USE OF NONINVASIVE METHODS TO DOCUMENT THE CHARACTERISTICS OF SEWING THREAD USED IN US WOMEN'S DRESS ENSEMBLES FROM 1880 TO 1909

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(ABSTRACT)

This study was an historical garment study that investigated the similarities and differences between variables for thread characteristics, such as thread configuration, degree of twist, direction of twist, color, and color match grades of sewing thread used in assembling American women's dresses and suits during the time period between 1880 and 1909. Items were selected using a convenience sampling from the Smithsonian Institution, National Museum of American History, in Washington, DC, and The Valentine Museum in Richmond, Virginia. A total of 417 observations were collected from 39 garments. Noninvasive procedures were used to examine late nineteenth and early twentieth century garments and record sewing thread characteristics from multiple designated locations. Research objectives of the study included: 1) documentation of thread characteristics for machine-sewn seams, 2) documentation of thread characteristics for handsewn seams or stitchings, and 3) documentation of dominant thread characteristics by five year periods.

Frequency distributions and frequency distribution tables were completed. The results of this study revealed widespread use of one basic type of sewing thread for the total sample during the time period 1880-1909. Characteristics of threads

used in handsewn and machine-sewn seams or stitchings were 3/2-cord thread with high degree of twist and S direction of twist. It appeared that aesthetic concerns for color differences and matching contrasts of thread with the fashion fabric did not always coincide with use of threads with high strength.

Data analyses revealed recurring patterns. Results found for year to year observations were consistent with results found within the five year group increments. Dominant thread characteristics found within the group observations for chain stitch thread characteristics were also present in the lockstitch group observations and machine-sewn group observations. Patterns noted in observations for handsewn seams or stitchings were also similar to those found in machine-sewn seams.

Noninvasive methods were used for collection of data during the study. Methods used included naked-eye visual observations and hand-held microscope observations for recording seam, stitch, and thread characteristics.

TO—

Jerome, Benita, and Meshay,

and in loving memory of Brittany

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CHAPTER ONE - INTRODUCTION

Origin and Importance of the Study

The study of primary sources, such as clothing, provides an accurate view of social situations and physical environments for a particular time. Identification of historical garments and analyses of their type, structure, and components in context of use can provide extensive information about economic, technological, religious, and social practices. Helpful information includes whether or not the garments were altered, remade, or recycled. The analysis of garment structure details the technological capabilities available at the time period and for the location (Kite, 1989). Garments can also function as a means of communication and can be used to control and regulate social interaction (Prellwitz & Metcalf 1980). The analyses of garment use, type, and structure reveal iconographic value of garments, use by specific groups and at specific ritual times, and symbolic components of the garments (Merchant, 1982). The physico-chemical analysis of garment components may elaborate on cultural and technological choices made within the community (Sibley & Jakes, 1989).

Period identification of garments is accomplished in a number of ways. Detailed analyses of the garment's style, structure, type, and function are performed. These analyses focus on garment pattern pieces, construction techniques, embellishments, colors, and additional fabrications. Information provided by others through oral and written social histories is also used as an analytic tool (Farrell-Beck, 1992; Kite, 1989; Landi, 1992; Prellwitz and Metcalf, 1980). This information can establish and verify the time period and provenance of the object.

Today garment pieces may be form molded, glued, heat bonded, or stitched together (Glock & Kunz, 1995). Historically, stitching garment pieces with sewing threads has been the dominant means for assembling garments. Sewing thread is probably the most inconspicuous component of a garment, yet it serves many functions. This method for joining garment pieces is accomplished by working a threaded needle back and forth through fabric layers and may be accomplished by hand or by machine. The use of sewing thread is not restricted to garment assembly; it may also be used for attachment of closures and decorative trim. The stitch method is often used on a garment to secure closure features, such as buttons, zippers, snaps, and velcro. Decorative aspects of sewing thread include embroidery, top stitching, cross-stitch, appliqué, and quilting.

To date, research on nineteenth and early twentieth century women's clothing has been conducted on social communication and psychology (Paoletti, 1980; Prellwitz & Metcalf, 1980), apparel style, and garment structure. Belleau (1987) studied cyclical fashion changes of women's day dresses, using periodical illustrations from 1860 to 1980. Severa (1995) described mainstream American clothing styles from 1840 to 1900 based on extant photographs. Kidwell & Christman (1974) reviewed the increasing impact and demands for clothing for all economic classes. Farrell-Beck (1987) traced changes in nineteenth century construction techniques of U.S. women's dresses, ensembles, and wraps through detailed analysis of extant garments. Kidwell's 1979 publication of American dressmaker systems examined construction techniques and practices used during the nineteenth century. Farrell-Beck, Haviland, & Harding (1986) studied sewing techniques for periods in the nineteenth century. Documentation of characteristics of sewing threads for garment construction, however, is limited.

Background of the Problem

There is currently no definitive guide to identify threads manufactured during the nineteenth and early twentieth centuries. Identification of nineteenth century threads in terms of configuration, degree of twist, and direction of twist would be useful for historical costume archival purposes. Identification of these characteristics would contribute to the body of knowledge on the type and use of sewing thread in nineteenth century society.

Production sources for American women's dress during the latter half of the nineteenth century significantly increased due to industrialization (Farrell-Beck, 1992; Kidwell & Christman, 1974). Farrell-Beck (1992) notes an increase in the number of manufactured women's garments dated between 1880 and 1900 and traces construction characteristics, such as seam and stitch type noted in these garments, to patented technology. New technologies for fiber production, fabric manufacture, and sewing machine innovations provided additional capabilities in the garment industry and affected all economic classes (Kidwell & Christman, 1974). Improvements in fiber production, such as fiber waste reduction, faster spinning machinery, and lowered specialized manpower requirements, led to the increase in yarn for fabric manufacture and thread for apparel production. Innovative technologies for fabric manufacture provided cheaper and faster means for fabric generation (Copeland, 1912). The inventions and improvements in the coloration areas allowed for improved colorfast dyes and printing capabilities (Copeland, 1912). Patents for sewing machines allowed manufacturers to keep up with the increased supply of fabric and increased demand for cheaper clothing (Kidwell & Christman, 1974). Technological improvements of sewing machines stimulated increased demand for cotton sewing thread and led the way for enhancements in the thread production industry (Bourne, 1895).

Additional techniques for garment analyses have provided information on technological changes and choices along with cultural influences of these choices. Sibley & Jakes' (1989) model for cultural inference uses technical fabrication studies and physico-chemical textile analyses as components for expanding cultural knowledge through the recording of textile attribute data during archeological study. General knowledge of the physico-chemical analysis component is not as extensive as knowledge of areas covered in technical fabrication studies (Sibley & Jakes, 1989). The importance of physico-chemical information is that it leads to a better understanding of cultural and technological choices made in processing, distributing, and consuming the textile or garment and the opportunities made available. The physico-chemical component includes chemical composition and the micro and macro aspects of a textile's physical structure. Like the textile, thread can be seen as a component, integral to the construction of a garment, but with a physical structure that lends insights about cultural and technological choices during its manufacture.

Purpose and General Objectives

The purpose of this study was to document the physical characteristics of sewing thread used in American made women's dresses and suits during the time period 1880 to 1909 using noninvasive procedures. American women's dresses and suits included one- and two-piece ensembles used for daywear. This study excluded outerwear, lingerie, eveningwear, sports apparel, or wedding attire. The study included garments produced by home sewers, dressmakers, or ready-made establishments. (Ready-made is the historical equivalent of ready-to-wear.) Thread characteristics, including configuration, degree of twist, direction of twist, color, and color match between thread and fashion fabric, were identified for machine and hand sewn structural and non-structural seams or stitchings.

Benefits

The lack of research on the development during the nineteenth and early twentieth centuries of sewing thread leaves an identification void. This void presents opportunities for possible misidentifications of altered or repaired garments from varying time periods.

Documenting thread in extant women's garments will build a knowledge base for sewing thread characteristics in the period under study. Specific information pertaining to the physical characteristics of sewing thread in a garment can be used to establish and verify the time period for the object. This information can also be used to expand the knowledge base through documentation of the technological choices available at the turn of the nineteenth and twentieth centuries for sewing thread.

At the present, the most commonly-sold sewing thread is a two-ply core-spun sewing thread with an S directional twist for the cotton fiber wrapped around a polyester core and a final Z directional twist for the ply. Since polyester was not invented until 1944 and was not popular as a sewing thread until 1953 (Smith & Block, 1982), the presence of cotton/polyester core-spun in a nineteenth century garment would indicate an alteration or repair. Other thread characteristics may also distinguish different time periods and serve as dating information.

Remodeled garments donated to collections present additional problems for garment dating (Farrell-Beck, 1987). Identification of the original garment must be accomplished along with the identification of the remodeled or altered style. Information pertaining to the sewing threads can be used to eliminate style periods that are non-synchronous with period sewing thread characteristics. Reconciliation of the later style changes with the original style can be facilitated by the identification of sewing thread characteristics prevalent for different time periods.

Noninvasive methods, used by Amin (1970) for the analysis of yarn twists in cotton ply yarns, can be modified and applied to the collection of thread characteristics data without altering historical textile items. Thread-in-the-seam observations can be used to collect thread characteristics, such as configuration, degree of twist, direction of twist, color, and color match between thread and fashion fabric.

CHAPTER TWO - REVIEW OF LITERATURE

This review of literature investigates current historical costume identification procedures, nineteenth century developments in the production of cotton sewing thread, and the influence of industrialization on cotton sewing threads.

Current Identification Procedures

Historical identification and dating of garments are generally accomplished by detailed analyses of the object. Components reviewed for these analyses include garment style, construction techniques, embellishments, fabrication, and coloration. Object documentation is supported by an history of the garment from the donor and primary information regarding period garment styles or construction patterns. Primary sources for period dress include personal writings, advertisement and newspaper copy, magazines, mail-order catalogues, books, photographs, paintings, sketches, and other publications from the specified time period.

Style guides, such as Boucher (1987), Payne, Winakor, & Farrell-Beck (1992), and Bradfield (1968), are also available for dating period garments. These sources, which illustrate and describe clothing styles (e.g., garment line and embellishment), do not provide information on sewing thread characteristics such as twist, configuration, or color. Though based upon direct analyses of primary sources, these references are secondary sources and were completed outside of the time period of the study. However, they contain representative samples of paintings, photographs, and sketches of garments and accessories from primary sources.

Undated garment pattern pieces can be compared to documented garment silhouettes and pattern shapes for period time frames

(Arnold, 1972; Hill & Bucknell, 1987; Waugh, 1969). Studies have documented the development and implementation of construction methodologies for hand- assembled garments and historical construction techniques (Arnold, 1972; Bradfield, 1968; Farrell-Beck, 1987; Kidwell, 1979; Waugh, 1968). Bradfield (1968) provides detail sketches for period English women's garments from 1790 to 1930. The book includes such construction information as seam types, lengths, stitches used, fabrics, and embellishments. Bradfield provides information about neatness of seams and stitchings with occasional reference to types of stitches used for hand sewing. Information pertaining to sewing thread, however, is not provided. Style and fabrication guides, such as Arnold (1972), Bradfield (1968), and Waugh (1968), have limitations as references for dating American dress because they are based on British garments (Farrell-Beck et al., 1986).

The study conducted by Farrell-Beck et al. (1986) of women’s outerwear from 1800 to 1869 documents stitching techniques but not degree and direction of twist, configuration, or color match of thread to fabric. Fabrication advances in the textile industry have been documented for fiber processing and identification of processing procedures for different types of fabrics (Copeland, 1912). Coloration of fabrics and threads is restricted to the technological advances available in the areas of dye formations and application processes (Thomas, 1976; Storey, 1978).

Kidwell (1979) details systems used by U. S. dressmakers for patternmaking and garment construction and shows the transition from hand to machine sewing technology during the nineteenth century. Based on sewing machine patents, Farrell-Beck (1992) traces construction methods used on mass-manufactured garments dated circa 1860-1900 and examines lag time between the introduction of new technology and industry utilization. She identifies over 200 patents for the sewing machine, attachments, and stitches filed between 1849 and 1899 and concludes that new technology was related to an expanding consumer base, textile innovations, and demands to produce hand-made details by machine.

Oral and written histories of donated objects are collected from donors for registration purposes. These histories may provide background information concerning the owner, manufacturer, designer, purpose of the object, and use of the object (Severa, 1995). The information collected from donors is used for establishing and for verifying the time period of object manufacture and use.

Sewing Thread Analyses

An area of analysis usually excluded from the study of construction techniques is sewing thread. Physical analysis of sewing thread, however, is used in the study of period household textiles. Fiber content, twist of thread, color, and use (e.g., sewing, basting, piecing, quilting, and appliqué) are used to help date quilts (Bowman, D., personal communication, June 16, 1995). In addition, the physical characteristics of sewing thread as well as stitching methods used for construction have been employed to date flags (Cooper, 1973). Two of these categories, fiber content and degree of twist of thread, normally require the extraction of specimens from the item for data collection (Landi, 1992) and are invasive processes. Fiber content is determined microscopically and requires the preparation of slides from small samples. Fiber content may also be determined by using a burn test. Precise assessment of degree of twist requires untwisting samples of thread from the item. Data pertaining to color and function may be collected without removing specimens from the item.

Sewing thread is defined by ASTM D123-95a (1995) as a small-diameter yarn or strand that is flexible and usually treated with a surface coating and a lubricant. Sewing threads are intended to be used to stitch one or more pieces of fabric or an object to fabric or for decorative purposes. Yarn refers to threads that are continuous strands used in the weaving or knitting process to generate fabric (ASTM D123-95a, 1995). Warp or pick yarns are stronger and more tightly twisted than weft yarns and have been used for sewing in some periods (Tarrant, 1994).

Sewing thread may consist of various natural and man-made materials. The three main natural fibers designated by AATCC Test Method 20-1990 (1993) are protein (e.g., silk, wool), cellulosics (e.g., cotton, linen), and asbestos. Due to scientific advances and technological inventions, manufactured fibers have been developed and used in sewing threads. Manufactured fibers may be classified as cellulosics (e.g., acetate, rayon, triacetate), non-cellulosics (e.g., polyester, modacrylic, spandex), and glass. Since the 1950s and 1960s, most sewing thread has been prepared from a mixture of cotton and polyester fibers.

The physical characteristics used in general fiber identification include appearance of the epidermis, medulla, pigment, fiber contour, and measurements of scale fineness, when applicable (AATCC Test Method 20-1990, 1993). Additional physical and chemical characteristics can be detailed through the use of qualitative observation and quantitative measurement. These methods include microscopical examination, burn tests, solubility, melting point calculation, refractive index readings, drying twist readings, stain results, moisture readings, and content weight (AATCC Test Method 20-1990, 1993; AATCC Test Method 20A-1989, 1993).

Fiber content dictates procedures used to prepare fibers for thread construction (Baird, 1880; Bruchey, 1967; Marsden, 1888; Ures, 1875). For example, carding and combing of cotton and wool fibers and reeling or unwinding silk fibers from the cocoon are necessary steps prior to spinning. Methods required for dyeing thread fibers may negatively or positively impact thread wear and dictate fiber preparation procedures (Hyde, 1864). The composition of fibers used in sewing thread is also important. For example, cotton and silk fibers make strong sewing threads due to their ability to be tightly twisted.

Sewing thread characteristics, including configuration and degree of twist, affect performance characteristics (Ures, 1875). Configuration refers to the construction of the yarn or thread. Thread construction may be accomplished by twisting fibers, single yarns, or multiple component yarns together. During the nineteenth century and early twentieth century thread construction using single or multiple component yarns (plys or cords) was generally referred to as either doubling or twisting. Thread doubling refers to plying yarns or twisting two or more single or ply yarns together. This twisting process causes internal torque in the yarn. The fiber to fiber friction causing torque increases thread strength and resistance to extreme extension, abrasion, and irregular surface areas due to compaction of fibers. Wakefield (1929) notes that the object of doubling and twisting cotton yarns was to improve strength by providing limited elasticity and increasing evenness.

Research by Amin (1970) analyzes the effects of twist on certain properties of cotton ply yarns. The study was mainly concerned with twist-against-twist combinations of 2-, 4-, and 6-ply cotton yarns. The procedures used by Amin do not require invasive use of untwist/retwist procedures to determine yarn twist. Using noninvasive procedures, Amin documents ply helix angles, yarn diameters, ply twists, and component twists for the plied yarns and the single yarns as-they-lay-in-the-ply.

Primary sources from the nineteenth century provide detailed instructions for production of various thread configurations and direction of twists (Baird, 1880; Dobson, 1893; Hyde, 1864; Marsden, 1888; Morris and Wilkinson, 1897; Ures, 1875). These sources, while providing valuable insights into the possible practices used during the nineteenth century, do not include information on specific manufacturing practices for individual companies. Possible thread configurations for the time period included single yarns of low, medium, and high twist and 2- to 12-ply configurations with twist levels of low, medium, and high. Cord designations could range from 2 to 6 or more multiple ply yarn structures combined to form one yarn or thread.

The standard test method for evaluating sewing threads established by the American Society for Testing and Materials (ASTM) D204-82 (1994) describes procedures for measuring physical characteristics, such as colorfastness, diameter, shrinkage, length of thread on spool, strength and elongation, twist, twist balance, and thread number. These procedures are not intended for sewing threads retrieved from seams but for threads from spools. Additional test methods are available to collect data related to thread used in seams but these are destructive tests, e.g. seam breaking strength, seam bursting strength, and seam elongation (ASTM D1683-90a, 1994; ASTM D3940-84, 1994).

Amin's (1970) procedures for microscopical examination of threads can also be used to collect data on color of sewing threads. Likewise, ASTM D204-82 (1994) method for collecting thread diameter data can be adapted for nondestructive or noninvasive use.

An indication of thread fineness or bulk is provided by numerical indication, e.g. 6, 40, 180. The terms number, count, and weight are used to describe the amount of fiber per length of thread. The thread numbering system used for cotton is an indirect system. The higher the number, the finer the cotton yarn. Thread number is calculated by the number of 840 yard lengths of yarn required to make up a 1 lb. reading. This identification is an indication of linear density or mass per unit length (ASTM D123-95a, 1995; ASTM D3823-94, 1994).

