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Date: 11.7.2019
Spinning Superior Socks
A Comparative Study of Hand Spun Sock Yarns

Prepared for the Olds College Master Spinners Program by Michelle Boyd
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Mara Mori brought me
a pair of socks
which she knitted herself
with her sheepherder’s hands,
two socks as soft as rabbits.
I slipped my feet into them
as though into two cases
knitted with threads of twilight and goatskin.

Violent socks,
my feet were two fish made of wool,
two long sharks
sea blue, shot through by one golden thread,
two immense blackbirds, two cannons, my feet were honored in this way
by these heavenly socks.

They were so handsome for the first time
my feet seemed to me unacceptable
like two decrepit firemen,
firemen unworthy of that woven fire,
of those glowing socks.

Nevertheless, I resisted the sharp temptation
to save them somewhere as schoolboys
keep fireflies,
as learned men collect
sacred texts,
I resisted the mad impulse to put them
in a golden cage and each day give them
birdseed and pieces of pink melon.

Like explorers in the jungle
who hand over the very rare green deer
to the spit and eat it with remorse
I stretched out my feet and pulled on
the magnificent socks and then my shoes.

The moral of my ode is this:
beauty is twice beauty,
and what is good is doubly good
when it is a matter of two socks
made of wool in the winter.

-Pablo Neruda
(Translated by Robert Bly)
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Introduction

The humble sock is often taken for granted. In our northern climate, most people wear socks daily for the larger part of the year, yet little or no consideration is given to the construction and materials used in these common garments. They can be easily obtained at any discount store for a nominal cost and are largely considered to be disposable. For the last half of the 20th century and into the 21st century, socks have become a mundane necessity.

Enter the hand spinner. While the vast majority of people take their socks for granted, those who create yarn from scratch appreciate socks. Hand spun and hand knit socks represent a creative expression, a small act of independence from globalization, or a measurable accomplishment. The gift of hand spun socks is a gift of warmth, comfort. The spinning of the yarn is relatively quick and the knitting is short-term and portable.

There are as many “perfect” hand spun sock yarns as there are hand spinners. Each person has their own preference of materials, technique, and ply. There are those who claim that blending in nylon will make the socks last forever, others who hate the texture added by nylon. Some spinners claim that a soft, cushy woollen sock yarn is warmer and more comfortable, while others argue that woollen yarns are not durable enough for the wear and tear that socks are subject to.

This study will endeavor to compare hand spun sock yarns based upon the most commonly encountered differences: woollen versus worsted; two-ply versus three-ply; with nylon blended in or not. As a natural alternative, a silk-blend will also be compared. These different yarn will be tested for comfort, warmth, durability and washability.

The study will begin with a comprehensive overview of the history of socks and the materials traditionally used, then will explore the materials currently used in commercially spun sock yarns. All yarns compared will be based upon the blends and grist used by most commercial mills, as most modern-day sock patterns are based upon those standards. Sample sock yarns will be knit into a standard sock pattern, then worn by a variety of testers, who will complete a survey of the comfort and warmth of the socks. Durability will be observed, and the impact of repeated washings noted.

The final results of these tests, while not expected to be definitive, will give guidelines for hand spinners to follow while designing their own sock yarns, enabling them to make the necessary choices to create their own “perfect” sock yarn.
Historical Overview

Since the beginning of time, human beings in cold, northern climates have worn a soft, protective covering on their feet. As most textiles do not survive in the archeological record, we can only speculate upon the earliest forms of these foot coverings based upon the tools used by early peoples.

The earliest garments worn to warm and protect the foot were most likely pieces of animal skins wrapped around the foot and tied in place with sinew. The neolithic ice mummy known as Otli (c. 5000 BCE), who was discovered in the Tyrolean Alps in 1991, wore boots of sewn animal skin, probably oxen. While he did not wear a specific garment to warm his feet inside his shoe, the shoes were lined with wadded grass for insulation and padding.¹

By 1000 BCE, there is firm evidence that a form of felted boot liner was used among the nomadic tribes of the Eurasian steppes. Mummies unearthed near Cherchen in the Chinese-administered Uyghur Autonomous Region were buried wearing boots as well as a colorful felted garment that was worn between the boot and the foot.² There is no apparent structure, such as weaving or knitting, involved in the construction of these garments, instead, they appear to have been formed of felted wool, with decorative seams re-enforcing joins³. The fact that these individuals were buried in brightly colored and carefully constructed garments suggests that the felted boot-liners were an important piece of their wardrobe. Other examples of this garment found in the region exhibit signs of deliberate construction and embellishment, and almost every mummy—man, woman and child—was found wearing some form of this garment.⁴

The first true socks appeared in the 2nd to 3rd century CE among the Berbers of the Middle East.⁵ These nomadic herders wore a garment inside their sandals to protect their feet from sand and stones. Surviving fragments of these so-called sandal socks show that they are constructed using a single-needle looping technique, which we now call Naalbinding. This technique made a flexible, yet sturdy, fabric that was elastic enough to mould close to the foot and stay in place without ties or garters. Through trade with other Middle Eastern cultures, most notably Coptic Egypt, this sock-like garment became widely worn in the region.

Often referred to as Coptic or Egyptian socks, these garments were made of either tightly spindle spun cotton or wool. They are ankle-high, with several rounds of ribbing near the top of the ankle. The socks appear to be worked from the toe up, frequently with a separation between the big toe and the rest of the foot. It is believed that this separation left room for the thong of a sandal. The heel is turned by means of a fold and a thick seam that leads up into the ribbing.⁶
Naalbinding socks also appear in Northern Europe by the 7th Century CE. It is presumed that the technique spread through Roman conquest of first Egypt, then northward through Germany and into Saxon England. Viking raiders carried the technique to Scandinavia, where it is still used to create socks to this day.

