Guthrie's fulling order in Hannah Wilson's day book from November of 1822. *Courtesy of Chester County Historical Society Library, West Chester, Pennsylvania. Photo by the author.*

The corresponding column on the opposite page lists the finished lengths and prices:

> 11 yards at 8 [cents] per yard. Paid. 88 [cents total].
>
> 9 ½ yards at 10 [cents] per yard. Paid. 94 [cents total].

The exact meaning of "Brandywine manner" women's wear is likely lost to history. It may have referred to some element of the finish, or possibly it described a textile produced by one of the Brandywine woolen factories which Guthrie desired Harry to replicate. Despite this mystery, it seems reasonable that both lengths of cloth were what was known in Hannah Wilson's day book as "flannel." This is the most common textile term used in Wilson's accounts. In fact, the orders both above and below Guthrie's are both for flannel. Both include lengths to be finished for men's and women's wear. Before I could attempt to reproduce this cloth, I needed a definition of flannel.

One of the biggest challenges faced by textile historians lies in identifying the meanings of different textile names. According to Merriam Webster's Dictionary, flannel is "a soft twilled wool or worsted fabric with a loose texture and a slightly napped surface" or "a napped cotton fabric of soft yarns simulating the texture of wool

flannel."[165] Florence Montgomery quotes William Beck's *The Draper's Dictionary* in *Textiles in America, 1650-1870*, defining flannel as "made of woolen yarn 'slightly twisted in the spinning, and of open texture, the object in view being to have the cloth soft and spongy, without regard to strength.'"[166] This softness is what is most commonly associated with flannel. While the fiber, and even the weave structure (sometimes twill and sometimes plain woven) can vary,[167] flannel is meant to be a soft to the hand. Historically it was often used for garments which were worn near the skin, such as shirts or inner petticoats.[168] That soft texture was achieved by raising a nap on the surface of the cloth. Other definitions of flannel explicitly describe it as a cloth which is not fulled. In his *Family Director*, Atkinson states that flannels "undergo no shrinkage in fulling."[169] This finishing process, consisting of napping, but no fulling (or shearing, for that matter), might be considered the true definition of flannel, since so many other factors in its makeup are not fixed. It is the finishing process which makes flannel soft, and it is flannel's softness which gives it its utility as a textile which can be worn next to the skin (figures 41 and 42).

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[165] *Merriam-Webster*, s.v. "flannel (n.)," accessed March 17, 2019, http://www.merriam-webster.com/dictionary/flannel.

[166] Montgomery, *Textiles in America, 1650-1870*, 238.

[167] Eric Kerridge, *Textile Manufactures in Early Modern England* (Manchester, UK; Dover, N.H.: Manchester University Press, 1985), 108–10. Kerrige discusses examples of mixed fiber flannel. I have not heard of references to cotton flannel prior the 20th century.

[168] Kerridge, 108.

[169] Atkinson, *The Family Director*, 42.

Figure 41 This shirt or under-waistcoat which belonged to Admiral, Lord Nelson, is an example of the types of garments often made from flannel. *Nelson's Shirt*, c.1800. *Royal Museums Greenwich*. Object ID: ZBA4566.

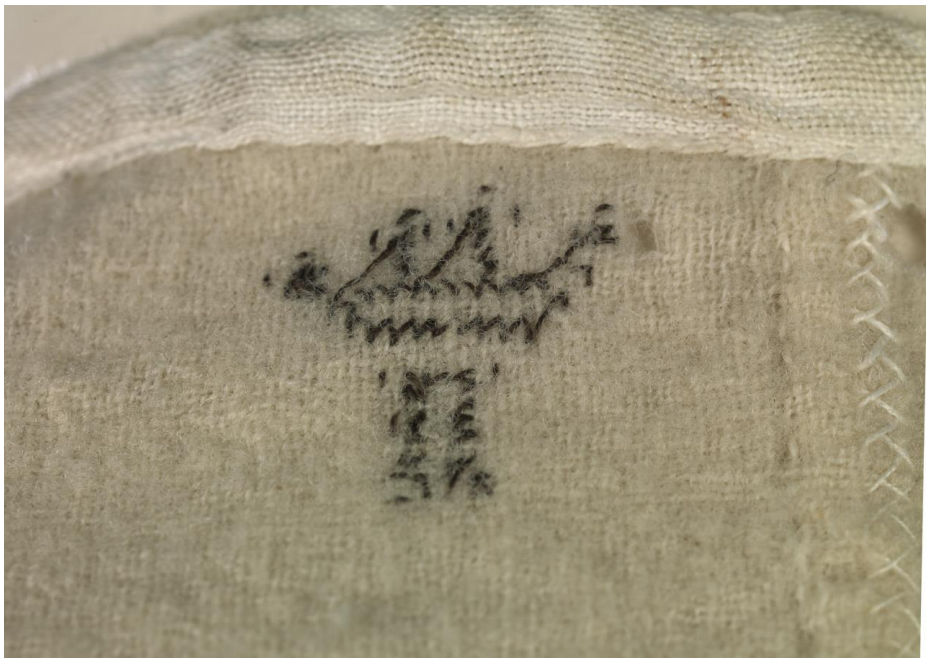

Figure 42 This close-up of the textiles of Nelson's shirt shows the loose weave and soft napped finish typically associated with flannel. *Nelson's Shirt*, detail of textile and laundry mark, c.1800. *Royal Museums Greenwich*. Object ID: ZBA4566

A definition of flannel as a soft, un-fulled, fabric with a brushed surface, commonly made of wool or cotton, unfortunately fails to account for a variety of facts which clearly pertain to the flannel detailed in the Broad Run mill's accounts. William Guthrie's order, as well as those surrounding it in the day book, record the degree to which each length of fabric shrank in the finishing process. Clearly the flannel referenced in this account book *was* fulled. Additionally, the Broad Run Mill account book also makes plain that there wasn't just one way to finish flannel, instead categories existed which defined the cloth further as suitable for women's garments, when it was only lightly fulled, or for men's, in which case it was shrunk a considerable amount.

One more complicating factor is also relevant. Atkinson uses the phrase "in the flannel" to describe textiles before they are fulled, while Partridge states that "a cloth [straight] from the loom is called a say, or flannel."[170] If flannel can refer to a textile which simply had not yet been fulled, then the entries in the Broad Run Mill account book might refer to the cloth both when it enters the mill as flannel (which is to say, cloth *in the flannel*) and, separately, to the cloth when it leaves the mill (now defined as men's wear or women's wear). This explains why the term flannel is used in reference to a textile which has clearly been fulled. Unfortunately, this explanation is also flawed. Newspaper advertisements exist for the Broad Run fulling mill, and in 1820, under the ownership of Andrew Wilson, the mill sold yard good of "flannel for Men's and Women's ware," making it plain that the word flannel was not simply being used to describe cloth prior to the fulling, but was also in use for the finished cloth which had undergone not only napping, but also significant fulling.[171] As is the case with many historic textiles, no one definition perfectly encompasses the meaning of the word flannel. Variation was possible in virtually every step of this one textile's production. For the purposes of this experiment, the fact that flannel is used to describe the majority of textiles processed at the Broad Run mill suggests that it was a typical home-produced cloth, and therefore almost certainly a relatively straightforward textile to create.