Twentieth century sewing thread has different requirements for industrial and non-industrial sewing thread. Pizutto (1987) lists the function of sewing threads but provides no distinction between industrial and non-industrial requirements. In both cases, sewing threads should be able to rapidly pass through a sewing machine, form efficient stitches, and function within the product without breaking or distorting during the item’s useful life (Pizutto, 1987). In comparison to non-industrial threads, industrial threads require greater strength and fineness and the ability to withstand higher levels of stress, heat, and friction caused by the rapid operation of industrial machines. Industrial sewing threads are also coated with special lubricants to reduce these strain factors (Bobbin, 1995).

The Nineteenth Century Developments and Production of Sewing Thread

The limited amount of historic documentation on thread makes it difficult to chronicle the history of sewing thread. There is currently no timeline from the nineteenth century into the twentieth century that depicts changes in physical structure of sewing thread as a consequence of its development for the mass-manufacture of apparel and the transition from handsewn to machine-sewn garments.

Nineteenth century sewing threads were made from linen, silk, or cotton (Tarrant, 1994). Cotton became a serious contender for sewing thread use in North America and Europe when Napoleon's blockade disrupted silk exports from Italy in the early nineteenth century (Tarrant, 1994). Details concerning the fibers used in sewing thread for the nineteenth century and the dates of production vary widely (Copeland, 1912; Harley, 1992; Wakefield, 1929). Cotton thread was found to be stronger and more flexible than linen and cheaper than silk. Widely-used varieties of cotton were Surinam, Sea Island, Surat, and East Indian (Bishop, 1868/1966c; Cooper, 1976; Ures, 1875). Surinam cotton is a strong and lustrous fiber (Wingate, 1975). Sea Island cotton, considered the best variety of cotton with the longest fibers, has high strength, uniformity, and luster (Wingate, 1975).

Cotton Thread Manufacturers

Detailed information on the beginnings of cotton sewing thread production in North America and Europe has not been located. Some secondary sources (Bishop, 1868/1966b; Cooper, 1976; Wilson, 1979) suggest that cotton sewing thread was an American invention and indicate that Mrs. Hannah Wilkinson Slater spun Surinam or Sea Island cotton fibers into thread at her husband's Pawtucket, Rhode Island mill, circa 1793-1794. In Stanley's (1993) book of female inventors of technology, Hannah Wilkinson Slater is mentioned within a footnote as only the mother-in-law of an inventor. There has been no formal recognition of her invention of cotton sewing thread or any other invention (Stanley, 1993).

John L. Bishop's (1868/1966a,b,c) three volume history of American manufacturing spans the 1608 to 1860 time frame. Bishop provides short notes and write-ups of American manufacturers from different areas of technology. Bishop (1868/1966b) identifies 1798 as the year for the construction of a new thread spinning mill at Pawtucket by Oziel Wilkinson, Samuel Slater's father-in-law, and provides the earliest reference to bleached cotton sewing thread by citing an 1808 advertisement for Samuel Slater and Co. of North Providence, Rhode Island. Bishop also reports that Slater's business manufactured cotton warp yarns. Cooper (1976) cites an 1809 advertisement from the firm of Almy and Brown, which states Mr. Slater's business interest as weaving threads and hank threads, which might also be used for sewing purposes.

Cooper (1976) credits the beginning of cotton sewing thread manufacturing (as 1812) to a Paisley, Scotland firm, J. & J. Clark and Company, headed by two brothers James and Patrick Clark. According to Cooper, J. & J. Clark sold threads in hank yarn format prior to 1820. After 1820 threads were provided on refundable wooden spools. Conversion of cotton thread to spool format, an innovation of the Clark company, occurred before the large-scale production and use of the sewing machine.

James Coats started a company in 1815 in Ferguslie, Scotland also to produce threads (Cooper, 1976). A history of J. & P. Coats from 1830-1883 is offered by Cairncross & Hunter (1987). The authors use statistical analysis of company archives to reconstruct profit margins and company progress and document a tenfold profit increase for machine-spun thread from £500,000 to £1,760,000 between 1832 and 1883. The archives, however, did not contain documentation on shipping manifests, distributor listings, internal innovations and inventions, copyright and patent awards, or company product specifications (i.e., thread characteristics for color, twist, or ply). This information might provide a clearer picture of cotton sewing thread characteristics from this time period.

Bishop (1868/1966c) identifies the importance of northeastern U.S. companies to developments in thread manufacturing. A listing of cotton thread and fabric manufacturers along with their main products is provided. For example, one manufacturer was reported to produce 20,000 dozen spools of cotton thread in white and other colors on a weekly basis. Bishop identifies yarns, warps, threads, and spool cottons for companies, such as Portsmouth Steam Factory, S. Johnson and Co., and Amos Pratt, but does not provide detailed explanations about end use. For the time period, yarns might refer to supplies for knitting, crocheting, and weaving textiles (ASTM D123-95a, 1995; Beecher & Beecher, 1869/1975). Warps might refer to yarns used in cloth weaving (Bishop, 1868/1966b). Thread might refer to sewing thread produced and sold in hank form (Cooper, 1976), and spool cotton was used for sewing thread (Bishop, 1868/1966c; Cooper, 1976; Jary, 1993). Approximately fourteen companies designated spool cotton as their product of manufacture (Bishop, 1868/1966c). Clark (1929) reports that there were over 100 different brands of sewing thread manufactured in the United States in 1880 but does not indicate if this number included linen and silk sewing threads. No listing of these brands or the manufacturers was provided.

Cotton Thread Innovations

Numerous books were available for setting up and efficiently running cotton production mills for fabrics and yarns during the nineteenth century. As primary sources, they describe cotton production and spinning formulas that indicated thread production ranges at mills (Dobson, 1893; Ivey, 1904; Wakefield, 1929). Baird (1880) and Dobson (1893) discuss problems encountered during the setup and operation of cotton spinning mills. Hyde's (1864) book is an easy-to-follow practical guide for cotton spinning and provides possible direction of twist calculations for various yarns. Marsden (1888) presents information on the development, principles, and practices used during the late nineteenth century for cotton spinning. Production of varying configurations in a large range of thread numbers (e.g., 2-ply from 40 to 120, and 4-ply from 50 to 180) was possible based on the skill of the workers. Marsden also provided primary evidence of the varied capabilities for production of thread configurations ranging from singles to 6-ply cord as early as the 1830s. A 6-cord was formed by six single yarns twisted together. Various books were also available to provide details for achieving thread numbers in wide ranges from 6 to 350 (Hyde, 1864; Ivey, 1904; Marsden, 1888; Wakefield, 1929). Marsden (1888), Morris & Wilkinson (1897), and Wakefield (1929) also provided practical principles for achieving thread configurations. Cooper (1973) states that 6-ply thread configurations appeared in the United States about 1840. Prior to that time, different varieties of 2-ply, 3-ply, and 4-ply thread configurations were available. The 3-ply thread configuration was favored until 1840 (Cooper, 1973).

Jary (1993) indicates that narrow ranges of thread configurations and thread numbers were not a common business practice. In the cotton spinning industry, technological advances provided the capability to spin wide ranges of degree of twists and thread configurations for threads and yarns. With the invention and refinement of the throstle, ring frame, and doubling frame, production of thread numbers ranged from 6s to 350s (Hyde, 1864; Ivey, 1904; Marsden, 1888; Wakefield, 1929). Threads of higher numbers, 140s to 350s, were generally used in lace production (Wakefield, 1929).

Throstle innovations provided improved speed capabilities for mechanized spinning. Ring frames provided combination spinning processes of drawing, twist introduction, and bobbin winding. Doubling frames provided the capability to prepare multiple bobbins of ply and cord threads directly from spools at increased speeds. Improvement of the spinning process along with production of degree of twist (high, medium, and low) with varying thread configurations (e.g. 6-ply, 2/2-cord, 3/2-cord) was possible with the employment of experienced workers and knowledgeable managers. Skilled workers could produce a variety of thread configurations using different directions of twists. These varieties were not wholly dependent on equipment. The worker's knowledge of yarn manipulation and equipment adjustments was the manufacturer's biggest asset (Hyde, 1864).

Dispersal of Innovation Information

In 1845 Scientific American began carrying advertisements for the manufacture of ornamental show cards by J. B. Carey and Company. These forms of advertisement were popular vehicles for manufacturers after the Civil War. Show or trade cards were reproduced in bright colors with exquisite details. Cards generally were formatted 3 1/2 inches by 2 1/2 inches (Porter, 1845).

Jary (1993) notes these cards were excellent records of thread manufacturers' products. Trade cards distributed by sewing machine manufacturers showed the spool form of thread. The reverse sides of these cards provided information, such as the distributor's name and address, product lists, and available colors. One card from the Merrick Thread Company indicated thread numbers available from the manufacturer. Merrick Thread Company generated thread numbers in 8s, 40s, and 50s (Jary, 1993). Merrick Thread Company also owned a registered trademark for "Standard Thread for Machine Use." These threads were of the 6-cord variety. Not all cards, however, provided thread number information. J. & J. Clark Thread Company distributed trade cards with their O.N.T. trademark. These white and black threads were marketed in spool format for use on sewing machines. The illustrations on separate cards present white spools of thread and black spools of thread but no thread number, configuration, degree of twist, or direction of twist information (Jary, 1993).

Applicable Thread Patent Information

Cooper (1976) cites the periodical, Scientific American for information concerning the increased production of American thread manufacturing from 1843 to 1853. Review of the Scientific American provided information on industrial and mechanical improvements. Much of this information was conveyed in one line entries with limited or no source references. The journal also reported weekly on the patents awarded by the United States Patent Office. Patent awards were initially reported in table format listing shortened titles of patents, awardee, and date. Scientific American provided additional information on selected patented items and explained their application as mechanized innovations of spinning machinery that led to a finer and better quality product.

Patent information for sewing thread manufacture is limited. Marsden (1888) lists numerous inventions and innovations for the cotton spinning industry that were not registered with the patent office. A review of patents indexed from 1790 through 1875, however, reveals one patent for the manufacture of thread and yarn. No detailed information was provided for this patent granted to S. M. Allen, of Niagra Falls, New York on April 7, 1860. No patent listings for cotton sewing thread production were noted for the years prior to 1860, although Cooper (1976) cited an 1808 advertisement for sewing thread and Cairncross & Hunter (1987) provided production information for cotton sewing thread from 1812.

In April 1863, a patent was granted to H. Daniels of Pawtucket, Rhode Island for the invention of a machine that dressed sewing thread. An earlier 1855 patent for dressing of sewing threads was awarded to J. M. Heck of Plymouth, Connecticut, cited in Leggett (1874). Primary sources do not provide a definition for the term 'dressing' (Ivey, 1904; Hyde, 1864; Marsden, 1888; Ures, 1875; Wakefield, 1929; Wilkinson, 1898). This term may refer to the process of passing yarns over gas flames to remove protruding fibers from the product (Hyde, 1864; Marsden, 1888; Ures, 1875).

More trademark patents than actual development patents are recorded for sewing thread. Trademark patents give an awardee exclusive rights to use a particular logo or statement for a product or for their designated company, group, organization, or entity. In August of 1872, the Clark Thread Company received a trademark patent for spool thread. J. Brook and Bro. were able to obtain two simultaneous trademark patents in 1874 for cotton thread. In 1875 four additional trademark patents were awarded to various applicants for spool thread. Those awarded included G.F. Foster, Clark Thread Company, and Dunbar, Macmaster and Company (General Index, 1875, 1876).

Requirements for Sewing Thread

A standard practice for nineteenth century sewing thread was twisting 6- or 9-ply cotton strands together to form 6-cord or 9-cord thread (Morris & Wilkinson, 1897). Cairncross & Hunter (1987) refer to Coats' reputation as an acknowledged manufacturer of 3-cord cotton sewing threads and 6-cord cotton threads by 1830. The 6-ply yarn was in popular use starting in 1840. After 1860, requirements for sewing threads suitable for sewing machine use dictated a 3/2-ply cord (Cooper, 1973), consisting of three strands of 2-ply cotton yarns twisted together (Cooper, 1973).

Little mention, other than Cooper (1973), is found concerning the physical characteristics of color or twist for sewing threads. Cairncross & Hunter (1987) mention white and colors for J. & P. Coats household thread and industrial thread. Beecher & Beecher (1869/1975), providing similar but general guidelines, suggested good thread, straight pins and needles, and black, white, and colored sewing thread for preparation of proper sewing baskets for nineteenth century women. No references or guidelines are provided for configuration or degree of twist beyond mention of good quality thread. Limited patent information, short historical reviews, and limited studies are available to account for the introduction of specialty threads, such as waxed or elasticized threads and specialized sewing machines for their use (Bishop, 1868/1966c; Cooper, 1976; Leggett, 1874).

During the nineteenth century there were no government standards for production of industrial or household thread. These standards for textile components did not appear until 1898 under guidance of the American Society for Testing and Materials (ASTM) organization (ASTM, 1994). Twentieth century standards for cotton sewing thread give parameters for colorfastness, strength and elongation, shrinkage, twist, thread number, diameter, and length (ASTM D204-82, 1994). Standards for testing textile components were implemented in 1921 by another organization the American Association of Textile Chemists and Colorists (AATCC, 1993).

Influences of Industrialization on Cotton Sewing Threads

Harley, in a 1992 article for the Journal of Economic History, proposes two conditions that allowed America to become competitive in the cotton textile world market: industrialization and innovation. Industrialization was possible and encouraged through increased consumer base, increased patent activity, and increased labor pool resulting from large volume immigration from industrialized countries.

Farrell-Beck (1992), who reviewed research completed by Rosenberg (1963), observes that American manufacturing industries were a breeding ground for innovation. Innovation led to the use of lower priced textile yarns that were of high enough quality to allow product marketing of fabric throughout the world at cheaper prices. Harley (1992) suggests that this practice worked well enough to encourage other countries to imitate the United States mass-manufacture of these types of textile goods. Harley, however, overlooks the invention of the sewing machine. There was an increased demand for textiles due to the faster rates of apparel production possible after the invention of the sewing machine (Wakefield, 1929). This invention along with its refinements led to an increased demand for sewing thread (Ures, 1875). The increased production of cheaper textiles fueled the demand for garments and encouraged innovations in the area of sewing threads (Bishop, 1868/1966; Cooper, 1976; Godfrey, 1982).

Fenster's (1994) discussion of the invention of the sewing machine briefly describes societal reactions to the invention and its impact on needlewomen after the 1830s. Isaac Singer's marketing strategy allowed seamstresses and needlewomen to rent-to-own sewing machines. Singer advertised sewing machine sales in the six-figure range as testimony to the excellence of his company's products. Yet, even with the increase in factory production of garments, manufacturers continued to have work completed by hand. Ready-made garments would be distributed to workers for required work and retrieved after completion. By 1860 piecework garments assembled in this manner were a combination of hand and machine work. Machine stitching was used for structural seams and hand stitching would be used for non-structural seams and embellishment elements. Early sewing machines were not as proficient for sewing curved seams as seamstresses (Farrell-Beck, 1987; Kidwell & Christman, 1974). As seamstresses became more proficient at machine sewing curved seams the amount of hand sewing for seams decreased. By 1880 construction practices for garment assembly had advanced to the level of high sewing machine usage for construction (Farrell-Beck, 1987). Use of the sewing machine also advanced the operation of dividing garment construction into specialized tasks. This process led to task system operations for team work and was often accomplished by contracting out work for tasks such as sewing, pressing, and finishing (Kidwell & Christman, 1974).

Bourne (1895) reports single chain stitch sewing machines were the norm until 1846, when lockstitch machines became available. Double chain stitch sewing machines for non-commercial use were available until 1875 (Bourne, 1895). Grover and Baker Sewing Machine Company, the manufacturer of this double chain stitch sewing machine, sold the business in 1875, and soon afterwards the machines ceased to be manufactured. Sewing machines that produced similar double chain stitches, however, were available and used for construction of items such as knit goods and bags (Bourne, 1895).

The single chain stitch requires a single thread source. Lockstitch machines use two sources of thread: spool thread for the top thread and bobbin or shuttle sources for the bottom thread. Bourne (1895) mentions the use of commercial spool thread for the bottom thread source on double chain stitch sewing machines as opposed to a bobbin source.

By the middle of the nineteenth century cotton export and consumption increased to 423,000,000 lbs. (Wakefield, 1929) due to improved mechanization of yarn spinning and the invention of the sewing machine (Bishop, 1868/1966c; Cooper, 1976; Godfrey, 1982; Kidwell & Christman, 1974; Schmookler, 1966). By the latter half of the nineteenth century sewing machine sales had grown significantly. A partial list of authorized licensed or sold sewing machines included a total of 173,000 for 1867 (Bourne, 1895). By the year 1876 the listing reported that 3.7 million sewing machines had been licensed (Bourne, 1895). For sewing thread consumption, Ures (1875) provided a figure of over 2,100,000 lbs. for the export of sewing thread to the United States from Britain. This figure is one-fourth of the total quantity of sewing thread exported from Britain to over twenty-eight countries for 1871-1872 (Ures, 1875).

Increased demand for clothing also affected sewing thread requirements. In the clothing industry, earnings for custom-made and ready-made items for men were approximately $148,000,000 in 1870, with an increase to $251,000,000 by 1890 for ready-made items (Clark, 1929). Women's garments were traditionally made in the home or by dressmakers during most of the nineteenth century (Farrell-Beck, 1992; Kidwell & Christman, 1974). In a study completed by Farrell-Beck (1992), a significant increase was noted in the number of women's ready-made garments after 1880. Ready-made garments were produced for mail-order and retail businesses by mass-manufacturers or were purchased off-the-rack from dressmakers. Reported earnings for women's garments in the ready-made category were $13,000,000 for 1870 and $68,000,000 for 1890 (Clark, 1929).

Summary

At this point only a concise history of machine-spun cotton sewing thread, as influenced by improved spinning technologies and the invention of the sewing machine, is possible. The expansion of the topic to include the history of cotton sewing thread since its invention is not much more extensive. The patent office awarded only one patent for the manufacture of sewing thread. Granting of this patent did not occur until 1851, after initial development of the sewing machine.

Manufacturers were able to produce weight or twist ranges of thread from 6s to 350s. Doubling capabilities for production of plys and cords of various configuration designations were dependent on the expertise of workers and ranged from single to 9-cords as early as the 1830s. Consumer demand for sewing thread increased significantly with the demand for ready-made clothing and the invention of the sewing machine. After 1860, dominant threads for sewing machine use were 3/2-ply cotton cord.

Previous analyses of historical garments have included construction, embellishment, fabrication, color, and oral histories. The various methods used to collect this data may be classified as destructive (invasive) or nondestructive (noninvasive). The majority of the current methods for documenting physical characteristics of threads are destructive to the item. These methods can be modified to collect thread characteristics from thread-in-the-seam samples (Amin, 1970) in a nondestructive manner.

CHAPTER THREE - SETTING OF THE PROBLEM

The intent of this analysis of historical garments was to identify the physical characteristics of sewing thread in women’s dresses and suits from 1880 to 1909 made in the U.S. This information will fill a void in the current body of knowledge on historical garment construction. Noninvasive procedures were used for data collection to preserve the integrity of historical specimens. This chapter includes the problem statement, research objectives, operational definitions, assumptions, delimitations, and limitations.

Problem Statement

Based on the current literature review, there are no studies that comprehensively document the types of sewing threads manufactured and used in the production of nineteenth and early twentieth century clothing. Likewise, there are no definitive guides to identify threads manufactured during the late nineteenth and early twentieth centuries. Identification of thread characteristics, typical of that period, could be useful for dating garments and differentiating between original and altered seams in historical apparel.

Research Objectives

The objectives of this research were:

1. To document garment and thread characteristics for sewing thread used in machine-sewn seams in women's dresses and suits made in the U.S. between 1880 and 1909.
2. To document garment and thread characteristics for sewing thread used in handsewn seams or stitchings in women's dresses and suits made in the U.S. between 1880 and 1909.

3. To determine dominant garment and thread characteristics observed by five year periods beginning in 1880 and ending in 1909.

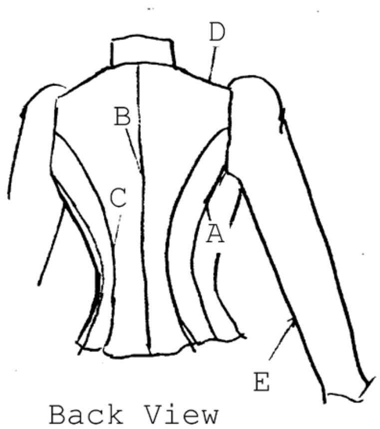
Operational Definitions

Critical terms were operationalized as listed below.

1. Dress - For the purpose of this study, dress included one- or two-piece garments worn by females of all social classes and groups during their day-to-day life. During 1890-1909, style variations of dress included bodice and skirt units, either sewn together or separate elements worn as ensembles (Kidwell & Christman, 1974; Landi, 1992). Excluded from this study was dress worn as part of outerwear, evening wear, wedding attire, sports apparel, or lingerie.
2. Suits - Separate clothing articles such as jacket and skirt worn as ensemble. For the purpose of this study these items did not include ensembles worn with blouses where the jacket was removable.
3. Seam or stitching function - The basic construction process used to create a seam or stitchings was considered in terms of its function in the garment (Gioello & Berke, 1979). The function of seams and stitchings was designated as either structural seams or non-structural seams and stitchings.See following definitions for each.
4. Structural seams - The seams required for joining garment parts and components and not initiated for decorative, finishing, or closure purposes (Gioello & Berke, 1979). These seams were operationalized in this study as a back bodice vertical seam, center back bodice seam, back bodice princess side seam, shoulder seam, vertical sleeve seam, armscye seam,

bodice side seam (Figure 1), bodice or skirt horizontal waist seam (Figure 2), and vertical skirt seam (Figure 3).

5. <u>Non-structural seams and stitchings</u> - The seams and stitchings initiated for decorative, finishing, or closure purposes and not as a joining element of the garment components. These seams and stitchings included a variety of techniques employed to finish a garment edge, to extend width of fabric to fit the garment component, to give a seam or structural element additional strength and endurance, or to anchor fasteners and decorative elements. These seams and stitchings (defined as single or group elements of thread manipulation) were operationalized as hem, seam edge finishes, basting stitches, specialty anchoring stitches (Figure 4), sleeve gusset seams, fabric piecing seams to provide additional fabric width, bodice placket seam, pleat anchoring stitches, buttonhole stitches, hook attachments, and darning stitches (Figure 5).
6. <u>Stitch type</u> - Terms used to classify variations of stitch classes and to record the structure of the stitch designated by FED-STD-751A included single chain stitch seam (101), lockstitch (301), and double chain stitch (401). Stitch classes of 100, 300, and 400 refer to machine-sewn stitches.
7. <u>Stitch type 101</u> - Single chain stitch is formed with one needle thread. A new loop forms under the fabric as the thread interloops with the previous stitch (FED-STD-751A, 1983; Glock & Kunz, 1995).
8. <u>Stitch type 301</u> - Lockstitch is formed using two thread sources. A needle thread fed from a top spool locks with a thread supplied from the bottom by a bobbin or



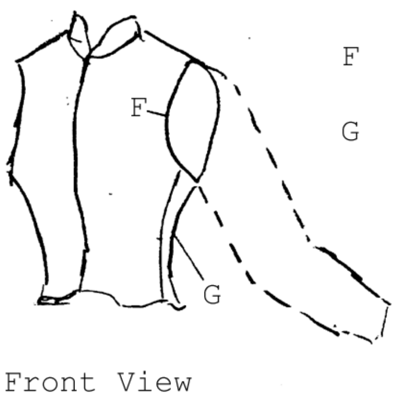
A Vertical Back Bodice Seam

B Center Back Seam

C Back Bodice Princess Side Seam

D Shoulder Seam

E Vertical Sleeve Seam



F Armscye Seam

G Bodice Side Seam

<u>Figure 1</u>. Structural seams in bodice.

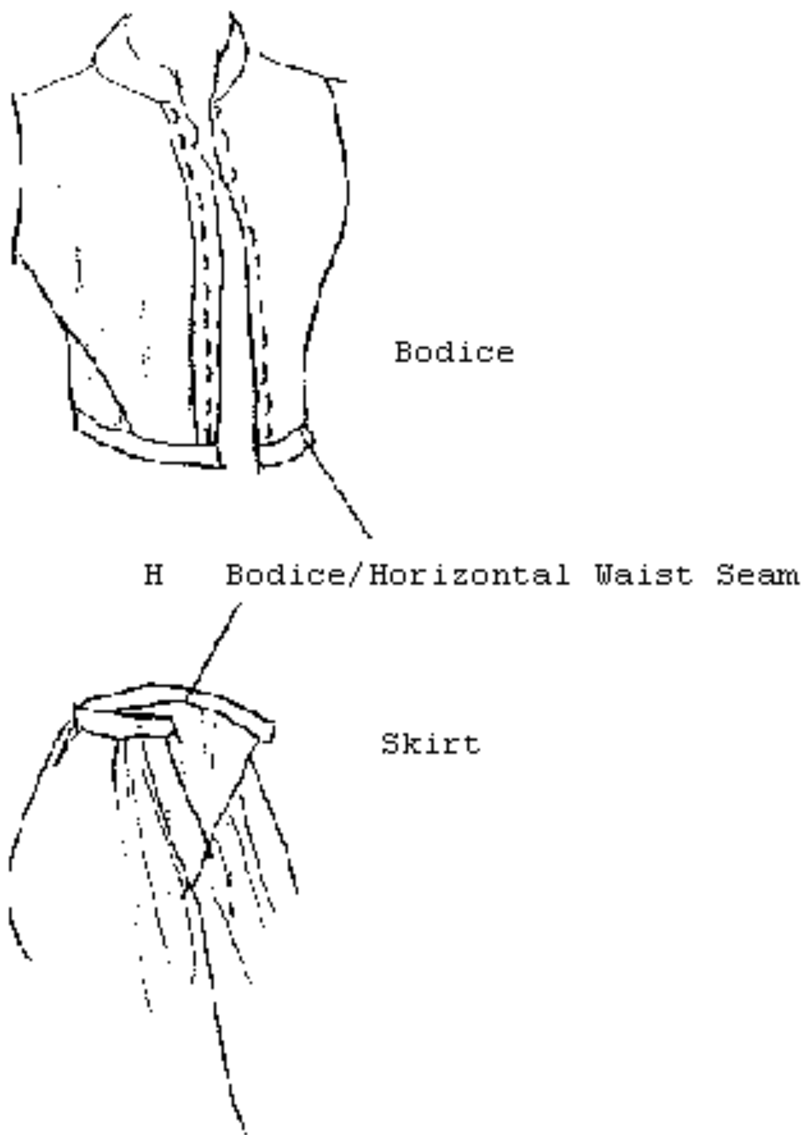


Figure 2. Structural seams at waist.

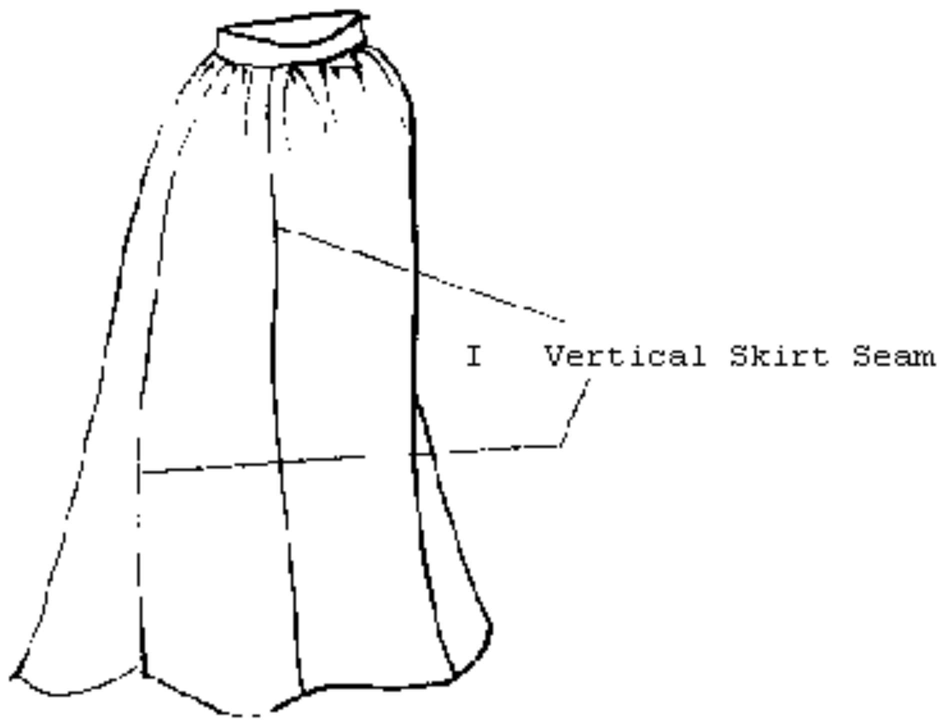


Figure 3. Structural seams in skirt.

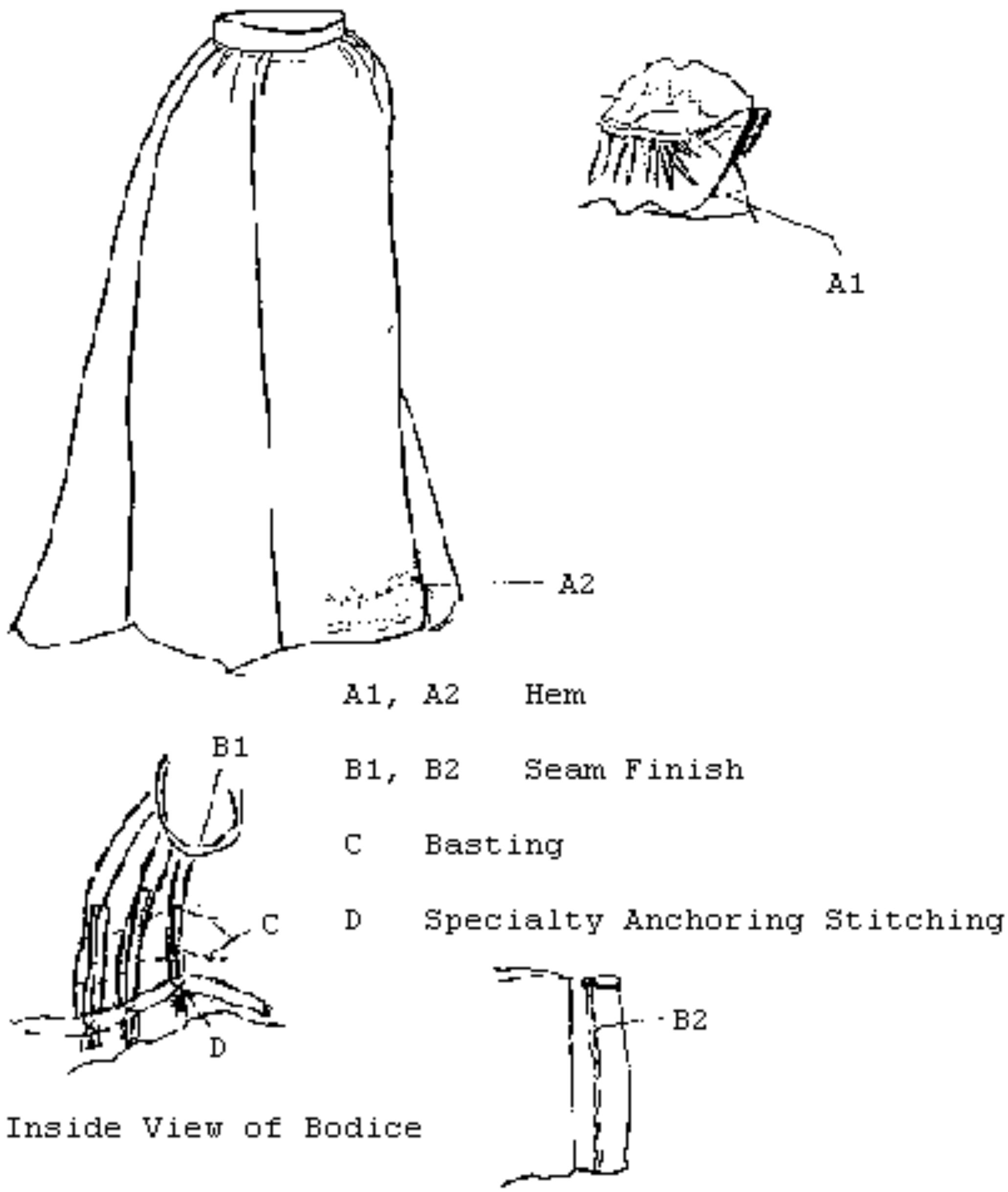


Figure 4. Non-structural seams and stitchings.

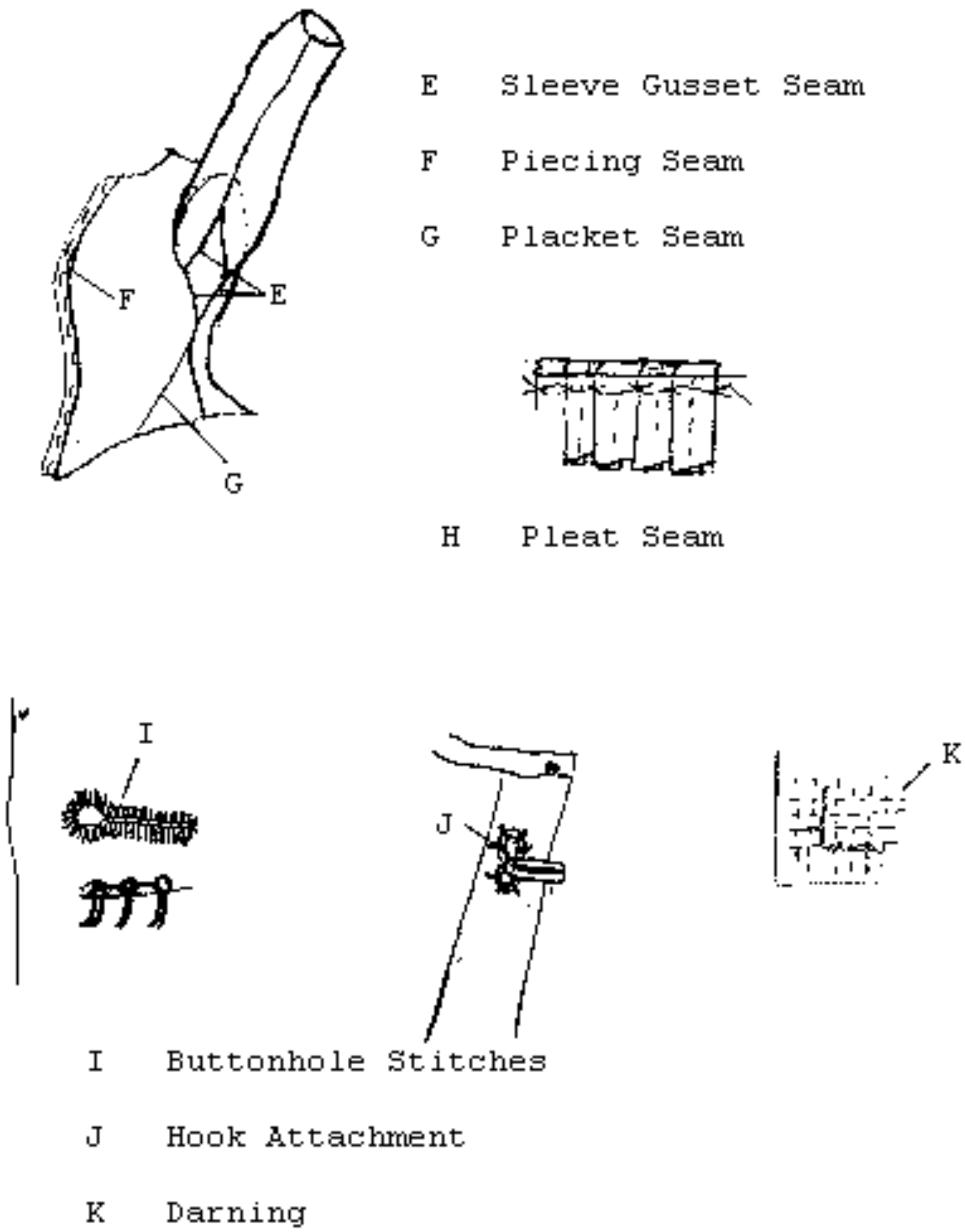


Figure 5. Non-structural seams and stitchings.

thread spool. The lockstitch is also called plain or straight stitch (FED-STD-751A, 1983; Glock & Kunz, 1995).