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[170] Atkinson, 43; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere,* 78.

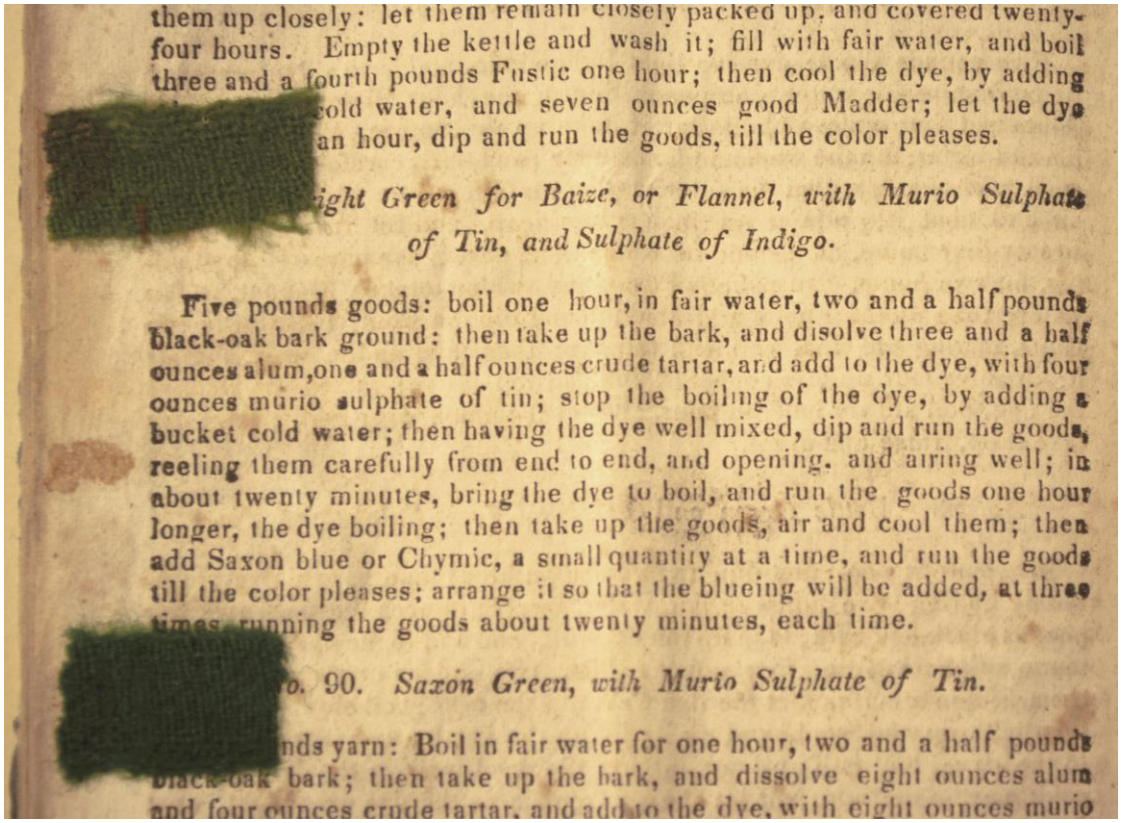
[171] Advertisement, *Village Record*, West Chester, Pennsylvania, November 1, 1820, America's Historical Newspapers.

Designing the Reproduction Flannel

Despite these challenges in clearly defining the textile referred to in William Guthrie's fulling order, it was still possible to approximate a textile which could yield helpful information about how the Broad Run Fulling Mill had worked. Justin Squizzero and I discussed at length the best way to reproduce a textile which might be roughly equivalent to the flannel described in the account books of the Broad Run fulling mill. Combining my research with Squizzero's craft knowledge, we decided how finely the cloth should be woven, and selected a suitable yarn. The very few extant flannels and all of the American-made woolens I had had a chance to examine were woven with a plain weave structure of singles, or un-plied, yarn. We based the gauge of the cloth (the number of warp and weft threads—also known as ends and picks—per inch) on dye swatches glued into the pages of Matthew Atkinson's *Family Director* (figure 43) and a men's flannel under waistcoat in the collections of Colonial Williamsburg (figures 45 and 46).

The reproduction cloth was set to 32 ends per inch, with the goal of making the cloth as square as possible, meaning that the number of picks per inch and ends per inch would be equal. In the end, Squizzero wove the cloth with 28 picks per inch, a compromise which resulted from the challenges he encountered working with the fine woolen yarn, which was prone to breakage. This was slightly coarser than the flannels I examined, but we knew that the thread count would increase as the dimensions of the cloth shrank in fulling. The resulting cloth was comparatively tightly woven, meaning that there was not much space between the threads. This produced a stronger, and more stable fabric, but also meant that the threads had less room to move during fulling, resulting it a denser fabric. I hoped that a tightly-woven fabric would help to

prevent the unattractive “cockling” which was described by the Bronsons, and in evidence in several of the American-made woolens I studied.[172]



them up closely: let them remain closely packed up, and covered twenty-four hours. Empty the kettle and wash it; fill with fair water, and boil three and a fourth pounds Fustic one hour; then cool the dye, by adding [redacted]old water, and seven ounces good Madder; let the dye [redacted]an hour, dip and run the goods, till the color pleases.

[redacted]ight Green for Baize, or Flannel, with Murio Sulphate of Tin, and Sulphate of Indigo.

Five pounds goods: boil one hour, in fair water, two and a half pounds black-oak bark ground: then take up the bark, and disolve three and a half ounces alum, one and a half ounces crude tartar, and add to the dye, with four ounces murio sulphate of tin; stop the boiling of the dye, by adding a bucket cold water; then having the dye well mixed, dip and run the goods, reeling them carefully from end to end, and opening, and airing well; in about twenty minutes, bring the dye to boil, and run the goods one hour longer, the dye boiling; then take up the goods, air and cool them; then add Saxon blue or Chymic, a small quantity at a time, and run the goods till the color pleases; arrange it so that the blueing will be added, at three times running the goods about twenty minutes, each time.

[redacted]o. 90. *Saxon Green, with Murio Sulphate of Tin.*

[redacted]nds yarn: Boil in fair water for one hour, two and a half pounds black-oak bark; then take up the bark, and dissolve eight ounces alum and four ounces crude tartar, and add to the dye, with eight ounces murio

Figure 43 Green dye samples of wool flannel. These samples have a thread count of approximately 35 picks by 44 ends. In *The Family Director*. By Matthew Atkinson. (Carrollton [Ohio]: Printed by John Hudson, ca. 1844, 28.) *Courtesy, the Winterthur Library: Printed Book and Periodical Collection.*

[172] Bronson and Bronson, *Early American Weaving and Dyeing*, 49.