9. Stitch type 401 - Double chain stitch or double-locked chain stitch requires one needle thread and one looper thread for loop formations on the underside of the fabric (FED-STD-751A, 1983; Glock & Kunz, 1995).

10. Machine-sewn seams - Seams constructed through the arrangement of sewing threads in a repeating unit formed by a sewing machine (ASTM D 5646-95, 1994). Machine-sewn seams can be classified as structural seams or non-structural seams.

11. Handsewn seams and stitchings - Seams and stitchings produced by a person working with threaded needle according to upright or slanting sewing actions of hands, which alternate between plies or penetrate one ply before another. The sewing motion may be left to right or right to left. These stitches may be used for closure, finishing, or decorative functions; are visible or nonvisible; and are applied to one or more plies along seam or style lines within the garment body (Gioello & Berke, 1979). Handsewn seams and stitchings can be classified as structural seams or non-structural seams or stitchings.

12. Configuration - The method of component assembly used in the production of cotton sewing thread. Configurations possible in this research included single, ply, and cord.

13. Single yarns or threads - Single yarns are continuous entities of one strand of fibers grouped or twisted together that when deconstructed or untwisted, break down into loosely aligned fibers. Single yarns or threads also describe a yarn (thread) that has not been twisted (plied) with other yarns (threads) (Wingate, 1975). In this study the placement of entry and return paths of the fibers along the center

longitudinal axis of the yarn were observed. Single yarns show entry and exit paths for fibers (see Figure 6). Single yarns or threads were determined by microscopical examination for identification of fiber placement in the sewing thread (Amin, 1970).

<u>Figure 6</u>. Single yarn or thread placement along longitudinal axis.

14. <u>Ply yarns or threads</u> - Two or more single threads combined to form continuous entities that break down into single threads when deconstructed or untwisted. (Textile, 1991; Wingate,

1975). Ply yarns or threads were determined by microscopical examination for identification of single thread placement of the sewing thread (Amin, 1970). The placement of entry and paths of the thread components along the center longitudinal axis of the yarn were observed for their placement. Ply yarns showed entry and exit paths for threads compatible with the number of component yarns in the ply (see Figure 7).

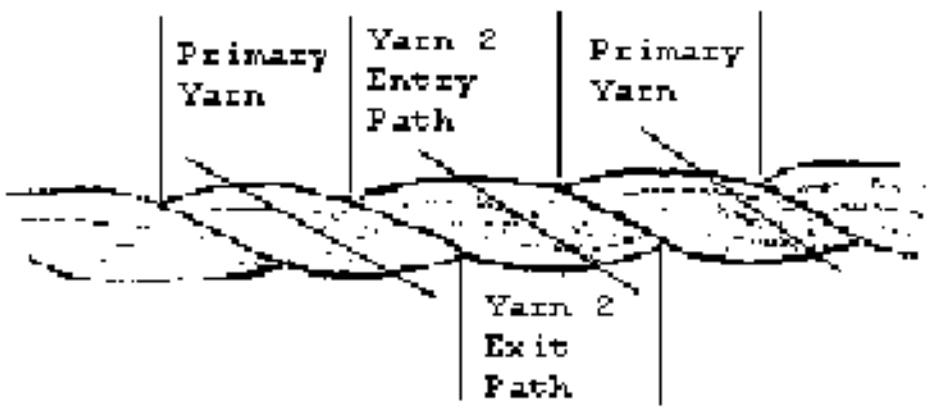


Figure 7. Ply yarn or thread placement along longitudinal axis.

- A yarn of 2-ply composition showed one additional entry and exit path before the reappearance of the primary or first yarn component selected for observation.
- A yarn of 3-ply or higher composition had 3 or more entry and exit paths.

15. Cord yarns or threads - Two or more ply threads twisted together form a corded thread that becomes individual ply threads when deconstructed or untwisted (Wingate, 1975). A numerical indication is provided for the number of ply threads included in the configuration of the cord. In this study cord yarns or threads were determined by microscopical examination for identification of ply thread placement of the sewing thread (Amin, 1970). Entry and return paths of the cord components along the center longitudinal axis of the yarn were observed for their placement. Entry and return paths for ply yarns were also visible. Entry and exit paths for threads were compatible with the number of component yarns in the ply (see Figure 8).
    - 6-cord - six single threads twisted together to form a single thread (Morris & Wilkinson, 1897).
    - 6-ply cord - also called 3/2-cord. Two single threads are twisted together to form a 2-ply thread. Three sets of these 2-ply threads are twisted together to form a cord (personal communication, Crews, P., March 18, 1996).
    - 9-cord - nine single threads twisted together to form a continuous entity (Morris & Wilkinson, 1897).

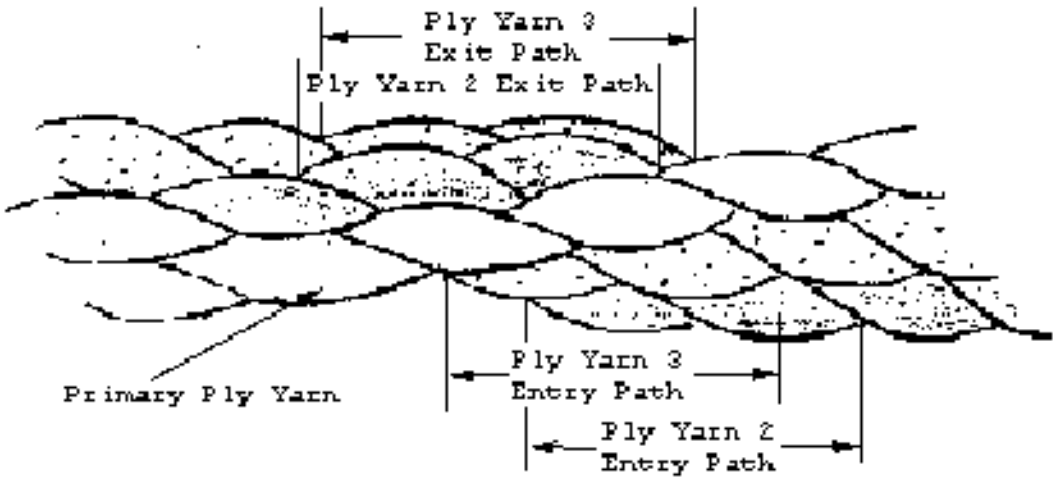


Figure 8. Cord yarn or thread placement along longitudinal axis.

16. Degree of twist - The number of turns per unit of length about the longitudinal axis of the fiber, yarn (thread), or cord (ASTM D123-95a, 1995). This measurement may be shown as turns-per-inch (TPI), turns-per-meter (TPM), or turns-per-centimeter (TPCM) and indicates levels of twist for high (approximately 30 or more TPI), medium (approximately 20 to 29 TPI), and low (approximately 19 or less TPI) twist yarns (Hatch, 1993; Wingate, 1975). In this research twist was determined using a subjective categorization for high, medium, and low in conformance with a visual match guidance scale after microscopical examination of seam sewing thread.

17. Direction of twist - Threads with twist direction of S have a spiral direction of twist caused by clockwise rotation of the fibers, plys, or cords along the longitudinal axis. Threads of Z twist direction have counter-clockwise rotations. Note:

In this study direction of twist was only recorded for the external twist of the composite thread.

18. Color - The hue gradation of the thread by saturation and lightness of color in comparison to black, white, and gray of a garment (Woolf, 1981). Color was operationalized in this research as white, black, brown, blue, yellow, green, and red colors and could include a range of hues. Color ranges included brown for colors such as cream, tan, and brown; red for pink, red, and burgundy; black for hues of gray and black; and white, which was assigned to white threads only.

19. Color match between thread and fabric - The perceived color differences between the sewing thread and the fashion fabric were graded (AATCC, Evaluation Procedure 1, 1993). The AATCC Gray Scale for Evaluating Change in Color with 9 match grades was used to determine color differences and contrast. Match grade of 1 indicated no contrast, match grade 5 indicated extreme contrast, e.g. 1, 1-2, 2, 2-3.

20. Noninvasive - A practice or procedure that does not encroach or trespass into the designated areas of construction components or fabric elements of garments (Woolf, 1981). Noninvasive procedures do not cause irreversible harm to items or require deconstruction or destruction of garments or its components to obtain data. Garments are not dismantled, seams are not deconstructed, and sewing threads are not removed or untwisted during the collection of data.

Assumptions of the Research

The assumptions for this research are listed below.

1. Original seams were distinguishable from altered seams.
2. All garments would have structural seams and non-structural seams or stitchings that could be used in the study.

3. Garments were accurately dated by museum staff.
4. Machine and handsewn stitch types were identifiable and classifiable by FED-STD-751A (1983).
5. Machine-sewn and handsewn seams and stitchings could be easily distinguished.
6. Portions of seams and stitchings viewed in situ were representative of the entire length of thread used in the seam or the remaining stitches.

Delimitations of the Research

The delimitations for this research are listed below.

1. Selection of garments with assigned dates were placed within five-year periods (e.g., 1880-1884) between 1880-1909.
2. At least three structural seams were selected for data collection from each garment.
3. Two non-structural seams or stitchings were selected for data collection from each garment.
4. Women's dresses and suits were selected as the category for garments used in the study.

Limitations of the Research

The limitations for this research are listed below.

1. Use of a convenience sample limited the generalizability of the study.
2. Collection policies of the museum collections used for this study were accurate for current collection policies and did not reflect the collection policies and goals active during the periods when the studied garments were collected.
3. Items were from owners or donors who were politically active or socially prominent in non-detailed geographic locations.
4. Garments might not be representative of the range of American women's garments made by home sewers, dressmakers, and ready-

made establishments in the United States during the period of 1880 to 1909.

5. Sample might not be representative of home sewing, dressmaking, and ready-made establishment production levels for American women’s dresses and suits between 1880 and 1909, and of apparel in regards to use, style, fabrication, and construction for the time period of 1880 to 1909.
6. Thread characteristics were limited to those that could be assessed using noninvasive methods.
7. Original thread twist might be altered by addition or removal of thread twist during machine or hand sewing process.

CHAPTER FOUR - METHODS

Noninvasive procedures were used to document garment and thread characteristics of sewing thread found in extant women's dresses and suits made in the U.S. between 1880 and 1909. The characteristics included configuration, degree and direction of twist, color, and color match between thread and fashion fabric for machine-sewn and handsewn seams and stitchings based on location and function of seam and stitch type. This chapter includes discussion of the following: research design, research population and sampling, data collection procedures, garment characteristics, thread characteristics, noninvasive identification procedures, and data analyses.

Research Design

For this study late nineteenth century and early twentieth century garments were examined and characteristics of sewing thread from designated locations were recorded using noninvasive procedures. Each garment provided multiple structural and non-structural seam and stitching sites (i.e., specimen locations) for data collection.

Variables in the research were designated as predictor variables and outcome variables. Garments in the study had garment and thread characteristics that were not manipulable and therefore could not be classified as independent or dependent variables. The variables selected for the study were not used to determine cause-and-effect but to identify characteristic differences among garments from the time period in the study. Variable categories included predictor, or garment, variables and outcome, or thread, variables. Garment variables included year group, year, seam or stitching function, specimen location, and stitch type. Thread variables selected for the study included configuration, degree of twist, direction of twist, color, and color match between thread and fashion fabric.

Microscopical analysis of cotton sewing thread characteristics were conducted with thread-in-the-seam procedures described by Amin (1970) and other modified procedures. Descriptive statistics were used to document garment and thread characteristic trends and frequency contingency tables were used to compare frequency distribution groups.

Research Population and Sampling

The research population for this study was American women's dresses and suits made in the U.S. from 1880 to 1909. The time frame selection was predicated on evidence reported in the literature. Clark (1929), Farrell-Beck (1992), and Kidwell & Christman (1974) found an increase in the number of manufactured women's clothing to complement dressmaker and home sewn apparel after 1880. This increase should provide the opportunity to observe changes in the characteristics of sewing thread as dictated by expanding technological capabilities used by home sewers, dressmakers, and ready-made establishments.

Items were selected using purposive convenience samples from the Smithsonian Institution, National Museum of American History, in Washington, DC, and The Valentine Museum, in Richmond, Virginia. These museums were chosen due to accessibility, collection size, and diversity. The Smithsonian Institution, National Museum of American History, Division of Social History contains over 26,000 apparel items. The collection includes clothing from all social classes and ages worn by Americans. The Division has a vast collection of garments for the category of women’s dress for the nineteenth and twentieth centuries. The Valentine Museum Costume and Textile Collection contains over

35,000 items. The collection contains clothing from all social classes and ages, worn by Virginians, with a very large collection of nineteenth century women's dresses.

Garments in the preliminary sample were identified by reviewing the museum registration cards for all garments from the specified time frame of 1880 to 1909 and selecting those that met established criteria for a) date specificity, b) type of women's apparel, c) country of origin,
d) availability of specimen locations, e) correct filing of registration card, and f) garment condition. Date specificity required that garments had assigned dates that fell within the five-year periods established for the study. For example, a garment dated 1880-1884 or 1885-1889 was included in the sample, but a garment dated 1883-1887 was not. This criteria was necessary to assist in identifying trends in 5 year periods. Garments with approximate dates that were larger than five year periods (e.g., 1880-1900) were excluded from the study. However, the researcher found that garment dates for the study were extremely precise. All garments had single year designations attributable either to dating by museum personnel or to background information or provenance. The provenance often designated the creation or acquisition of the garments for specific events or times in the owners' lives that could be traced to specific year dates.

Type of women's apparel was restricted to women's daywear garments, including dresses and suits. Specifically excluded were garments categorized as outerwear, lingerie, evening wear, sports apparel, or wedding attire.

Country of origin was limited to garments made in the United States to ensure more homogeneity in style, source of thread, and construction techniques. In the late nineteenth century, styles and construction techniques differed from country to country (Kidwell et al., 1986; Kidwell, 1979).

Criteria for availability of specimen locations required garments to have a minimum of five of the following structural seams: back bodice vertical seam, center back bodice seam, back bodice princess side seam, shoulder seam, vertical sleeve seam, armscye seam, bodice side seam, bodice or skirt horizontal waist seam, and vertical skirt seam. It was assumed that all garments would have two non-structural use of threads that could be used in the study.

Misfiled registration cards were excluded to remove inappropriate garments from the initial count for preliminary sample size. Examples of misfiled registration cards would apply to cards from other categories such as childrenswear or menswear.

The criteria for garment condition required exclusion of cards indicating damage to seams or stitchings or fragility of item. Garments with indications of alteration or repair were also excluded from the study. Garments whose cards indicated major areas of disintegration, wear, or stress were not included in the study.

Garments that met all criteria were recorded in a sort table according to the dates assigned for the garments. Five garments for each date category (i.e., 1880-1884) were randomly selected using a random number table. The registration numbers for these garments were submitted to museum personnel for approval for use in the study.

Approximately 215 cards were reviewed from the collection at the Smithsonian Institution. A total of 81 garments from the Smithsonian Institution met criteria for inclusion in preliminary sample of the study (see Table 1). Location information was also reviewed for Smithsonian Institution cards for adjustments to the final preliminary list. Garments stored at off-site facilities restricted garment access and reduced the number of garments available for this study. From this list, 23 were available for the final sample. A list of the final sample garments was presented to the museum staff for approval for use in the study. From the final preliminary list a total of 9 garments were approved for use in the study (see Table 2).

At the Valentine Museum approximately 300 registration cards were reviewed and 116 garments met the criteria for inclusion in the study (see Table 1). A list of 30 garments was compiled using the random number method of selection
(see Table 2). All 30 garments were approved by museum staff for inclusion in the study.

Table 1

Year Group Distribution of Garments That Met Criteria for Inclusion in the Study

	1880-1884	1885-1889	1890-1894	1895-1899	1900-1904	1905-1909	TOTAL
SI	14(5)	10(3)	13(3)	15(4)	11(5)	18(3)	81
VAL	8	15	16	24	18	35	116
TOTAL	22	25	29	39	29	53	197

SI=Smithsonian Institution

VAL=Valentine Museum

( )=Indicates number of garments not in off-site storage.

Table 2

Year Group Distribution of Randomly Selected Garments Approved by Museum Personnel for Inclusion in the Study

	1880-1884	1885-1889	1890-1894	1895-1899	1900-1904	1905-1909	TOTAL
SI	2	2	1	2	2	0	9
VAL	5	5	5	5	5	5	30
TOTAL	7	7	6	7	7	5	39

SI=Smithsonian Institution

VAL=Valentine Museum

Data Collection Procedures

A data collection instrument was developed to record general garment information, as well as garment characteristics and thread characteristics of concern in the study (refer to Appendix A). General garment information included name of the museum, accession number, catalogue number, and donor number assigned by the collection registrar. A sample number and data collection date were assigned for tracking garments during the study. A brief description of the garment being analyzed was chronicled for visual recognition. The text for this description was copied from the accession card as recorded by the registrar. The manufacturer and manufacture location provided by the garment label were recorded.

Garment Characteristics

Year groups for five year periods, beginning in 1880 and ending in 1909, were assigned to garments based on the identified garment date. The date was identified as the date initially attributed to the garment by the registrar, curatorical, and conservation staff. This date was confirmed by donor information, style dating, or label information as indicated in the collection records.

Thread specimens were analyzed from a minimum of five sites (three structural and two non-structural locations) from each garment in the study. The five sites were used to get an overall view of the types of sewing threads used in the construction of the garment. The multiple readings for each garment were used to reduce error based on choice selection for site reading. Multiple readings were also used to reduce the probability of selecting a seam or stitching that had been repaired, altered, or damaged. Alteration and repair indicators included seams with areas of thread that differed along the full seam length or from seam to seam. These threads might differ in configuration, degree of twist, direction of twist, or color. These altered or repaired areas might also show areas that differed in stitch types (e.g., combinations of handsewn backstitching and running stitches or machine-sewn and handsewn stitches). Empty stitch holes could also be visible in the fabric and indicated removal of threads and restitched areas. To avoid collection of data from distorted sewing threads, garments were excluded from the sample if they exhibited large worn, pulled or stretched seam areas, multiple abraded seam areas and threads, and multiple areas with broken seams and threads. Site selection was guided by seam or stitching function.

Seam or stitching function was operationalized as structural seams and non-structural seams or stitchings. The location of this seam was recorded on the Data Collection Sheet. First choice sites for structural seams (see Figures 1,2, and 3 in Chapter Three) were bodice side seam, vertical sleeve seam, armscye seam, bodice or skirt horizontal waist seam, and vertical skirt seam. If one of these five seams was not present, one of the following listed seams was used as a replacement: back bodice vertical seam, center back bodice seam, back bodice princess side seam or shoulder seam.

Non-structural seams or stitchings served finishing, utilitarian or decorative purposes. These seams or stitchings finished a garment edge, gave a seam or structural element additional strength and endurance, added fabric width, or anchored fasteners and decorative elements. The first choice locations for non-structural seams or stitchings were seam finishes and hems. Other non-functional seams or stitchings included basting stitches, specialty anchoring stitches, sleeve gusset seams, fabric piecing seams to provide additional fabric width, bodice placket seam, pleat anchoring stitches, buttonhole stitches, hook attachments, and darning stitches (see Figures 4 and 5 in Chapter Three).

Stitch types were visually assessed and categorized in accordance with FED-STD-751A. Stitch types for machine-sewn stitches were as follows: single chain stitch (101), lockstitch (301), and double chain stitch (401) based on expected sewing machine technological capabilities for home sewers, dressmakers, and ready-made establishments. Handsewn stitches did not match the class 200 stitchings depicted in FED-STD-751a and were therefore referred to collectively as handsewn.

Thread Characteristics

Information on configuration, degree of twist, direction of twist, color, and color match between thread and fashion fabric were collected for each specimen. Configuration designations for thread specimens were single, ply, and cord. Degree of twist was a subjective indication of the number of turnings of thread or thread components along the longitudinal axis of the thread during production. Degree ratings of high, medium, and low were assigned. Direction of twist was recorded to indicate final twist direction of yarn during construction. Thread directions of S or Z were recorded.

Thread colors were categorized as white, black, brown, blue, yellow, green, and red. Information on the color match between thread and fashion fabric was recorded. Color match grades were used to evaluate differences in color between sewing thread and fashion fabric. Each method is presented below.

Noninvasive Identification Procedures

Data collection was performed in situ, in the garment, to preserve the characteristics of the sewing thread and to avoid degradation of the garment. Readings were made using a hand-held, illuminated, stereo microscope with power magnification of 30X. This instrument allowed collection of data in a noninvasive manner with minimal manipulation of the garment.

A descriptive card for visual presentation of entry and exit paths of component yarns along the longitudinal axis of the thread (see Figure 9) was used for designating configuration for single, ply, and cord threads. Single threads have fiber components, ply threads have two or more single thread components, and cord threads have two or more ply thread components. Ply and cord threads had numerical designations recorded (e.g., 2-ply, 3-ply, 3/2-cord).

A degree of twist reference card was used for subjective ratings of high, medium, and low (see Figure 10). High degree of twist had approximately 30 or more twist-per- inch (TPI) along the longitudinal axis of the thread. Medium degree of twist threads had approximately 20 to 29 TPI and low degree of twist threads had approximately 19 or less TPI (Hatch, 1993).

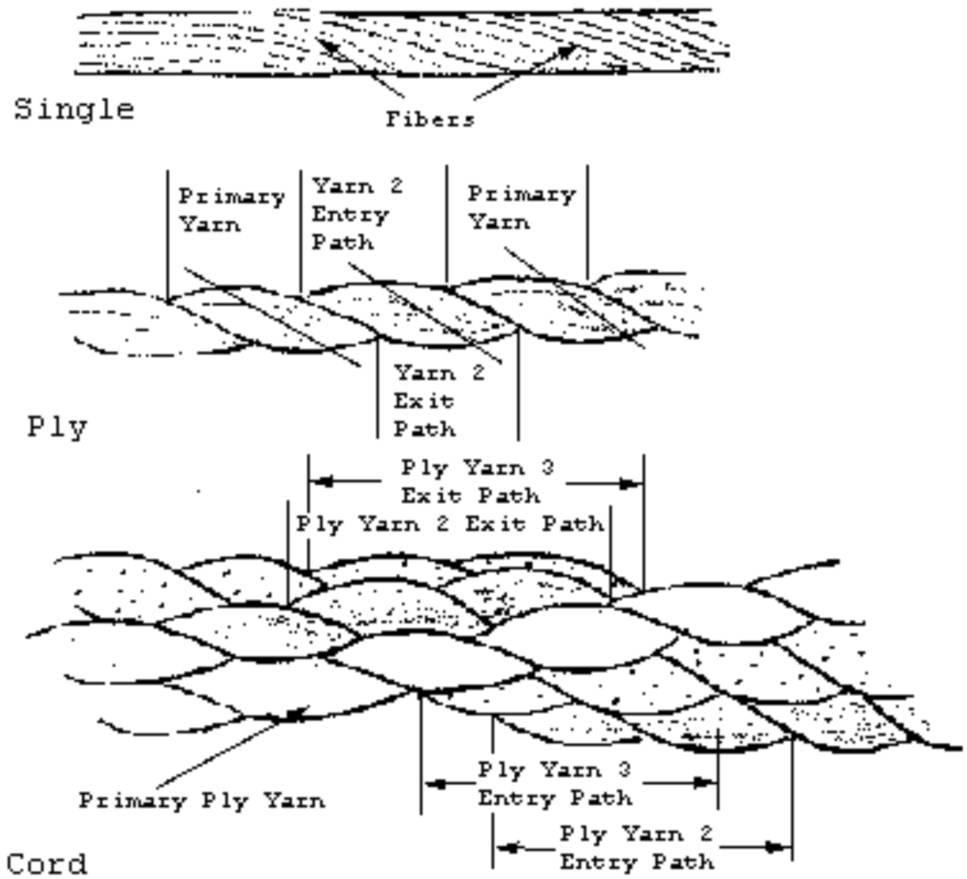


Figure 9. Descriptive card for component yarns along longitudinal axis of thread for designation of single, ply, and cord thread configuration.

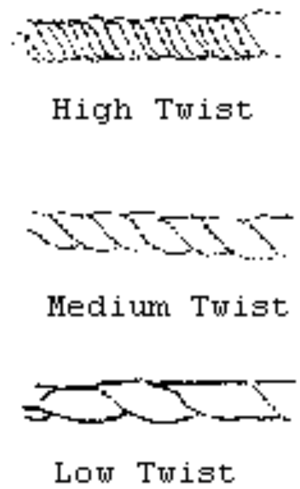


Figure 10. Degree of twist reference card used for subjective gradings of high, medium, and low degree of twist.

A descriptive card for direction of twist (see Figure 11) was used to determine twist directions of S and Z for threads encountered. Threads with twist direction of S have a spiral direction of twist caused by clockwise rotation of the fibers, plys, or cords along the longitudinal axis. Threads of Z twist direction have counter-clockwise rotations.

There is no procedure for accurately determining thread color from seams in a noninvasive manner. Categories assigned to sewing threads were subjectively determined by assessing the most dominant color hue for the thread by visual observation. The following colors were used: white, black, brown, blue, yellow, green, and red. Subjective assignment of color types was based on naked-eye observations and generalization to the nearest hue. Brown was recorded for colors such as cream, tan, and brown; red for pink, red, and burgundy; black for hues of gray and black; and white for white threads only.

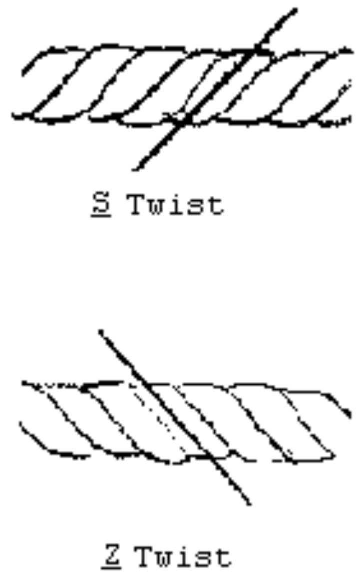


Figure 11. Descriptive card for direction of twist used to determine S and Z directions.

The AATCC Gray Scale for Evaluating Change in Color was adapted for use to assign match gradings for thread color and fashion fabrics. Color match between the fashion fabric and sewing thread was compared for perceived visual differences and graded against perceived differences represented by the AATCC Gray Scale for color change. The AATCC Gray Scale was aligned with the garment and seam area to be reviewed. The Gray Scale for color change provides nine levels of color contrast, which are normally used for evaluation of colorfastness of fabrics. The range was 1 (drastic or extreme contrast), 1-2, 2, 2-3, 3, 3-4, 4, 4-5, 5 (no contrast). No other standard method was available that was noninvasive.

Data Analyses

Frequency distributions were used to describe and summarize the data collected from the samples. Frequency distributions indicated the number of occurrences for the variables and defined the proportion of each occurrence within the sample (Zikmund, 1994). Frequency distributions also provided the mode (i.e., value occurring most often) and were used to document dominant garment and thread trends. Frequency contingency tables were used to organize data by groups or categories for comparisons of frequency distributions on two or more variables (Zikmund, 1994). Descriptive statistics and frequency contingency tables were conducted to complete the following objectives.

1. To document garment and thread characteristics for sewing thread used in machine-sewn seams in women's dresses and suits made in the U.S. between 1880 and 1909.
2. To document garment and thread characteristics for sewing thread used in handsewn seams or stitchings in women's dresses and suits made in the U.S. between 1880 and 1909.
3. To determine dominant garment and thread characteristics observed by five year periods beginning in 1880 and ending in 1909.

Characteristic features of garment and thread variables for machine-sewn seams were reported using frequency distributions (Research Objective 1). Machine-sewn seams included seams assembled using a 101-single chain stitch or 301-lockstitch. Percentages from the frequency distributions of garment and thread characteristics of machine-sewn seams were compared to percentages found in the total sample. Lockstitch and chain stitch percentages were compared to each other, with machine-sewn seams, and with total sample percentages.

Characteristic features of garment and thread variables for handsewn seams or stitchings were reported using frequency distributions (Research Objective 2). Percentages of garment and thread characteristics for handsewn seams and stitchings were compared to percentages from machine-sewn seams and the total sample.

Frequency contingency tables were generated for documentation of garment and thread characteristics for five year periods from 1880 to 1909 (Research Objective 3). Dominant garment and thread characteristics were recorded for each year group and exceptions to these characteristics were noted.

CHAPTER FIVE - RESULTS AND DISCUSSION

This chapter presents a description of garment and thread characteristics of sewing thread found in selected women's dresses and suits from 1880 to 1909 made in the U.S. The thread characteristics under study included configuration, degree of twist, direction of twist, color, and color match between thread and fabric. Frequency distribution tables were used to document thread characteristics for the total sample and to trace dominant thread characteristics between 1880 and 1909.

Description of the Research Sample

The purposive convenience sample used in this study consisted of 39 garments including nine from the Smithsonian Institution and 30 from the Valentine Museum (see Table 2 in Chapter Four).

The silhouettes and style elements observed in the garments used in the study were appropriate for the time period studied (Boucher, 1987). Between 1880 and 1909 women's dresses and suits in the study generally had the following silhouettes and style elements. Bustle silhouettes dominated the early years of the study and then hour-glass silhouettes by 1900. Style elements until 1900 included horizontal waist seams, high stand collars, long sleeves, front closures, and fitted bodies. From 1900 to 1909, garments remained fitted in the waist with a looser fit in the bodice areas and slimmer skirts. The one-piece garments in the study had similar style elements as the two-piece garments and included a maternity dress from 1880. The maternity dress did not have a waist seam but did have a stand collar, long sleeves, and a loose A-line silhouette. One-piece garments occurred throughout the study but were concentrated in the latter years with two such garments from 1908 and one each from the following years: 1885, 1890, 1897, 1900, 1902, and 1909. The majority of the garments

(74%) in the study were two-piece garments consisting of bodice and skirt.

A minimum of five thread locations (three structural seams and two non-structural seams or stitchings) were investigated for each of the 39 garments, yielding 195 observation sites for data analyses. An additional 77 thread observation sites from various garments in the total sample were selected for analyses by the researcher because thread characteristics appeared to differ from the characteristics observed in specified locations. These additional sites provided a total of 272 observation sites for sewing thread.

One stitch type encountered during the study, 301-lockstitch, was produced using two threads. Of the 272 observation sites, 145 had this type of stitch, raising the total number of thread specimens for the study to 417. The 301 stitch type required the use of top and bottom thread sources, but it was not possible in this study to determine which thread was the bottom or top thread source. Chain and hand stitch types used only one thread source.

Distribution of All Thread Specimens by Garment and Thread Characteristics

A presentation of the garment and thread variables for the total sample is provided. Characteristics are presented for garment variables, which include dating, seam or stitching, and thread information.

Garment Variables

Garment variables for the study included year group, year, seam or stitching function, specimen location, and stitch type.

Year Group

Garments were grouped according to the year attributed to them by museum staff through provenance documentation. Year categories were sorted into the following groups: 1880-1884, 1885-1889, 1890-1894, 1895-1899, 1900-1904, and 1905-1909. Table 3 shows the distribution of thread specimens by five year periods. The largest number of observations were from the time period 1895-1899 (21%), followed closely by the 1885-1889 year group (19%). Distribution of specimens was similar to distribution of garments indicating that the additional seams selected for analysis were well distributed across the date range of the study.

Table 3

Distribution of All Thread Specimen Observations by Year Group

Year Group	Number of Garments	Percent of Total Garment Observa-tions	Number of Total Sample Observa-tions	Percent of Total Sample Observa-tions
1880-1884	7	18	70	17
1885-1889	7	18	81	19
1890-1894	6	15	49	12
1895-1899	7	18	86	21
1900-1904	7	18	76	18
1905-1909	5	13	55	13
Total	39	100	417	100

Year

Precise year information (one year increments) was an unexpected benefit to the study and may be attributed to the types of garments collected and the background of the owner. The number of thread specimen observations per year is highly influenced by the number of garments observed from that year (see Table 4). There were no garments included for nine of the years in the study. For two years of the study, 1900 and 1897, eight garments were included leading to high numbers of thread specimen observations from those years. Single year dates are presented to clarify distribution of garments within the five year groups.

Seam or Stitching Function

Seam or stitching function referred to the basic construction process used to create a seam or stitching and was considered in terms of its structural or non-structural function in the garment. Structural seams accounted for 155 (57%) of the 272 thread observation sites while non-structural seams and stitchings accounted for 117 (43%). These results reflect the research design, which required that a minimum of three structural seams (117 specimen observations) and two non-structural seams or stitchings (78 specimen observations) be recorded for each garment in the study. An additional 38 specimen observations were from structural locations, and an additional 39 were from non-structural seams or stitchings. These specimen observations were collected for thread characteristics that appeared to differ from the characteristics observed in specified locations.

Specimen Location

First choice specimen locations for structural seams were bodice side seam, armscye, bodice or skirt horizontal waist seam, vertical sleeve seam, and vertical skirt seam. First choice specimen locations for non-structural seams or stitchings were seam finishes and hems. For structural seams, the pre-selected seam locations of bodice side seam, bodice or skirt horizontal waist seam, vertical sleeve seam,

Table 4

Distribution of Garments and Thread Specimen Observations by Year

Year	Number of Garments	Number of Thread Specimen Observations	Percent of Thread Specimen Observations	Year	Number of Garments	Number of Thread Specimen Observations	Percent of Thread Specimen Observations
1880	3	33	8	1895	3	31	7
1881	1	7	2	1896	0	0	0
1882	0	0	0	1897	3	47	11
1883	2	21	5	1898	1	8	2
1884	1	9	2	1899	0	0	0
1885	3	36	9	1900	5	56	13
1886	1	11	3	1901	0	0	0
1887	0	0	0	1902	1	11	3
1888	1	11	3	1903	1	9	2
1889	1	23	6	1904	0	0	0
1890	2	9	2	1905	1	13	3
1891	0	0	0	1906	0	0	0
1892	1	8	2	1907	2	11	3
1893	3	32	8	1908	1	24	6
1894	0	0	0	1909	1	7	2
				Total	39	417	100

Note: Percentage total does not equal 100% due to the rounding off of percentages.

and armscye seam were present in most garments, resulting in more than 30 specimen observations for each of these locations (see Table 5). The low number of vertical skirt seam observations was due to the collection of the minimum number (three) of structural seams prior to the examination of the vertical skirt seam location. The homogeneity of thread characteristics in vertical skirt seams with the remaining observed thread characteristics would also explain the exclusion of observations from this location. For non-structural seams and stitchings the highest percentage for specimen observations were from seam finish (39%) and hem locations (33%), as shown in Table 5. The remaining non-structural seams and stitchings contributed less than 9% each.

Stitch Type

Stitch types recorded for the 272 specimen observation sites in machine-sewn seams included 101-single chain stitch and 301-lockstitch. Handsewn stitches viewed during the study did not match any of the class 200 handsewn stitches designated in FED-STD-751A. Therefore, all handsewn stitches were just identified as handsewn.