Figure 44 Under Waistcoat, Bell Hall, Yorkshire, England, 1800-1830, wool, linen, and silk, accession number: 2018-126, Image number: D2018-JBC-0406-0004. *The Colonial Williamsburg Foundation. Museum Purchase.*

Figure 45 The light-weight woolen flannel used for this waistcoat has a thread count of 39 picks by 43 ends. The fabric is loosely woven, and has been napped, but not fulled significantly. Detail of Under Waistcoat, Bell Hall, Yorkshire, England, 1800-1830, wool, linen, and silk, accession number: 2018-126. *Photo by Eliza West with permission of The Colonial Williamsburg Foundation. Museum Purchase.*

Yarn selection proved to be another challenge. Singles yarn consists of just one strand of twisted fiber. It is much better suited to meshing with the other yarns in a piece of cloth—a key goal of a fulled textile—but it lacks the strength of plied yarns.

Additionally, to weave cloth at 32 ends per inch required a very fine yarn. Such yarns can easily fray and break during the tension of weaving. Because of this, it is an uncommon choice for hobby weavers today, and so sourcing was a challenge. In the end, we purchased Supersoft yarn from the British yarn manufacturer Knoll.

Yarn is measured in many different ways, but the unit used in the Philadelphia region starting in the eighteenth century measured how many 300-yard skeins (or cuts) of yarn equaled one pound in weight. In this type of fixed-weight unit of measure, a higher number indicates finer yarn.[173] By this system, the yarn we purchased was 19 cut.[174] John Chamber's 1818 advertisement for his woolen factory near Kennett Square, Pennsylvania, listed the different fabrics he could manufacture, with prices based on the cut of yarn. The mill wove and spun yarn from 8 cut, up to 20 cut. The 8 cut yarn was used in blankets. Flannel was manufactured from 12 cut yarn. Chambers also sold "cloth"—referring to a fulled woolen textile—made of anything from 12 cut to 20 cut yarn. According to this advertisement, the fabric we produced for this project more closely resembled "cloth" than flannel. Unfortunately, this particular advertisement surfaced after the yarn for the project had already been purchased, but it does clarify that the Knoll Supersoft was within the range of yarns being produced and made into cloth in early-nineteenth-century Pennsylvania.[175]

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[173] David J. Jeremy, "British and American Yarn Count Systems: An Historical Analysis," *The Business History Review* 45, no. 3 (1971): 352, appendix, https://doi.org/10.2307/3113665.

[174] Knoll uses the metric yarn count system and states that their Supersoft yarn is Nm11.5/1, or 11.5 kilometers per kilogram, and single ply.

[175] *Village Record*, May 18, 1818, Newspaper Clippings Collection: Industry Files: Wool Carding, Chester County Historical Society Library, West Chester, PA.

When it comes to fulling, not only the gauge, weave structure, and yarn, but also the type of wool fiber itself is essential to how the cloth will turn out. Ideally, this cloth would be made from the fleece of heritage sheep breeds known to have been present in Pennsylvania in 1820; the next best solution was fleece with a similar fiber diameter to that which might have been present the region. The American wool supply was decidedly mediocre in the eighteenth century. Americans owned sheep in large part for the meat and fertilizer they produced. In some ways their fleece was a by-product, and little care was taken to breed sheep for superior wool.[176] This changed upon the introduction of merino sheep from Spain in 1801 by the du Ponts, who sought to improve the American wool supply. This Spanish breed produced fine, high-quality fleece, and records of the du Pont woolen ventures show extensive cross-breeding of their merino stock with other breeds. Merino wool fibers have an average diameter of 20 to 25 microns, while the less refined American fleeces were almost certainly coarser, with fiber likely ranging up to 40 microns in diameter.[177] The wool used in the Knoll Superfine yarn is a mixture of a New Zealand wool with an average fiber diameter of 29 microns, and a South American wool with an average fiber diameter of 21 microns, resulting in an overall average of 25 microns.[178] Though likely slightly finer than the average wool available in Chester County, Pennsylvania,

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[176] Hood, *The Weaver's Craft*, 57–58.

[177] Michael L Ryder, "The Evolution of the Fleece," *Scientific American* 256, no. 1 (1987): 115; Gordon, *The Final Steps*, 1–7, 23–26.

[178] David Oxley (Sales Manager, Knoll Yarns), email to author, January 28, 2019.

in 1822, this wool is still within a reasonable range of what would have been available to local cloth producers at the time.

Considerations of fiber, yarn, and thread count were essential for this project because each effected how the cloth would full. For this project to be a meaningful recreation of a textile which might have been processed at the Broad Run mill, each of these factors needed to be within a reasonable range of what was available and produced in that region. These were the same factors that effected how David Harry chose to full each piece of cloth which customers sent to the Broad Run mill.

Making and Finishing the Cloth

Justin Squizzero runs his weaving business out of the parlor of his 1810s house in rural Newbury, Vermont (figure 46). He wove the thirty yards of cloth for this project (the 25 of Guthrie's original order, and an additional five for experimentation) on a nineteenth-century barn loom. On the loom, the web of cloth looked nothing like the fabric used in any part of men's or women's clothing of the 1820s. Though the cloth was tightly woven, the weave structure was readily apparent, and it was possible to see through the minute gaps between the threads. Throughout this re-creation, I struggled to cast my imagination into the future to imagine how this cloth would look once it had been finished. At no point was that more challenging then when the cloth was on the loom. Once removed from the loom, I worked with Squizzero to mend the cloth, or weave in the ends of warp threads which had broken and been repaired in the weaving process (figure 47).

Prior to washing, the cloth was surprisingly stiff; it still contained grease from the spinning process which I needed to wash out before proceeding to the finishing process. To do this I followed the directions provided by the yarn manufacturer, which

also happened to approximate the requirements of the period textile manuals. I used 100-degree Fahrenheit water and Dawn dish soap, a reliable and relatively neutral detergent, recommended by Kate Smith from her own years of experience, and gently washed the cloth in a bathtub. The initial wash water was brown, illustrating the importance of this step. The two twelve-and-a-half-yard pieces of cloth, which had originally weighed a little over 4.5 pounds apiece, each lost just under an ounce of weight by washing out the grease.