The stitch type with the largest number of observations, as shown in Figure 12, was from machine-sewn seams (61%). Handsewn stitches accounted for 39% of the specimen observations. Of the machine-sewn seams, lockstitch seams accounted for 53% and chain stitch for 8% of the seams observed in the total sample. The high number of machine-sewn seams might be due to the large number of sewing machines in use during the time period. Singer reported that 3.7 million machines had been licensed by 1876 (Bourne, 1895). This figure referred to the number of

Table 5

Specimen Locations Observed for the Total Sample

Seam or Stitching Function	Specimen Location	Number of Observa-tions	Percent of Observa-tions
S	Vertical Sleeve Seam	39	25
S	Bodice Side Seam	39	25
S	Armscye Seam	37	24
S	Bodice or Skirt Horizontal Waist Seam	32	21
S	Back Bodice Vertical Seam	2	1
S	Center Back Bodice Seam	2	1
S	Shoulder Seam	2	1
S	Back Bodice Princess Side Seam	1	1
S	Vertical Skirt Seam	1	1
Total		155	100
NS	Seam Finishes	46	39
NS	Hem	39	33
NS	Buttonhole Stitches	10	9
NS	Hook Attachments	7	6
NS	Basting Stitches	3	3
NS	Bodice Placket Seam	3	3
NS	Specialty Anchoring Stitches	2	2
NS	Piecing Seam	2	2
NS	Darning Stitches	2	2
NS	Pleat Anchor Stitches	2	2
NS	Sleeve Godet Seam	1	1
Total		117	100

S=Structural Seams
NS=Non-structural Seams or Stitchings
Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

machines sold by Singer only and did not account for other manufacturers. None of the observed seams were assembled using the double chain stitch. This might be attributed to the nonproduction of the Grover and Baker sewing machine, which produced the stitch, after 1875 (Bourne 1895). These results were consistent with previous findings (Farrel-Beck, 1987; Kidwell & Christman, 1974) for the use of handsewn and machine-sewn stitches in garments in structural and non-structural locations.

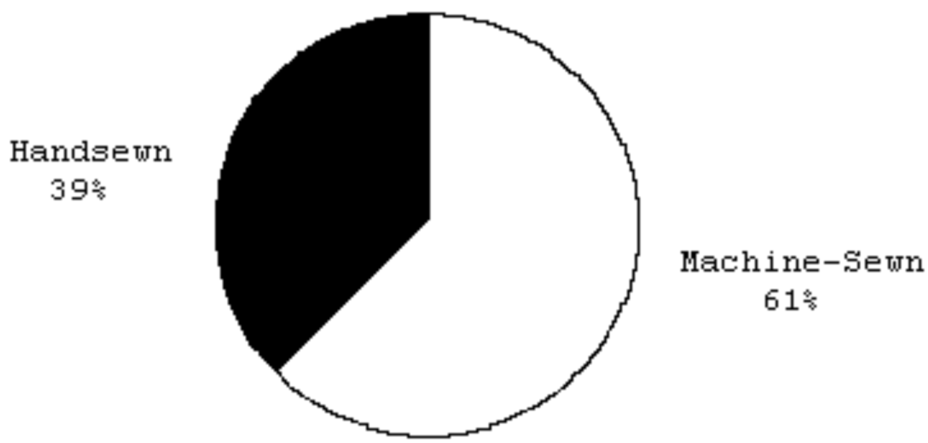


Figure 12. Stitch type specimen observations for total sample.

Thread Variables

Thread characteristics analyzed in the study included configuration, degree of twist, direction of twist, color, and color match between thread and fabric.

Configuration

From a field of 12 possible configurations, only three were noted in the study: 3/2-cord, 2-ply, and 3-ply. The most commonly occurring configuration was 3/2-cord accounting for 97% of the 417 thread specimens (see Table 6). Thread configuration anomalies will be discussed within the section of the Results Chapter that specifically deals with Objectives 1 and 2.

Table 6

Distribution of Configuration Specimen Observations for the Total Sample

Configuration	Number of Observations	Percent of Observations
3/2-cord	405	97
2-ply	9	2
3-ply	3	1
Total	417	100

Degree of Twist

Degree of twist was designated as either high, medium, or low twist. Most thread specimens (97%) had high twist (see Table 7). Medium twist was present in thread found in a seam finish of an 1885 garment and a hem of an 1888 garment. Threads having a low degree of twist were found for 11 specimens, the majority of which were in non-structural locations. Low-twist thread observations were from the following years: 1881 (four observations), 1883, 1885 (two observations), 1889 (two observations), 1895, and 1902.

Table 7

Distribution of Degree of Twist Specimen Observations for the Total Sample

Degree of Twist	Number of Observations	Percent of Observations
High	404	97
Medium	2	1
Low	11	3
Total	417	100

Note: Percentage totals do not equal 100% due to the rounding off of percentages.

Direction of Twist

Direction of twist designations were S for all thread specimen observations with only one exception. A final S twist for

3/2-cord indicated that the internal twist for the plys were Z twist. The internal twist for single twist components were S. The single example of an external Z twist was found in a 3-ply, medium twist thread used to handsew the hem of an 1885 garment. Due to the consistency of this variable in the study, this variable will not be discussed under the objectives for this research.

Color

The dominant thread color designation found during the study was for brown color range at 53%. The next most commonly used color of thread was black (19%), suggesting a preference for neutral color thread. White thread accounted for 11% of the specimens while other colors (blue, yellow, green, and red) only accounted for 17% altogether (see Table 8). Brown color range designation included colors within the cream, tan, and brown range.

Colors were not always used in close relation with the fashion fabric. For example, an 1883 striped dress made from blue, yellow, and cream fabric was sewn with lavender, white, and black sewing threads. Thread colors might have been disregarded in favor of thread configurations and of twists appropriate for the stitch type, location, and function of the thread use. The high number of specimen observations for the brown range may be attributed to the technological capabilities available during the period for colorfast and boilfast dye and the desire for threads that would pose less of a problem for color bleeding onto fabrics. The colors observed in the study are also influenced by the dye left in the garment and the dyes that did not damage the garment. Consumer recycling of popular colored garments from the time period would also influence the colors observed in the study (Willman, P., personal communication, October 24, 1997). The distribution for color ranges found in garments in the study were: 10 black, 8 blue, 7 red, 6 each of cream and white, and 2 green garments.

Table 8

Color Specimen Observations for the Total Sample

Color	Number of Observations	Percent of Observations
White	47	11
Black	80	19
Brown	221	53
Blue	23	6
Yellow	2	1
Green	9	2
Red	35	8
Total	417	100

Color Match Between Thread and Fabric

AATCC Gray Scale for Color Change for thread encountered in seam color match designations included 1, 1-2, 2, 2-3, 3, 3-4, 4, 4-5, and 5. A designation of 1 indicated a drastic or extreme level of contrast. A designation of 5 indicated a perfect match with no contrast in hue or saturation. For 60% of the thread specimens, the color match between thread and fabric was graded a 5 or perfect match (see Table 9). On the other hand, 24% of the specimens were graded as 1 indicating a drastic contrast. Overall with 76% of the color matches graded 4 or higher it appeared that efforts were made and colors were available to provide a close color match between the fashion fabric and sewing thread.

Table 9

Color Match Between Thread and Fabric Specimen Observations for the Total Sample

Color Match	Number of Observations	Percent of Observations
1 (Extreme Contrast)	100	24
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	3	1
4	63	15
4-5	1	1
5 (No Contrast)	250	60
Total	417	100

Note: Percentage total does not equal 100% due to the rounding off of percentages.

Garment and Thread Characteristics for Machine-Sewn Seams

Research Objective 1: To document garment and thread characteristics for sewing thread used in machine-sewn seams in women's dresses and suits made in the U.S. between 1880 and 1909.

Machine-Sewn Seams

Machine-sewn seams included all thread specimens that were assembled using a sewing machine and comprised 61% of the total sample. Machine-sewn seams were assembled using the 101-single chain stitch or the 301-lockstitch.

Garment Variables

Garment variables for machine-sewn seams included year group, year, seam or stitching function, specimen location, and stitch type.

Year group. The highest percentage of the specimen observations were recorded for year group 1895-1899 (21%), which was the same percentage reported for the total sample. The next highest number of specimen observations recorded for machine-sewn seams were 60 and 59 observations (19%) respectively for year groups 1885-1889 and 1900-1904, as shown in Table 10. The distribution of specimen observations for machine-sewn seams or stitchings correspond to that of the total sample and does not vary more than 3% from the total sample percentages.

Table 10

Distribution of Machine-Sewn Thread Specimen Observations by Year Group

Year Group	Number of Observations	Percent of Observations
1880-1884	46	15
1885-1889	60	19
1890-1894	34	11
1895-1899	66	21
1900-1904	59	19
1905-1909	46	15
Total	311	100

Year. The largest number of observations for year from machine-sewn seams was 1900, which accounted for 14% of the specimen observations. The next highest number of specimen observations was recorded for 1897 (13%), as shown in Table 11. As noted earlier both of these years included a greater number of garments than other years of the study. This fact might be skewing year group distributions of specimen observations.

Seam or stitching function. Of the threads observed in machine-sewn seams or stitchings, 80% were found in structural seams. This percentage is higher than the percentage of structural seams in the total sample (57%) and suggests a preference for machine-sewn stitching for joining garment components. The

Table 11

Distribution of Garment and Thread Specimen Observations for Machine-Sewn Seams by Year

Year	Number of Garment Observa-tions	Number of Machine-Sewn Observa-tions	Percent of Machine-Sewn Observa-tions	Year	Number of Garment Observa-tions	Number of Machine-Sewn Observa-tions	Percent of Machine-Sewn Observa-tions
1880	33	26	8	1895	31	24	8
1881	6	2	1	1896	0	0	0
1882	0	0	0	1897	47	39	13
1883	15	12	4	1898	8	3	1
1884	6	6	2	1899	0	0	0
1885	36	26	8	1900	56	43	14
1886	11	10	3	1901	0	0	0
1887	0	0	0	1902	11	10	3
1888	11	8	3	1903	9	6	2
1889	23	6	5	1904	0	0	0
1890	9	4	1	1905	13	10	3
1891	0	0	0	1906	0	0	0
1892	8	4	1	1907	11	9	3
1893	32	26	8	1908	24	22	7
1894	0	0	0	1909	0	5	3
				Total	417	311	100

Note: Percentage total does not equal 100% due to the rounding off of percentages.

remaining 34 specimen observations (21%) were non-structural seams or stitchings.

Specimen location. As noted above the most commonly observed thread location for machine stitching occurred in structural seams. High percentages were observed for vertical sleeve seam (28%), bodice side seam (27%), and armscye seam (23%) (see Table 12). These percentages are slightly higher than those for the total sample for vertical sleeve seams (25%) but lower than those for bodice side seam (25%), armscye seam (24%), and bodice or skirt horizontal waist seam (21%).

The largest number of non-structural seams and stitchings were hem locations (71%), as compared to 27% occurrence for the total sample, and seam finishes (15%), versus 37% occurrence for the total sample. These percentages suggest that machine-sewn stitchings were more likely to be seen in hem locations than other non-structural locations.

Stitch type. The largest number of observations by stitch type for machine-sewn seams was the lockstitch, with 145 specimen observations for 87% occurrence. Chain stitch accounted for 21 (13%) of the specimen observations in this group. The lower percentage of chain stitch observations might be influenced by the increased number of lockstitch machines available. Singer reported a significant increase by 1876 for sales of sewing machines (Bourne, 1895).

Thread Variables

Thread variables for machine-sewn seams included all designated variables.

Configuration. The most commonly occurring configuration was 3/2-cord accounting for 99% threads observed versus 97% for the total sample. Anomalies observed for thread configuration included

Table 12

Specimen Locations Observed for Machine-Sewn Seams

Seam or Stitching Function	Specimen Location	Number of Observa-tions	Percent of Observa-tions
S	Vertical Sleeve Seam	37	28
S	Bodice Side Seam	35	27
S	Armscye Seam	30	23
S	Bodice or Skirt Horizontal Waist Seam	23	17
S	Center Back Bodice Seam	2	1
S	Shoulder Seam	2	1
S	Back Bodice Vertical Seam	1	1
S	Back Bodice Princess Side Seam	1	1
S	Vertical Skirt Seam	1	1
Total		132	100
NS	Hem	24	71
NS	Seam Finishes	5	15
NS	Piecing Seam	2	6
NS	Specialty Anchoring Stitches	1	3
NS	Bodice Placket Seam	1	3
NS	Pleat Anchor Stitches	1	3
Total		34	100

S=Structural Seams
NS=Non-structural Seams or Stitchings
Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

four thread specimens of 2-ply thread. These two specimens were observed in two lockstitch structural seams (bodice side seam and vertical sleeve seam) of the same 1885 garment.

Degree and direction of twist. Degree of twist for all observed threads was high. High twist threads are appropriate for use in structural seams to help withstand stress during use of the garment. High twist threads also appear to be appropriate for use in sewing machines, based on the number of observations recorded. External or final direction of twists for all threads in machine-sewn seams were S.

Color. The dominant thread color was the brown color range with 161 specimen observations accounting for 52% of the occurrences. Black thread occurred in 21% of the specimen observations, and white thread occurred in 11% of the specimen observations, as shown in Table 13.

Table 13

Color Specimen Observations for Machine-Sewn Seams

Color	Number of Machine-Sewn Observations	Percent of Machine-Sewn Observations	Percent of Total Sample Observations
White	33	11	11
Black	66	21	19
Brown	161	52	53
Blue	14	5	6
Yellow	1	1	1
Green	8	3	2
Red	28	9	8
Total	311	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Color match between thread and fabric. The highest number of specimen observations recorded for color match between thread and fabric was graded 5, no contrast, for 61% of the machine-sewn occurrences, while color match grading 1, extreme contrast, accounted for 22% of the machine-sewn specimen observations, as shown in Table 14. Approximately 77% of the machine-sewn observations were graded a close match, 4 or higher, compared to 76% of occurrences for the total sample.

Table 14

Color Match Between Thread and Fabric Specimen Observations for Machine-Sewn Seams

Color Match	Number of Machine-Sewn Observations	Percent of Machine-Sewn Observations	Percent of Total Sample Observations
1 (Extreme Contrast)	67	22	24
1-2	0	0	0
2	0	0	0
2-3	0	0	0
3	0	0	0
3-4	2	1	1
4	51	16	15
4-5	0	0	1
5 (No Contrast)	191	61	60
Total	311	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Assembly of Machine-Sewn Seams

The following sections present the results for the two stitch types, chain stitch and lockstitch, identified in machine-sewn seams.

Chain Stitch

A small number of the seam and stitching locations viewed from the sample were assembled using a single chain stitch; 13% of the specimen observations in machine-sewn seams were chain stitch.

Garment variables. Garment variables for chain stitch specimen observations included year group, year, seam or stitching function, and specimen location. Stitch types will not be discussed in this section because all observations in this section are from chain stitch specimens.

Year group. Six specimen observations of chain stitch (29%) were noted for each of the three year groups, 1880-1884, 1895-1899, and 1905-1909, see Table 15. These percentages were higher than the distribution of machine-sewn observations. The large range in chain stitch observation percentages is due to the number of multiple chain stitch observations recorded from single garments, as explained under the year variable.

Table 15

Distribution of Chain Stitch Thread Specimen Observations by Year Group

Year Group	Number of Chain Stitch Observations	Percent of Chain Stitch Observations	Percent of Machine-Sewn Observations
1880-1884	6	29	15
1885-1889	2	10	19
1890-1894	0	0	11
1895-1899	6	29	21
1900-1904	1	5	19
1905-1909	6	29	15
Total	21	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Year. The largest number of observations by year group for chain stitch thread specimen observations was for 1880 with six of the 26 machine-sewn seam observations (29%). All of these six observations were from the same garment. The year 1909 followed which accounted for 24% of the specimen observations, all in the same garment. The three specimen observations recorded for 1898 were also from the same garment. Two specimen observations were recorded for 1886 and 1895 each. The remaining observations (10%) were for 1897, 1900, and 1907, each had one specimen observation recorded for 5%.

Seam or stitching function. Of these 21 chain stitch locations, 13 (62%), versus 87% for machine-sewn seams, were in structural seams. Eight observations (38%) were in non-structural seams and stitching locations, versus 13% for machine-sewn seams. The low number of single chain stitch seams may be attributed to the large number of lockstitch machines available after 1880 (Bourne, 1895).

Specimen location. The largest number of chain stitch structural seam locations were for vertical sleeve, four specimen observations (31%); armscye seams and bodice side seam, three specimen observations (23% each); bodice or skirt horizontal waist seam, two specimen observations (15%); and one specimen observation for center back bodice seam (8%). The largest number of observations for structural seams in chain stitch locations were similar to those for machine-sewn, vertical sleeve seam, for 31% and 28% respectively.

Non-structural seam or stitching specimen observations were four for hem (50%), two for seam finishes (25%), and one (13%) each for bodice placket seam and pleat anchor stitches. The largest number of observations for non-structural locations for machine-sewn seams were for hems (71%). Seam finishes accounted for only 15% of the machine-sewn seams.

Thread variables. Thread variables for chain stitch seams included all designated variables.

Configuration. All of the configurations found in chain stitch seams were 3/2-cord.

Degree and direction of twist. All chain stitch thread specimens from machine-sewn seams or stitchings had a high degree of twist and S direction of twist.

Color. Additional characteristics observed in chain stitch seams include high levels of threads with thread color designation of brown color range at 48% (see Table 16) of the specimen observations. White threads accounted for 43% of the specimen observations which is much higher than the percentage recorded for machine-sewn seams.

Table 16

Color Specimen Observations for Chain Stitch Seams

Color	Number of Chain Stitch Observations	Percent of Chain Stitch Observations	Percent of Machine-Sewn Observations
White	9	43	11
Black	2	10	21
Brown	10	48	52
Blue	0	0	5
Yellow	0	0	1
Green	0	0	3
Red	0	0	9
Total	21	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Color match between thread and fabric. Thread color match grades of 5, no contrast, between thread and fashion fabric accounted for 52% of the specimen observations, see Table 17. The remaining specimen observations were for color match grade 1, extreme contrast, designation (19%). Percentages for close match grades, 4 or higher, were recorded for 81% of the observations found in chain stitch locations. Close match grades for machine-sewn seams were 77%.

Table 17

Color Match Between Thread and Fabric Specimen Observations for Chain Stitch Seams

Color Match	Number of Chain Stitch Observations	Percent of Chain Stitch Observations	Percent of Machine-Sewn Observations
1(Extreme Contrast)	4	19	22
1-2	0	0	0
2	0	0	0
2-3	0	0	0
3	0	0	0
3-4	0	0	1
4	6	29	16
4-5	0	0	0
5 (No Contrast)	11	52	61
Total	21	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Lockstitch Seams

Lockstitch seams accounted for 87% of the stitch types in machine-sewn seams.

Garment variables. Garment variables for lockstitch specimen observations include year group, year, seam or stitching function, and specimen location. Stitch types will not be discussed in this section because all observations in this section are from lockstitch specimens.

Year group. The largest number of specimen observations by year groups for lockstitch seams were 1895-1899 year group (21%) followed by year groups 1885-1889 and 1900-1904 accounting for 20% each. The percentages recorded observed by year group for lockstitch seams parallel the percentage distributions recorded for machine-sewn seams.

Table 18

Distribution of Lockstitch Thread Specimen Observations by Year Group

Year Group	Number of Lockstitch Observations	Percent of Lockstitch Observations	Percent of Machine-Sewn Observations
1880-1884	40	14	15
1885-1889	58	20	19
1890-1894	34	12	11
1895-1899	60	21	21
1900-1904	58	20	19
1905-1909	40	14	15
Total	290	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Year. Highest number of year specimen observations from the study were 42 for 1900 (15%, versus 14% for machine-sewn seams), 38 for 1897 (13% each for lockstitch and machine-sewn seams), and 26 for 9% (which accounted for all of the observations recorded for machine-sewn seams) for 1885 and 1893. Table 19 shows the comparison of lockstitch thread observations to the percent of machine-sewn seams.

Seam or stitching function. Seam or stitching function for lockstitch seams had 119 specimen observations, or 82% in

Table 19

Distribution of Garments and Thread Specimens for Lockstitch Seams and Stitchings by Year

Year	Number of Lockstitch Observa-tions	Percent of Lockstitch Observa-tions	Percent of Machine-Sewn Observa-tions	Year	Number of Lockstitch Observa-tions	Percent of Lockstitch Observa-tions	Percent of Machine-Sewn Observa-tions
1880	20	7	8	1895	22	8	8
1881	2	1	1	1896	0	0	0
1882	0	0	0	1897	38	13	13
1883	12	4	4	1898	0	0	1
1884	6	2	2	1899	0	0	0
1885	26	9	8	1900	42	15	14
1886	8	3	3	1901	0	0	0
1887	0	0	0	1902	10	3	3
1888	8	3	3	1903	6	1	2
1889	16	6	5	1904	0	0	0
1890	4	1	1	1905	10	3	3
1891	0	0	0	1906	0	0	0
1892	4	1	1	1907	8	3	3
1893	26	9	8	1908	22	8	7
1894	0	0	0	1909	0	0	3
				Total	290	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

structural seams versus 87% for machine-sewn seams. The remaining 26 specimen observations (18%) were for non-structural seams and stitchings, versus 21% in machine-sewn seams.

Specimen location. The largest number of observations by specimen location for lockstitch seams was recorded for vertical sleeve seams, with 33 specimen observations (28%). The percentages for machine-sewn were 28%. The bodice side seam specimen location had the second highest number of specimen observations, 32 (27%), versus 27% machine-sewn seams. The next highest number of observations for lockstitch seams was recorded for armscye seams (23%) (see Table 20). This amount is higher than the percentages reported for chain stitch seams (14%). The percentage for machine-sewn seams and was 24% for armscye seams. Hems accounted for 78% of the non-structural locations observed for lockstitch seams followed by seam finishes for 12%.

Thread variables. Thread variables for lockstitch seams include all designated variables.

Configuration. Configurations for threads in lockstitch seams were 286 specimen observations (99%) with 3/2-cord and four specimen observations (1%) for 2-ply. Four specimen observations were recorded for 2-ply configuration. These observations were found in the same 1885 garment. The 2-ply thread was used in bodice side seam and vertical sleeve seam locations.

Degree and direction of twist. All lockstitch thread specimens from machine-sewn seams or stitchings had a high degree of twist and S direction of twist.

Table 20

Specimen Locations Observed for Lockstitch Seams

Seam or Stitching Function	Specimen Location	Number of Observa-tions	Percent of Observa-tions
S	Vertical Sleeve Seam	33	28
S	Bodice Side Seam	32	27
S	Armscye Seam	27	23
S	Bodice or Skirt Horizontal Waist Seam	21	18
S	Shoulder Seam	2	2
S	Back Bodice Vertical Seam	1	1
S	Center Back Seam	1	1
S	Back Bodice Princess Side Seam	1	1
S	Vertical Skirt Seam	1	1
Total		119	100
NS	Hem	20	78
NS	Seam Finishes	3	12
NS	Piecing Seam	2	8
NS	Specialty Anchoring Stitches	1	4
Total		26	100

S=Structural Seams
NS=Non-Structural Seams or Stitchings
Note: Percentage totals do not equal 100% due to the rounding off of percentages.

Color. There was a minimal number of differences in specimen observations recorded for color in sewing threads used in lockstitch stitch types when compared to machine-sewn seams. There were 151 specimen observations (52%) for brown color range and 64 observations (22%) for black thread. Observations for white threads accounted for 8% of the observations from lockstitch seams, see Table 21.

Table 21

Color Specimen Observations for Lockstitch Seams

Color	Number of Lockstitch Observations	Percent of Lockstitch Observations	Percent of Machine-Sewn Observations
White	24	8	11
Black	64	22	21
Brown	151	52	52
Blue	14	5	5
Yellow	1	1	1
Green	8	3	3
Red	28	10	9
Total	290	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Color match between thread and fabric. The dominant thread color match, 5 match grade, no contrast, accounted for 62% of the specimen observations (see Table 22). Color match percent for rate 1, extreme contrast, was for 21%. Overall a close match grade, 4 or higher, accounted for 77% of the observations in all of the machine-sewn groups.

Garment and Thread Characteristics of Threads Applied by Hand

Research Objective 2: To document garment and thread characteristics for sewing thread used in handsewn seams or stitchings in women's dresses and suits made in the U.S. between 1880 and 1909.

Handsewn Seams

The handsewn stitch type viewed during the study had a count of 106, or 25% of the stitches viewed in the total sample. Hand stitching declined as sewing machines were invented and perfected to stitch the variety of seams and stitchings in apparel.

Table 22

Color Match Between Thread and Fabric Specimen Observations for Lockstitch Seams

Color Match	Number of Lockstitch Observations	Percent of Lockstitch Observations	Percent of Machine-Sewn Observations
1 Extreme Contrast)	63	21	22
1-2	0	0	0
2	0	0	0
2-3	0	0	0
3	0	0	0
3-4	2	1	1
4	45	16	16
4-5	0	0	0
5 (No Contrast)	180	62	61
Total	290	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Garment Variables

Garment variables for handsewn specimen observations include year group, year, seam or stitching function, and specimen location. Stitch types will not be discussed in this section because all observations in this section are from handsewn specimens.

Year group. The highest number of the specimen observations was collected for year group 1880-1884 for 23% which was 8% higher than machine-sewn observations and 6% higher than total sample observations (see Table 23). Year group 1885-1889 had 21 handsewn seam specimen observations (20%) followed by year group 1895-1899 with 19% of the observations.

Table 23

Distribution of Handsewn Thread Specimen Observations by Year Group

Year Group	Number of Handsewn Observations	Percent of Handsewn Observations	Percent of Machine-Sewn Observations	Percent of Total Sample Observations
1880-1884	24	23	15	17
1885-1889	21	20	19	19
1890-1894	15	14	11	12
1895-1899	20	19	21	21
1900-1904	17	16	19	18
1905-1909	9	8	15	13
Total	106	100	100	100

Year. From the total specimen observations for handsewn seams, 1900 had the highest number of observations (12%). The year 1900 accounted for 13 of the 56 observations from the total sample. The next highest year, 1885, had 10 specimen observations (9%) of the observations recorded for handsewn seams, see Table 24.

Seam or stitching function. The non-structural seam or stitching function accounted for the majority of handsewn stitches (78%), in contrast to machine-sewn stitches. Many of the non-structural locations were from stitchings for finishing and closure purposes, which could not be completed using existing sewing machines and helps to explain the high percentage of non-structural observations. Structural seams accounted for 87% of the machine-sewn stitches and 43% of the total sample. A total of 106 specimen observations were recorded for handsewn seams or stitchings.

Table 24

Distributions of Garment and Thread Specimens for Handsewn Seams and Stitchings by Year

Year	Number of Garment Observa-tions	Number of Handsewn Observa-tions	Percent of Handsewn Observa-tions	Year	Number of Garment Observa-tions	Number of Handsewn Observa-tions	Percent of Handsewn Observa-tions
1880	33	7	7	1895	31	7	7
1881	6	5	5	1896	0	0	0
1882	0	0	0	1897	47	8	8
1883	15	9	9	1898	8	5	5
1884	6	3	3	1899	0	0	0
1885	36	10	9	1900	56	13	12
1886	11	1	1	1901	0	0	0
1887	0	0	0	1902	11	1	1
1888	11	3	3	1903	9	3	3
1889	23	7	7	1904	0	0	0
1890	9	5	5	1905	13	3	3
1891	0	0	0	1906	0	0	0
1892	8	4	4	1907	11	2	2
1893	32	6	5	1908	24	2	2
1894	0	0	0	1909	7	2	2
				Total	417	106	100

Note: Percentage total does not equal 100% due to the rounding off of percentages.

Specimen location. Four of the five structural seam specimen locations with observations from handsewn areas accounted for 22 of the 106 specimen observations recorded from the handsewn group. The two highest structural handsewn specimen locations were bodice or skirt horizontal waist seams (39%) and armscye seams (30%), see Table 25. Non-structural specimen observations were more distributed: 49% were seam finishes, 18% at hem sites, 12% of buttonhole locations, and 8% of hook attachment sites.

Table 25

Specimen Locations Observed for the Handsewn Seams and Stitchings

Seam or Stitching Function	Specimen Location	Number of Observa-tions	Percent of Observa-tions
S	Bodice or Skirt Horizontal Waist Seam	9	39
S	Armscye Seam	7	30
S	Bodice Side Seam	4	17
S	Vertical Sleeve Seam	2	9
S	Back Bodice Vertical Seam	1	4
Total		23	100
NS	Seam Finishes	41	49
NS	Hem	15	18
NS	Buttonhole Stitches	10	12
NS	Hook Attachments	7	8
NS	Basting Stitches	3	4
NS	Bodice Placket Seam	2	2
NS	Darning Stitches	2	2
NS	Specialty Anchoring Stitches	1	1
NS	Pleat Anchor Stitches	1	1
NS	Sleeve Godet Seam	1	1
Total		83	100

S=Structural Seams
NS=Non-structural Seams or Stitchings
Note: Percentage totals do not equal 100% due to the rounding off of percentages.

Thread Variables

Thread variables for handsewn seams and stitchings include all designated variables.

Configuration. Exceptions to the dominant 3/2-cord thread found in handsewn seams included eight specimen observations for 2-ply and for 3-ply. The 2-ply configuration specimen observations came from 1883, 1886, 1889, and 1902 garments and were used for anchoring stitches, basting stitches, and seam finishes. The 1883 2-ply thread was green with high degree of twist. The 1886 thread was red with medium degree of twist. The 1889 garment had two brown 2-ply threads, with a low and a high degree of twist. The 1902 garment had a single black, 2-ply thread, with low degree of twist. The specimen observations for 3-ply configurations were from the same 1885 garment and was used in the hem area, for basting stitches, and to attach hooks were brown with a medium, a high, and a low degree of twist.

Degree of twist. The dominant degree of twist designation was high (88%) which was lower than the 100% recorded for machine-sewn seams and the 97% recorded for the total sample. Specimen observations recorded threads with low (10%) and medium (2%) degrees of twist were observed more frequently in handsewn non-structural stitchings than in machine-sewn seams and the total sample. Medium degree of twist was present in garments from 1885 and 1888. Low degree of twist threads were found in garments from 1881, 1883, 1885, 1889, 1895, and 1902.

Direction of twist. The single exception for S direction of twist was found in the handsewn hem of an 1885 garment. The thread had medium degree of twist along with 3-ply configuration.

Color. Color characteristics were also consistent across handsewn, machine-sewn, and total samples. Threads in the brown color range were dominant (see Table 26). There were fewer observations for black threads in handsewn seams and stitchings than in machine-sewn seams or the total sample. The remaining color observations for handsewn seams and stitchings did not differ by more than 2% from the color observations recorded for machine-sewn seams and the total sample.

Table 26

Color Specimen Observations for Handsewn Seams and Stitchings

Color	Number of Handsewn Observations	Percent of Handsewn Observations	Percent of Machine-Sewn Observations	Percent of Total Sample Observations
White	14	13	11	11
Black	14	13	21	19
Brown	60	57	52	53
Blue	9	8	5	6
Yellow	1	1	1	1
Green	1	1	3	2
Red	7	7	9	8
Total	106	100	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Color match between thread and fabric. Color match 5 gradings, no contrast, for match between thread and fashion fabric accounted for 56% of the specimen observations, see Table 27. There were 33 specimen observations (31%) for color match 1 grades, extreme contrast. Close match grades, 4 and higher, accounted for 68% of the observations in handsewn stitches versus 77% for machine-sewn stitches. In comparison with threads used in machine-sewn seams, handsewn stitches appear slightly less likely to closely match the fashion fabric.

Table 27

Color Match Between Thread and Fabric Specimen Observations for Handsewn Seams and Stitchings

Color Match	Number of Handsewn Observations	Percent of Handsewn Observations	Percent of Machine-Sewn Observations	Percent of Total Sample Observations
1 Extreme Contrast)	33	31	22	24
1-2	0	0	0	0
2	0	0	0	0
2-3	0	0	0	0
3	0	0	0	0
3-4	1	1	1	1
4	12	11	16	15
4-5	1	1	0	1
5 (No Contrast)	59	56	61	60
Total	106	100	100	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Total Sample Comparisons by Year Group

Research Objective 3: To determine dominant garment and thread variables observed by five year period periods beginning in 1880 and ending in 1909.

Year Group Documentation Comparisons

Comparisons between specimen observations were completed for identification of similarities and differences in the garment and thread characteristics recorded by year group for the total sample. Year group characteristics were examined to identify dominant thread characteristic within specified time periods. Comparisons were not completed across year groups due to the uneven year to year distribution of garments.

Garment and Thread Variables

Garment variables discussed in each five year group include year and stitch type. Thread variables include configuration, degree of twist, direction of twist, color, and color match between thread and fabric. Dominant characteristics for each year group are presented along with anomalies. Tables 28 through 33 present garment characteristic for stitch type and thread characteristics for configuration, degree of twist, color, and color match frequencies by year group.

1880-1884. Dominant garment characteristics for year group 1880-1884 were 1880 for year (47%) and machine-sewn (52%) stitch type (see Table 28). Forty percent of the observations were lockstitch. Dominant thread characteristics for year group 1880-1884 were 3/2-cord configuration (99%), high degree of twist (93%), and S direction of twist (100%).

Brown color range was the dominant color (80%) and color match grading of 5, no contrast, was 43%. Additional color observations included 13% for blue, 6% for red, and 1% for black. Blue threads were located in two structural seams sewn with lockstitch (4 total observations). The remaining five observations were in handsewn non-structural locations. For red threads, two were from handsewn structural locations and 2 from handsewn non-structural locations. The single black thread observation was from a handsewn non-structural location. Match levels between thread and fabric had extreme contrast levels, gradings of 1, for 3% of the specimen observations. Close match gradings, 4 or higher, accounted for 69% of the observations.

Exceptions to the dominant characteristics are provided below. One specimen observation was recorded for 2-ply thread in this year group. The 2-ply thread was found in an 1883 garment, used for non-structural anchoring purposes, and characterized by a high degree of twist, color green, with match grade of 1 for extreme contrast. There were 5 specimen observations for low degree of twist. The threads with low degree of twist were from 1881 and 1883 garments. Four observations were from the 1881 garment. The thread had a 3/2-cord configuration, blue color, and color match grading of 1 for extreme contrast. All four observations were of handsewn stitch types. Structural specimen locations were bodice side seam and horizontal waist seam. Non-structural observations were from edge finish and hem locations. The 1883 garment thread found in a handsewn non-structural hem was 3/2-cord configuration and blue with match grading of 5, no contrast. Exceptions observed for year group appear to be anomalies in selected thread configuration and degree of twist. All exceptions were recorded from two garments and do not show a pattern of use for these characteristics.

1885-1889. For the year group 1885-1889, lockstitch was the dominant stitch type with 56% of the specimen observations for machine-sewn seams (60%), Table 29. The dominant configuration was 3/2-cord with high degree of twist (93%), and S direction of twist.

Exceptions for configuration were six observations (7%) for 2-ply thread and three observations (4%) for 3-ply thread. Four of the 2-ply threads were from two lockstitch seams. Both of these seams appeared in the same garment (1885) and were in structural specimen locations of bodice side seam and vertical sleeve seam. The remaining 2-ply observations were from handsewn

Table 28

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1880-1884 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	26	52
Chain	(6)	(12)
Lockstitch	(20)	(40)
Handsewn	24	48
Overall	50	100
Configuration		
3/2-Cord	69	99
2-Ply	1	1
3-Ply	0	0
Overall	70	100
Degree of Twist		
High	65	93
Medium	0	0
Low	5	7
Overall	70	100
Color		
White	0	0
Black	1	1
Brown	56	80
Blue	9	13
Yellow	0	0
Green	0	0
Red	4	6
Overall	70	100
Color Match		
1	22	31
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	0	0
4	18	26
4-5	0	0
5	30	43
Overall	70	100

non-structural locations in an 1889 garment. The 3-ply observations were all collected from the same garment, an 1885 dress. The only example of a thread with Z direction of twist had medium degree of twist and 3-ply configuration found in handsewn hem stitches. The remaining specimens were from non-structural handsewn stitches for basting and hook attachments.

Specimens with medium degree of twists (3%) were present in a seam finish and hem from 1885 and 1886 garments. A low degree of twist (5%) was found in non-structural seams and stitchings. Observations were from the following years: 1885 (two observations) and 1889 (two observations).

Brown color range (65%) was the dominant thread color followed by black (21%), blue (7%), and red (6%). Dominant color match levels between thread and fabric were 5, no contrast, and 1, extreme contrast, accounting for 48% each. The 2-ply and 3-ply configurations did not show distinct patterns of use in regards to color match with fabric. Portions of the exceptions had match grades of 5, no contrast, and 1, extreme contrast.