Figure 46 The first few woven inches of reproduction cloth on Justin Squizzero's loom. *Photo by the author.*

Figure 47 Darning in warp threads which had to be repaired during weaving. This process involved threading the broken yarn ends onto a needle and reweaving them into the cloth for a short distance. *Photo by the author.*

After scouring, I worked with Kate Smith to develop a fulling method which would produce results equivalent to those which David Harry had achieved on William Guthrie's cloth. Namely, shrinking one length of cloth down to as close to seventy-six percent of its original length as possible, and the other down to eighty-eight percent of its original length, to replicate the shrinkage documented in the mill book. We also aimed for consistent shrinkage, with the minimum warping or cockling of the textile. Since we unfortunately lacked access to historical fulling stocks to accomplish this task, we sought a method that would allow us to replicate the key features of fulling stocks: prolonged agitation and compression applied to warm, wet, soapy fabric. Searching for a means to produce the effects of a fulling mill resulted in thinking through the fulling process in new ways. As I discussed how to reproduce a specific fulling effect with both Smith and my father, I worked through many aspects

of how a fulling mill worked which I had not been forced to address previously. This ended up being one of the most fruitful aspects of this project.

I had set aside five yards of cloth to use as sample pieces to test out fulling methods before finishing the two more substantial lengths of cloth. Smith and I experimented with both manual and mechanized methods of reproducing the effects of a fulling mill. The former methods included tromping on the cloth in a tub of warm soapy water and pounding it with mallets. Neither of these tests produce results, though both are traditional forms of fulling, and might easily have worked if we had been able to sustain them for several hours. Conversation with Norman Kennedy, the authority on the waulking traditions of Scotland, highlighted that in that country, manual fulling is typically practiced on tweeds, which have a twilled weave structure, making them faster to full.[179] It was much harder to get this fine, tight, plains-woven cloth to shrink and felt the way we wanted it to.

Since we sought to reproduce the effects of a fulling machine, it made sense for us to experiment with mechanical fulling methods as well. We turned to the source of much accidental felting of wool sweaters – the washing machine. Designed specifically to agitate wet and soapy cloth without human supervision or effort, modern washing machines effectively imitate many qualities of early fulling mills. Our initial experiment with the washing machine used hot water and a top-loading machine. This successfully replicated the degree of shrinkage noted in the Broad Run Mill day book for William Guthrie's order for men's wear. Though the cloth shrank a lot, it lacked many of the qualities of well-fulled woolens. It took only about two hours

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[179] Norman Kennedy, conversation, January 20, 2019; Gordon, *The Final Steps*, 1–7, 23–26.

to shrink the cloth by 24% in hot water. However, the cloth shrank unevenly, and while the surface was very fuzzy and fluffy, the yarns of the cloth itself had not felted to each other. Pressing helped, but it was still far from the product of expert finishing.

To improve the results we had gotten in our first washing machine trial, I used a warm cycle instead of hot, and switched from a top loading washer, which relies on the cloth constantly sitting in a pool of water, to a front loading washer, which tumbled the wet cloth instead. To produce a higher degree of impact and compression, and hopefully producer a firmer and less-fluffy surface, I introduced a number of hard rubber lacrosse balls to the washer which were carried to the top of the washer drum by the interior baffles, before falling and impacting with the cloth. Throughout the process I continued to use Dawn dish detergent as a fulling agent, adding a small amount every time the cloth no longer felt sudsy.[180] With the knowledge that the cloth was capable of shrinking the amount we were hoping for, I patiently ran a one-yard sample through the machine a total of twenty times, or about seventeen hours. This produced a similar shrinkage rate to that achieved by the hot water machine wash, but the cloth showed less distortion. The surface was also much less fluffy, and when held to a window, less light shone through it. The hand, or feel, of this cloth also more closely resembled that of a range of extant men's garments made of woolen cloth. Developing a successful fulling technique using a washing machine involved balancing my theoretical understanding of the process with the results of

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[180] The use of a modern detergent made of synthetic surfactants likely produced maginally different results than would have bee achieved through the use of stale urine or soap. However, I chose to use it anyway because of the consistency which using a carefully formulated detergent permitted and Smith's prior positive experience with it.

experimentation, while being guided by my understanding of period textiles which I hoped the end product would resemble.

After having experimented with a variety of techniques, I moved on to fulling the two large pieces of cloth. I first processed the thicker men's wear flannel. It rapidly became apparent that with twelve times as much fabric in the washing machine, the half dozen individual lacrosse balls I had initially used to create compression were no longer sufficient. To amplify their ability to forcefully impact the cloth in the washer, I purchased a dozen more balls and grouped them together in fours by sewing them into small cotton muslin bags (figure 48). These packages were much heavier and more effective. Despite this, the fulling was slow going. While my men's wear test sample

Figure 48 The muslin lacrosse ball "packages" which I used to aid fulling in the washing machine. *Photo by the author.*

had taken almost twenty hours to full, the twelve-and-a-half-yard piece took half again as long. The flannel for women's wear took less time, and in fact, by the time I processed that second length of cloth, I was so confident in my technique that I slightly over-shrank the cloth.

The cloth occasionally became twisted in the machine. In order to ensure that it was not getting pulled out of shape, and to manually assess the progress of the fulling, I followed the advice laid out in the period finishing manuals and pulled the cloth out of the washing machine every two to three hours, felt and inspected the finishing, and loosely accordion folded it before putting it back into the machines (figure 49).

Figure 49 I took the cloth out of the washer, untangled, and re-folded it every few hours. Here, the cloth is folded at the beginning of a new wash cycle. *Photo by the author.*

I used several metrics to gauge the degree of fulling: I checked whether the yarns were felting together by looking for pinpricks of light between them when the cloth was held to a window; I measured the width of the cloth, as well as the length between markers which Squizzero had woven into the selvedge every yard, to gauge how much it had shrunk (figure 50); I also observed how fuzzy the surface of the cloth was, and how visible the weave structure was beneath the fibers which were starting to mat on the surface (figures 51 to 54, and Winterthur Copy: Appendix B). This final test was tactile as well as visual; I felt the cloth with my fingertip to assess whether the ridged bumps of the individual yarns were starting to meld together. I also felt for how fuzzy the cloth had become. Throughout these observations, I kept in mind that the cloth was wet, and that the finish would change still further after the cloth dried. Since I was aiming to replicate an exact degree of shrinkage in length, this meant being aware of the fact that the cloth lost an inch of length per yard in length when dry.

It is likely that a fuller like David Harry, when gauging a fabric for a specific use, relied primarily on long-standing experience, found in both his in brain and his fingertips. Some fullers, especially those who worked for textile factories, fulled cloth to standardized widths and lengths. For example, John Chamber's woolen factory near Kennett Square, Pennsylvania, which sold flannel which was one yard wide, and thick, or fulled, flannel which was 7/8ths of a yard wide.[181] Customers who brought their woolens to country fulling mills and specified an end use to the fuller likely relied on the fuller's expertise to determine when the texture of the cloth had sufficiently transformed to meet their needs. In my recreation of these two textiles, I was able to

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[181] *Village Record*, May 18, 1818, Newspaper Clippings Collection: Industry Files: Wool Carding, Chester County Historical Society Library, West Chester, PA.

rely on measurements to guide my sense of how long to full the cloth. Without the experience of an expert craftsman, I would have struggled to accurately judge when the cloth was ready to be removed from my make-shift fulling stocks.

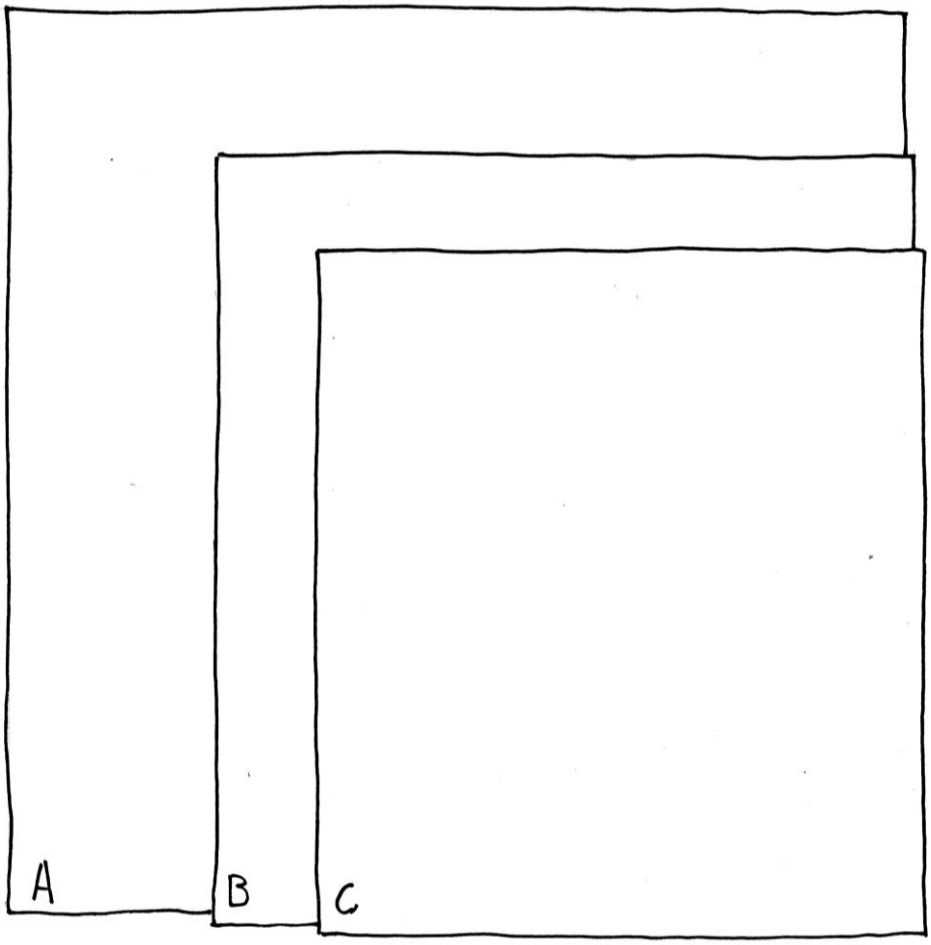

Figure 50 Diagram of the degree of shrinkage which occurred in both the women's wear cloth (B) and men's wear cloth (C) in fulling. **Square A** represents a 36" by 36" square of un-fulled cloth. **Square B** represents an identical piece cloth fulled for women's wear, which after fulling was 29.5" long by 28" wide, or 64% of the original surface area. **Square C** represents a piece cloth fulled for men's wear, which after fulling was 26.5" long by 24.5" wide, or 50% of the original surface area. *Illustration by the author.*

Figure 51 Close-up of unwashed cloth in raking light. *Photo by James Schneck, Winterthur Museum.*

Figure 52 Close-up of washed cloth in raking light. *Photo by James Schneck, Winterthur Museum.*

Figure 53 Close-up of "women's wear flannel" in raking light. The cloth shown here lost fifteen percent of its length in fulling. While it is clearly much fuzzier and more felted than the washed cloth, it is still possible to see some of the woven structure. *Photo by James Schneck, Winterthur Museum.*

Figure 54 Close-up of "men's wear flannel" in raking light. The cloth shown here lost twenty-five percent of its length in fulling. This cloth is so heavily fulled that the woven structure is entirely obscured. *Photo by James Schneck, Winterthur Museum.*

This fulling process yielded largely positive results. The men's wear flannel became thick and dense, and notably much softer than the cloth had been prior to fulling.[182] The surface of the cloth was raised and fluffy, helping to obscure the weave structure beneath. Despite this, when felt between thumb and forefinger, the cloth had a fine puckered texture, almost like seersucker. I remain unsure of exactly what caused this effect and believe it to be a form of the cockling described by the Bronsons' and in evidence on several early American extant woolens. Given that the goal of this project was to explore the experiences of early American country fullers, this seemed to be a particularly fitting flaw.

This project's aim was to explore how one piece of cloth could be transformed into two different textiles. In this regard it was successful. While the flannel for men's wear is so densely fulled that it has become stiff and structural, the flannel for women's wear is a much thinner textile. The washing process softened the cloth significantly from the state it was in when it left the loom, and the relatively light fulling meant that this fabric maintained a degree of drape and fluidity, meaning it could easily accommodate the slender, flowing women's silhouettes of the early nineteenth-century. Though both textiles now had the fundamental qualities needed for their intended uses, the surface of the cloth still required polish.

Unfortunately, I was unable to nap and shear the surface of these textiles in the course of this project. Given the thickness of the finished textile, I feel strongly that William Guthrie's men's wear flannel would likely have been both napped and

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[182] The softness was likely largely a result of the constant washing in soap, as much as it was of the mechanical fulling process itself. Nevertheless, it made the cloth much more wearable.

sheared. On my recreated textile, shearing the cloth might have produced problems, as the cockled texture of the cloth would have made it challenging to shear the nap without accidentally cutting into the cloth. The women's wear flannel was likely napped as well, though it may not have been sheared. Finally, both pieces of cloth would have been pressed. This stage of the process I was able to replicate, using technology specially developed by Kate Smith at Eaton Hill Textile Works, which was designed to replicate the products of a historical press. The press radically transformed the appearance of the cloth. Each length of fabric was subjected to pressure and 275° Fahrenheit heat between flat plates for five minutes. The result was that the textile was compacted, creating both a denser fabric and a smoother feel. The pressing almost entirely eliminated the cockled texture of the cloth, though it was still apparent when examined closely (figure 55).