1890-1894. The year with the highest number of specimen observations was 1893. For this year group, 1890-1894, 53% of the stitch types were lockstitch (see Table 30). The remaining stitch type recorded for this year group was handsewn seams and stitchings. This is the only year group with no specimen observations for chain stitch. All of the specimen observations for configuration were for 3/2-cord thread with a high degree of twist and S direction. For this year group, 1890-1894, red was the dominant thread color (33%). Fourteen of the 16 red threads were from lockstitch locations. The remaining two observations were

Table 29

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1885-1889 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	31	60
Chain	(2)	(4)
Lockstitch	(29)	(56)
Handsewn	21	40
Overall	52	100
Configuration		
3/2-Cord	72	89
2-Ply	6	7
3-Ply	3	4
Overall	81	100
Degree of Twist		
High	75	93
Medium	2	2
Low	4	5
Overall	81	100
Color		
White	0	0
Black	17	21
Brown	53	65
Blue	6	7
Yellow	0	0
Green	0	0
Red	5	6
Overall	81	100
Color Match		
1	39	48
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	0	0
4	3	4
4-5	0	0
5	39	48
Overall	81	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

found in handsewn non-structural locations. Red threads were found in three of the six garments in this year group. Red was followed by black (31%), and brown and green color ranges (18% each). Green threads were found in lockstitch structural locations and handsewn non-structural locations. Color match for year group 1890-1894 were grade 5, no contrast, (49%). Color grading of 4 (29%) and grading of 1 (22%) were also recorded. Close match gradings, 4 or higher, accounted (78%) of the observations. The increased percentage of thread colors other than brown color range and black, along with match 5 grades may be an indication of the technological changes occurring in thread and fabric during the time period. The match grades of 4 or higher are at least 9% higher than reported for the preceding year groups.

1895-1899. The dominant year was 1897 for year group 1895-1899 with 47 (81%) specimen observations. The majority of the stitch types was lockstitch (54%) (see Table 31). All but one specimen observations were 3/2-cord configuration with high degree of twist. All threads had S direction of twist. The single exception found in an 1895 garment was a brown thread with 2-ply thread configuration with low twist and a match grading of 5, no contrast.

The dominant color for year group 1895-1899 was brown color range (51%). Other thread colors recorded included black (26%) and white (20%). The remaining colors, blue locations. The dominant color match grading was 5, no contrast (59%) followed by grading 1, extreme contrast (27%). Close match gradings, 4 or higher, accounted for 72% of the observations. Exceptions to the dominant characteristics appear to be anomalies and do not indicate varying patterns for thread characteristics in this year group.

Table 30

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1890-1894 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	17	53
Chain	(0)	(0)
Lockstitch	(17)	(53)
Handsewn	15	47
Overall	32	100
Configuration		
3/2-Cord	49	100
2-Ply	0	0
3-Ply	0	0
Overall	49	100
Degree of Twist		
High	49	100
Medium	0	0
Low	0	0
Overall	49	100
Color		
White	0	0
Black	15	31
Brown	9	18
Blue	0	0
Yellow	0	0
Green	9	18
Red	16	33
Overall	49	100
Color Match		
1	11	23
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	0	0
4	14	29
4-5	0	0
5	24	49
Overall	49	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Table 31

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1895-1899 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	36	65
Chain	(6)	(11)
Lockstitch	(30)	(54)
Handsewn	24	35
Overall	56	100
Configuration		
3/2-Cord	85	99
2-Ply	1	1
3-Ply	0	0
Overall	86	100
Degree of Twist		
High	85	99
Medium	0	0
Low	1	1
Overall	86	100
Color		
White	17	20
Black	22	26
Brown	44	51
Blue	1	1
Yellow	2	2
Green	0	0
Red	0	0
Overall	86	100
Color Match		
1	23	27
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	1	1
4	11	13
4-5	0	0
5	51	59
Overall	86	100

1900-1904. Fifty-six specimen observations were recorded for the year 1900 making it the dominant year. The dominant stitch type was lockstitch with 29 specimen observations (62%) (see Table 32). Of the 76 specimen observations, 75 were for 3/2-cord thread. The single exception was a low twist, 2-ply thread of a 1902 garment, found in a handsewn non-structural seam/stitching location. All other threads had high degree of twist.

Dominant color for year group 1900-1904 was brown color range, with 61% of the specimen observations. Black thread had the next highest number of observations (18%) and white (one) and yellow (two), were from handsewn non-structural (13%). Six observations for blue threads were recorded from a 1900 garment with high degree of twist from lockstitch structural locations. All observations had close match grades, 4 or higher. The match colors between thread and fabric grading for 1900-1904 were 5 (88%) and 4 (12%) of the specimen observations. There are continued observations for white threads indicating that the appearance during the previous year group was not an anomaly and indicates a pattern of use.

1905-1909. The highest number of observations for any year (24) was 1908 for year group 1905-1909. The dominant stitch type was lockstitch with 57% of the specimen observations for machine-sewn seams (74%) (see Table 33). All of the specimen observations for configuration were 3/2-cord thread, high degree of twist, and S direction of twist. White was the dominant color (36%) for year group 1905-1909, followed by brown color range (24%), and black (20%). Ten observations for red threads were recorded from a 1908 garment with lockstitch structural and non-structural locations.

For color match the dominant grading was 5 (71%) of the specimen observations. Exceptions to the dominant characteristics appear to be anomalies and do not indicate varying patterns for thread characteristics in the year group.

Dominant characteristics for each year group are presented in Table 34. Year groups show consistent similarities for many of the garment and thread characteristics.

Table 32

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1900-1904 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	30	64
Chain	(1)	(2)
Lockstitch	(29)	(62)
Handsewn	17	36
Overall	47	100
Configuration		
3/2-Cord	75	99
2-Ply	1	1
3-Ply	0	0
Overall	76	100
Degree of Twist		
High	75	99
Medium	1	1
Low	0	0
Overall	76	100
Color		
White	10	13
Black	14	18
Brown	46	61
Blue	6	8
Yellow	0	0
Green	0	0
Red	0	0
Overall	76	100
Color Match		
1	0	0
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	0	0
4	9	12
4-5	0	0
5	67	88
Overall	76	100

Table 33

Frequencies and Percentages for Garment and Thread Characteristics by Year Group 1905-1909 for Total Sample

Characteristics	Number of Observations	Percent of Observations
Stitch Type		
Machine-sewn	26	74
Chain	6	17
Lockstitch	20	57
Handsewn	9	26
Overall	35	100
Configuration		
3/2-Cord	55	100
2-Ply	0	0
3-Ply	0	0
Overall	55	100
Degree of Twist		
High	55	100
Medium	0	0
Low	0	0
Overall	55	100
Color		
White	20	36
Black	11	20
Brown	19	24
Blue	1	2
Yellow	0	0
Green	0	0
Red	10	18
Overall		100
Color Match		
1	5	9
1-2	0	0
2	0	0
2-3	0	0
3	0	0
3-4	2	4
4	8	15
4-5	1	2
5	39	71
Overall	55	100

Note: Some percentage totals do not equal 100% due to the rounding off of percentages.

Table 34

Dominant Garment and Thread Characteristics by Year Group

Year Group	1880-1884	1885-1889	1890-1894	1895-1899	1900-1904	1905-1909
Year	1880	1885	1893	1897	1900	1908
Seam/Stitching Func.	Structural	Structural	Structural	Structural	Structural	Structural
Spec. Location	Vertical Sleeve	Bodice Side Vertical Sleeve	Bodice Side Vertical Sleeve	Bodice Side Vertical Sleeve	Bodice Side Vertical Sleeve	Horz. Waist Armscye Hem
Stitch Type	Machine-Sewn	Machine-Sewn	Machine-Sewn	Machine-Sewn	Machine-Sewn	Machine-Sewn
Configuration	3/2-Cord	3/2-Cord	3/2-Cord	3/2-Cord	3/2-Cord	3/2-Cord
Degree of Twist	High	High	High	High	High	High
Direction of Twist	S	S	S	S	S	S
Color	Brown	Brown	Red	Brown	Brown	White
Color Match	5	1 & 5	5	5	5	5

CHAPTER SIX - SUMMARY, CONCLUSION, IMITATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

This study investigated the similarities and differences of thread characteristics of sewing thread used in machine and handsewn structural and non-structural seams assembling women's dresses and suits made in the U.S. during the time period between 1880 and 1909. Thread variables included configuration, degree of twist, direction of twist, color, and color match of thread with fashion fabric.

Summary and Conclusions

Based on the current literature review, there are no studies that comprehensively document the types of cotton sewing threads manufactured and used in the production of late nineteenth and early twentieth century clothing. There are currently no definitive guides to identify threads manufactured during the nineteenth century. Identification of thread characteristics typical of that period could be useful for dating garments and differentiating between original and altered seams in historical apparel.

Nine garments were available for use in the study from the Smithsonian Institution. Thirty garments were available from the Valentine Museum. Thread observation sites were investigated for a minimum five structural and non-structural locations for each garment for 195 observation sites. An additional 77 sites from thread locations that appeared to differ from specified locations were also included for 272 observation sites. Total observation threads from the garments were 417, accounting for the second thread provided by 145 lockstitch locations.

All data were collected through the use of noninvasive methods. Methods used to record stitch type, color, and color match rates included naked-eye observation. Thread configuration, direction of twist, and degree of twist were recorded using a modification of Amin’s (1970) methodology. This noninvasive methodology was used for recording thread characteristics of plied yarns as they-lay-in-the-ply.

The data collection form was developed to record garment and sewing thread characteristics. Variables were selected to help identify similarities and differences of sewing thread characteristics among garments from the time period in the study. Garment variables in the research were year group, year, seam function, specimen location, and stitch type. Years between 1880 and 1909 were grouped into six categories using five year increments (year groups). Five year increments were selected to allow the inclusion of garments with non-discrete dates or date spans (i.e., garment dated 1902-1903). Year variable was the date attributed to the garment by the museum staff. Seam function referred to the classification of the seam or stitches functional contribution to the garment. Seam functions were structural (joining garment components) and non-structural (adding finishing, utilitarian, or decorative features). The fourth garment variable, specimen location, referred to specific sites on the garment that allowed opportunity to review sewing thread characteristics. Stitch type (chain stitch, lockstitch, and handsewn) was selected to identify stitchings in the garments as identified in FED-STD-751A.

Thread variables selected for the study included configuration, degree of twist, direction of twist, thread color, and color match for thread and fashion fabric. Thread configuration recorded the component assembly of the sewing thread; degree of twist, the subjective categorization of number of turns per unit of length about the longitudinal axis of the thread; and direction of twist, direction of fibers, plys, or cords along longitudinal axis of sewing thread. Color classified broad color designations (such as brown, inclusive of brown, tan, and cream variations) of threads, and color match rated perceived differences between thread and fashion fabric.

In satisfying the research objectives of the study, frequencies were used to record distribution of garment and thread characteristics. Frequencies distributions were used to indicate the number of occurrences for the variables and defined the percentage of each occurrence within the sample.

Research Objective 1: To document garment and thread characteristics for sewing thread used in machine-sewn seams in women's dresses and suits made in the U.S. between 1880 and 1909.

Sampling decisions and criteria concerning number of garments per year group, seam function, and specimen location may be influencing frequency distributions of thread variables. Results showed that the year group, 1895-1899, had a larger set of observations (21%) for this grouping than any other year group. Structural seams accounted for 57% of the specimen observations and 80% of the machine-sewn observations. Lockstitch accounted for 87% of the observed machine-sewn seams.

The trend for configuration of thread was 3/2-cord, accounting for 99% of the machine-sewn observations and 97% of the observations in the total sample. Four observations were recorded for 2-ply thread forming lockstitch seams in an 1885 garment. For degree of twist, all observations had high twist designations.

Both 3/2-cord configuration and high twist may be attributed to strength and fineness requirements for hand and machine-sewing.

Direction of twist for all except one thread encountered was S. This exception was located in an 1885 garment hem. The thread had medium degree of twist and a 3-ply configuration. Current favored direction of twist for sewing thread is Z for use in single needle lockstitch machines (Glock and Kunz, 1995). The Z direction of twist is favored to help control or eliminate thread untwist and knotting as the thread is carried through the looping mechanisms of a sewing machine.

Thread color designations were highest for brown color range thread followed by black and white threads. Match ratings were high for 5, no contrast, for garments in the study, accounting for 60% of the threads observed.

Research objective 2: To document garment and thread characteristics for sewing thread used in handsewn seams or stitchings in women's dresses and suits made in the U.S. between 1880 and 1909.

The number of thread observations of handsewn seams and stitchings declined in the latter five year periods of the study (from 23% and 20% for 1880-1884 and 1885-1889 to 16% and 8% for 1900-1904 and 1905-1909). The lower number of non-structural seams and stitchings required for the study, a minimum of two for each garment, may be influencing relative frequencies of hand sewn seams. The number of observations for handsewn seams and stitchings could be affected by the increased use and number of sewing machines with the ability to duplicate hand stitches (Bourne, 1895).

Results showed trends towards high use of 3/2-cord thread (93%), with high degree of twist (88%), and S direction of twist

(99%) for handsewn seams and stitchings. Exceptions to the 3/2-cord configuration included five observations for 2-ply thread from 1883, 1886, 1889, and 1902 garments and three observations for 3-ply thread from an 1885 garment. Non-structural locations (78%), especially seam finish locations, were the favored seam function for handsewn seams and stitchings.

Research objective 3: To determine dominant garment and thread characteristics observed by five year periods beginning in 1880 and ending in 1909.

The dominant year for each year group is driven by the uneven number of garments within each year group. The number of specimen observations were also affected by the number of additional seams and stitchings recorded that appeared to have different thread characteristics from the mandatory five seams and stitchings.

The rising numbers of machine-sewn (lockstitch) seams may be attributed to the increasing number of sewing machines available as the study progresses. Bourne (1895) reported that sales were increasing for sewing machine. It was also reported that as sewing machine operators became more proficient and sewing machines became more proficient at replicating the function of hand stitches, their use increased (Farrell-Beck, 1987; Kidwell & Christman, 1974).

Configurations, degree of twist, and direction of twist may be greatly affected by thread characteristics required or desired for use with sewing machines. After 1860 the 3/2-cord was the preferred configuration for sewing machine use (Cooper, 1973). The majority of the threads observed in this study had 3/2-cord configuration (97%), high degree of twist (97%), and S direction of twist (99%).

Brown color range was the dominant thread color for observations from four of the six year groups, 1880-1884, 1885-1889, 1895-1899, and 1900-1904. For the year group 1890-1894 red was the dominant color (33%). Red threads were found in 50% of the garments observed during this year group. White thread observations were not recorded until the 1895-1899 year group (20%) and accounted for 13% in year group 1900-1904, and 36% for year group 1905-1909. The latter entries of white thread in specimen observations may be due to advancing technological capabilities in the areas of dyes and coloration. Thread color, white, may also become more prominent as the study continues due to the introduction of clothing styles of lighter fabrics. Furthermore, with advancing coloration technology, such as increased range of color variation, the ability to match thread to fabric would increase.

Limitations and Suggestions for Future Research

There were limitations for this research that impacted the results of this study. Guidance for future research is based on the consideration of the limitations and the results from the study. Areas of consideration include generalizability of the results, sample diversity, and variable analysis.

Use of a convenience sample limited the generalizability of the study. A qualitative study of sewing thread characteristics is needed to reveal some of the underlying factors that may have influenced the variables for this study, e.g., specimen location, configuration, color. Further refinement of variable analyses is needed to allow weighting of the variables in a quantitative study. With weighting of the variables, more accurate measures of association for a truer indication of significant relationships can be recorded and allow for inference to other samples.

Collection policies of the museum collections used for this study were accurate for current collection policies and did not reflect the collection policies and goals active during the periods when the studied garments were collected.
Similarities found among the variables may be attributed to the homogeneity of the collection items due to the similarities of the collection policies and social and political levels of the donors and owners. Items were from owners or donors that were politically active or socially prominent from unspecified geographic locations. Garments may not be representative of the range of American women's garments made by home sewers, dressmakers, and ready-made establishments in the United States during the period of 1880 to 1909. Likewise, the sample may not be representative of home sewing, dressmaking, and ready-made establishment production levels for American women's dresses and suits between 1880 and 1909, and of apparel in regards to use, style, fabrication, and construction for the time period of 1880 to 1909. Studies that include collections of more heterogeneous American women's items are needed to measure factors such as, cross section of threads used by dressmakers, homesewers, and ready-made establishments.

Thread characteristics were limited to those that could be assessed using noninvasive methods and therefore thread characteristics located in unreachable areas may not have been consistent with the threads observed in the garment. Original thread twists may have been altered by the addition or removal of thread twist during machine or hand sewing processes preventing the assessment of true degree of twist of the thread when selected by the seamstress/sewer.

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APPENDIX A

DATA COLLECTION SHEET

Collection: ________________________ Sample #: ______

Collection Date: ___________________

Accession #: _______________________

Catalogue #: _______________________

Donor : ____________________________

Description:

____

____

____

____

____

____

____

Manufacturer: ______________________________

Location: __________________________________

Garment Date: ____________________

Confirmation: ____________________

Sample Thread:

Seam/ Stitch Function	Specimen Location	Stitch Type	Configu-ration	Degree of Twist	Direction of Twist	Color	Match
Structural Seams	Bodice Side Seam						
	Vertical Sleeve Seam						
	Bodice/Skirt Horizontal Waist Seam						
Non-Structural Seams	Seam Finish						
	Hem						
	Buttonhole Stitches						

Additional Information:

VITA

Renee Susan Jackson

Date of Birth: September 15, 1960

Place of Birth: New York, New York

Major: Clothing and Textiles

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Education:

Virginia Commonwealth University Richmond, Virginia	8/79-5/83	B.F.A.
Virginia Polytechnic Institute and State University Blacksburg, Virginia	8/93-5/97	M.S.

Awards:

Commonwealth Fellowship Virginia Department of Education	8/97-8/98
Outstanding Graduate Student Virginia Polytechnic Institute and State University	8/93-8/94

Academic Experience:

Taught: Textile Science, Apparel Textile Lab
Fashion Design, Basic Pattern Drafting

Business Experience:

Smithsonian Institution,
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