Creating a reproduction textile, and summitting it to two distinct degrees of fulling to produce two fabric with different properties brought a level of understanding to this thesis which would not have been possible without the making project. The process of researching, creating, and fulling this cloth required me to think through how each stage would affect the final fabric in a way which would not have been possible without the need to complete each step before I could advance to the next. This project also provided me with the chance to observe a single woven textile at several stages of completion. Early nineteenth-century woolen textiles, especially those with American provenances, are rare enough. Finding an example of a textile both before and after finishing is a much greater challenge. The extraordinary textile collection of eighteenth-century economist Anders Berch at Sweden's Nordiska Museet contains a set of samples showing the different stages of finishing of woolen

textiles. Sadly, however, the first sample in the series, showing the cloth prior to fulling, has been lost.[183] Through this project, I have been able to compare different stages of finishing on a single textile. This has proved to be an invaluable lesson for comprehending the extent to which woolen finishing is able to transform cloth (figure 56).

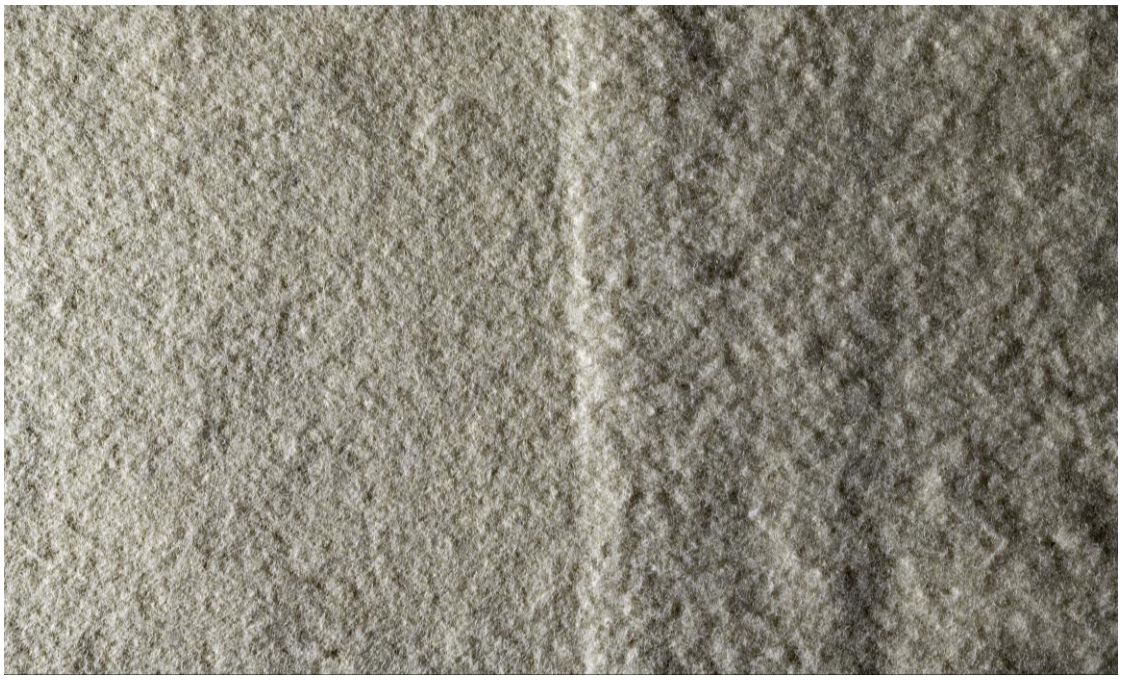

Figure 55 Detail showing the difference between the men's wear flannel before (right) and after pressing (left). The raking light clearly shows that the surface of the pressed cloth is much flatter and smoother than the unpressed cloth. *Photo by James Schneck, Winterthur Museum.*

[183] Nordiska Museet and Elisabet Stavenow-Hidemark, *1700-tals textil: Anders Berchs samling i Nordiska museet* (Stockholm, Sweden: Nordiska museets förlag, 1990), 141–42.

Figure 56 The finished men's wear cloth, showing a smooth surface finish and stiff, structural drape. *Photo by James Schneck, Winterthur Museum.*

Chapter 5

FINISHING REMARKS

The title of this thesis is a play on words intended to hint at its duel objectives: to advance the scholarship regarding the American cloth finishing trades in the critical years for American industry between 1790 and 1830, and to do so by accessing the experience and understanding of craft practitioners themselves. This approach has allowed me to explore how the skill and intention of textile makers affected the material landscape of the Early Republic. It has also illustrated both the importance and the versatility of American fullers by detailing the transformative nature of their craft on woolen cloth.

In December of 1807, Calvin Cooper made an entry in his day book for the Broad Run fulling mill (figure 57) recording an order placed by William Moode for

> 18 yds of cloth to be dyed middling dark drab. All but one yard [of] that cut off when middling flannel & raised. The rest milled fit for trowsers, then cut off as much as will make 6 yds of drest cloth for great coat.[184]

Moode's eighteen yards of cloth left the dye house a medium shade of gray-brown. When the whole piece had been only lightly fulled, shrinking from eighteen to perhaps sixteen and a half yards in length, Cooper pulled it from his fulling stocks and cut off a single yard. The rest he returned for further fulling. When he checked the cloth again and judged by feel that it was now a suitable weight for trousers, he cut it in half, reserving one seven-yard length, and returning the other to the stocks once again to shrink down at last to a length of six yards. This last and thickest piece Cooper napped

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[184] Cooper, *Textile Mill, Dyer, and Fuller Account Books, 1791-1815*, vol. 2.

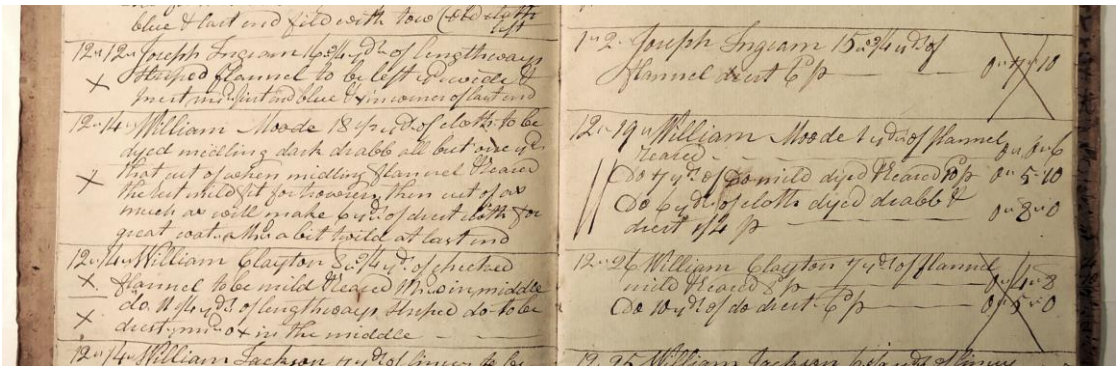

Figure 57 A page in Calvin Cooper's day book from 1807-1809 including an order placed by William Moode. *Courtesy of Chester County Historical Society Library, West Chester, Pennsylvania. Photo by the author.*

and sheared, producing a hefty textile with a handsome finish, suitable for a coat. This order exemplifies the versatility of American country fulling mills, just as it highlights the importance of woolen textiles for many different aspects of clothing and life in the Early Republic.

The creation of a fulled textile involved awareness of the cloth's final function from the very earliest stages and continuing as the wool passed through the hands of sorters, carders, spinners, and weavers, before finally arriving at the fulling mill where it went through yet another transformation, becoming cloth with a clear utility. Only at this point was that fabric suitable to be used, perhaps thrown over a bed as a blanket or cut and stitched into clothing. At every stage of its creation, woolen cloth is handled and altered by craftspeople. Likewise, the end goal of producing a textile is to create a material with which people will interact as clothing, insulation, and decoration for their homes. Textiles like this must be considered in the context of the relationships which exist between them, their makers, and their users. Only by looking at cloth in this light can we fully appreciate what it has to tell us. For woolen textiles, this story

cannot be considered complete without addressing the work and experience of fullers. These craftspeople wrought the final, and often most significant, change on these fabrics before they left the realm of production and entered the world of use.

This thesis begins to explore how fulling defines certain textiles. It lays out how the degree to and manner in which woolen cloth is finished can radically alter its suitability for different tasks. In the region around south-eastern Pennsylvania and the Brandywine Valley, the individuals who wrought these transformations often did so on a small scale, without the training and specialization expected in major centers of woolen manufacturing like Yorkshire or the west of England. These country fullers were versatile craftspeople. Though the application of their craft was often imperfect, the great diversity of work which they performed provides a key insight on woolen finishing's role in the made world of the late-eighteenth and early-nineteenth centuries. This was a craft which made possible a great degree of diversity and utility in domestically produced woolens.

Through this thesis I have sought to look at cloth finishing not merely as a trade in need of economic analysis or simply a means to an end of domestically produced cloth. Rather, my project has been to explore cloth finishing as a process and a set of skills, possessed and carried out by American craftspeople who both participated in and broke from traditions because of both the origins of and rapid changes to their society. To do this, I got my hands dirty (or rather clean, given the amount of soap involved) and sought to access the knowledge of fullers through experimentation. This undertaking was crucial to my research, as it allowed me to comprehend words and objects which would otherwise have refused to cough up their secrets.

It would be a disservice to the legacy of this craft, and to contemporary craftspeople as well, to ignore the information which can only be found within the process itself. In this thesis I have united the knowledge of both minds and hands to explore a single craft in detail. It is not easy to put the entirety, or even the true essence, of this research into writing, a fact confirmed by the attempts of period textile manual authors. I have sought to compensate for this through images and, in the print copy of this thesis which resides in the Winterthur Library, with textile swatches. The information I have gathered will be most useful, however, if other craftspeople take it into their workshops and use it as the basis of their own experiments. Likewise, I hope it serves as an example to other scholars to pursue knowledge not only by reading the words of past generations, but also by interacting with history through experimentation and tactile exploration.

This work is important because it helps to complete our understanding of early American textile production. More than that, though, I hope it stands as a reminder of the ingenuity which resides within craft traditions. After ceding its place first to cotton and then to synthetic material, in the twenty-first century, wool is making a come-back. However, for many decades wool was relegated to the realm of scratchy sweaters, and because of this our appreciation of wool's remarkable versatility has faded. Until two hundred years ago, knowledge of wool's extraordinary properties was common. Not only did most individuals wear wool, at least occasionally, a large portion of the population worked with the fiber as it was transformed into garments and other articles of use. With this thesis, I hope I have illuminated not only an aspect of that transformation, but also the value inherent in understanding how people practiced this transformative craft.

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Appendix A

GLOSSARY OF TEXTILE NAMES WITH ASSOCIATED FINISHES

Baize: Baize is a woolen cloth, commonly dyed green or brown and often used to cover tables. Florence Montgomery describes baize as a heavily felted textile, suitable for covering billiards table, but other descriptions imply a lighter textile:

Ellis: "Baizes, as they are designed to be both light and warm, should have but a light milling and napped on both sides."

Bemiss: "Baize or flannels should be fulled lightly."

Gott: "The Baizes, Surges Strouds Bockings are only brushed on the tenters."[185]

Bearskin: Bearskin is a thick, cloth with a long nap which evokes the appearance of fur.

Ellis: "Bearskins should be napped on both sides and fulled thicker than common cloths, as they are designed for winter garments."

Bemiss: "Some fulled cloths do not require shearing, which are dressed with a thick nap, sufficient to cover the thread…this kind of cloth is called bear-skin or coating. Bear-skin should be pressed in the cold press, never in the hot-press."[186]

Beaver Coating: Ellis: "Beaver coating, should be fulled closely, napped and shorne once even; then it should be teaseled, and left with a short, fine nap."[187]

Broadcloth: Broadcloth was woven on an extra wide loom so that the cloth was still quite wide (54 to 63 inches, according to Montgomery) even after extensive fulling. William Partridge refers to the final desire width for broadcloth being seven quarters of a yard.

Gott: "*Finishing Routine for Best Superfine Cloth.* When best Superfine Cloth is taken from the Mill it is first dryed on the Tenters, when dry it is taken off & well wet out and taken immediately to the Raising Board and given five throughs with old Teasels,

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[185] Montgomery, *Textiles in America, 1650-1870*, 152; Ellis, *The Country Dyer's Assistant*, 108; Bemiss, *The Dyer's Companion.*, 69; Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 301.

[186] Ellis, *The Country Dyer's Assistant*, 108; Bemiss, *The Dyer's Companion.*, 69.

[187] Ellis, *The Country Dyer's Assistant*, 108.

using the worst first, the sixth time use new ones (and if the Piece be very stout or a mixture it will one thro' with Flatter Cards)—in this state it is thrown on a Horse to sipe (about 10 ,minutes) if thin cloth it ought to be dryed before it is taken to the Shear Board where it is cut one over without raising the wool, (this operation is called cropping) it is then well wet out again and raised four times thro' with old Teasels on the Raising Board, it is then struck twice through with the flatter Cards at the Perch which stands in a Trough of Water, roll it up for Tenter and let it lay one day wet; then take it to the Tenter and strike it down with Cards and brush it, it is always stretched one yard to the score and it stamped 58 inch broad stretch it to 61, when dry take it to the shear Board and cut it three times over with the best finishing Shears and once on the back side."[188]

Cassimere: A twilled cloth with a noticeable diagonal rib. It was patented in 1766 by Englishman Francis Yerbury. Bronson and Bronson page 102 contains a weaving draft for Cassimere.

Gott: "The Slays [width at which the cloth is woven] of all Cassimeres single Milled Cloth are 34" inches wide—all double milled cloth are 42." "Cassimeres double milled are dressed the same as fine cloth. Singled milled always raised upon a whole wool—cut twice over, low priced only once."[189]

Coating: Gott: "The lowest priced coating are raised wet mostly with cards only two thro', tentered, brushed and dryed then run thro' the brushing mill, when worth about 4/6 or 5 Shillings they are lightly raised dry with cards and cut, then raised wet, dryed tentered and put thro' the brushing mill. The fine coatings are raised wet and brushed tentered and cut."[190]

Flannel: According to Bronson and Bronson, flannels "undergo no shrinkage in fulling." Instead they should be "woven closely, as the beauty and durability of this

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[188] Montgomery, *Textiles in America, 1650-1870*, 177; Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere*, 110; Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 301.

[189] Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 54, 297, 302; Montgomery, *Textiles in America, 1650-1870*, 192; Bronson and Bronson, *Early American Weaving and Dyeing*, 102.

[190] Crump, Rogerson, and Gott, *The Leeds Woollen Industry 1780-1820*, 301.

excellent article of dress, depend, in great degree, on bring well put together in the loom."

Bemiss: "Baize or flannels should be fulled lightly."[191]

Kerseymere: Montgomery says this is an alternate name for cassimere.

Ellis: "kerseymere… must be fulled lightly, and well dressed."[192]

Lambskin: Ellis: "Lambskin must be napped on both sides and not milled so thick as for shearing."[193]

Satinette (also Satinet): Because Satinette and Linsey (also known as linsey woolsey) had a wool weft on a cotton or linen warp, respectively, they only shrank in one dimension during fulling. Using only half wool created a fabric which would still full but could be produced more cheaply.

Bronson and Bronson: "As the shrinkage in lindseys and satinettes, in fulling, is all breadthwise, it is very important that, the weaving should be uniform as possible."[194]

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[191] Bronson and Bronson, *Early American Weaving and Dyeing*, 42; Bemiss, *The Dyer's Companion.*, 69.

[192] Montgomery, *Textiles in America, 1650-1870*, 273; Ellis, *The Country Dyer's Assistant*, 118.

[193] Ellis, *The Country Dyer's Assistant*, 108.

[194] Bronson and Bronson, *Early American Weaving and Dyeing*, 42.

Appendix B

TEXTILE SAMPLES (Winterthur Copy Only)

Textile swatches from the woolen finishing experiments described in Chapter Four can be found on the following page of the print copy of this thesis which resides at the Winterthur Library, 5105 Kennett Pike, Winterthur, DE 19735.

Woolen Cloth – washed but unfulled.

← Grainline (Direction of Warp) →

"Women's Wear Flannel" fulled by 15% in length.

← Grainline (Direction of Warp) →

"Men's Wear Flannel" fulled by 25% in length.

← Grainline (Direction of Warp) →

The Lefthand side of this swatch is UNPRESSED the righthand side is PRESSED

Appendix C

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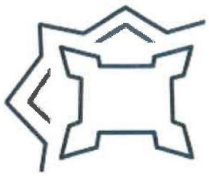

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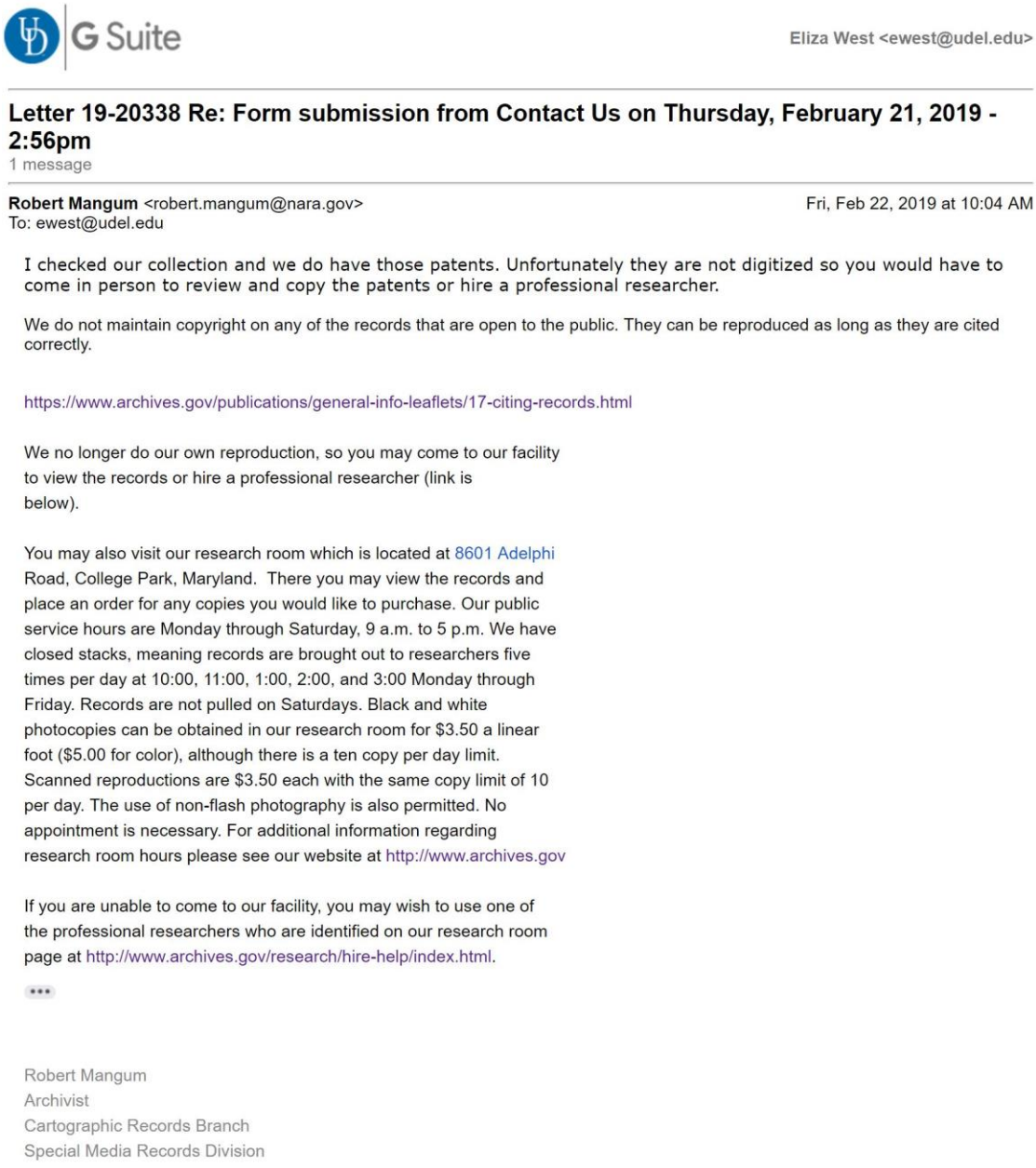

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