True knitting first appears in the form of socks, or more accurately, knee-length stockings from 7th century CE Egypt. These stockings are worked in the familiar toe-up style of the earlier Naalbinding socks, but are clearly knit in stockinette stitch. One fine example of this work is a fragment of knitted silk, worked to a gauge of 36 stitches to the inch. It is speculated that these stockings were knitted on metal rods, similar to modern-day double-pointed needles, as they are shaped through the foot with increases in the round. The leg portion of these stockings appear to have been knitted flat in order to incorporate traditional Islamic motifs and sayings, then seamed up the side of the leg.

The tradition of these knitted stockings travelled to Spain with the Moorish invaders in the 8th century CE. The Moorish and Jewish craftsmen in Spain during the Dark Ages were amongst the most skilled and admired in the world, and their work was exported to the royalty of France and Rome. By the turn of the new millennium in 1000 CE, the clergy of Europe and the royalty of England also wore knitted hose. Garments made of hand spun wool and linen, copying Spanish silk knitted hose soon became a part of every European’s wardrobe.

The hose that were worn in the Dark Ages bore little resemblance to the stockings and socks of today. Rather, they were a footless tubular garment that covered the leg from the ankle to the top of the thigh. They were loose-fitting and had to be held in place by means of ties that were fastened to a cotton belt worn around the waist under a tunic or jacket. Soft boots of leather, often lined with fur
for warmth were worn to cover the foot. Variations on these garments were the fashion standard for the next several hundred years, and by the 13th century CE a single-piece, footed version of hose had appeared. By the end of the century, hose had been divided into two separate pieces at the knee, with the upper portion serving as what we now consider underwear and the lower portion becoming stockings.9

An early illustration shows gentlemen dressing in their hose. Image from medievalproductions.nl

By the reign of Henry VIII (c. 1509-1547 CE), knitted silk stockings were regularly imported from Spain. These stockings were tightly fitted, sometimes puffed at the knee for fashion. They were held in place with ribbons or ties at the knee or mid-thigh and were often decorated with pearls or precious stones. The fineness of a gentleman's stockings reflected his status.

Stockings were knitted flat from the top to the ankle, with shaping for the wearer's calf built in to the stitch pattern. In most cases, the foot appears to have been shaped a little more by the knitter, then sewn together at the sides or the ankles. These flat stockings were then seamed up the back with delicate handsewn stitches. The gap that was created by the bend at the ankle was filled with a triangular piece of fabric, or embroidered in a circular pattern that resembled the face of a clock. These “clocks” were later embellished with embroidery to draw attention to the gentleman's calf and ankle and became a fashion hallmark in the 18th and 19th centuries. The clocks of ladies' stockings remained unembellished, as a true lady did not draw attention to her ankles.

Household records from that time also indicate that the lower classes wore hose knitted from less luxurious fibres such as wool and linen. These more humble garments appear to have been worn primarily by the merchant class and the manufacture of these hose became the foundation for the thriving English knitting industry of the next century.
It is Queen Elizabeth I (c. 1558-1603 CE) who is most commonly credited with the popularity of what we now consider the stocking. Contemporary accounts of her life include a story of her discovery of silk stockings, and her subsequent decree that no other hose were to grace her person. This created a mania among the upper classes to wear the Queen's fashion favorite and the demand for fine stockings was overwhelming. The stockings had to be imported from Spain at great cost and great risk. Records of ships wrecked or plundered often included the loss of silk stocking shipments.  

Queen Elizabeth I is credited with popularizing silk stockings.  
Image from library.northwestern.edu

During this era, a knitting apprentice by the name of William Rider is credited with creating the first fine worsted wool stockings. Worsted wool had previously only been used for weaving fine cloth, but legend tells that in 1564 Mr. Rider was inspired by the fineness of a pair of Italian silk stockings and copied them using fine worsted wool and fine steel knitting needles. The Earl of Pembroke was alleged to have been the first gentleman to wear these new stockings.  

Mr. Rider's new stockings caused an explosion in the knitting industry, leading to rapid advancements in production techniques. In 1589, Mr. William Lee petitioned the Queen for a patent on a device that converted the actions of two knitting needles into a mechanized process. This device was known as the "knitting frame" and was designed solely for the mass manufacture of worsted stockings.  

The knitting frame made stockings easily available and affordable to the average working person in England. But, as with any new trend, there was a backlash against the decadence of such a fashionable item. English moralist George Gascoigne ranted that stockings "are pricking spurs, provoking filthy pride, and snares unseen which lead a man to Hell." The outcry against stockings eventually forced William Lee to move his industry to France, where stockings were acceptable to even the most common folk. Lee continued to manufacture and export stockings to England until his
death in 1614. After his death, his son returned with Lee’s equipment to a less-Puritanical England and established what soon became a thriving industry in the Midlands town of Calverton. This knitting industrial community gave birth to many others, and the frame knitting industry thrived in England until well into the 19th century CE and laid the groundwork for the Industrial Revolution.

Frameknit stockings from Calverton, circa 1700.
Image from knittingtogether.org.uk

Of course, not everyone could afford manufactured stockings. It is around the same time that frame knit stockings appear that the first records of hand knit wool stockings appear. Paintings of peasants from Europe and England from the 1600’s often depict both men and women knitting. In 1601, William Shakespeare mentions knitters sitting out in the sun in his play Twelfth Night. In spite of the furore against manufactured stockings, the hand knitting of stockings by simple folk quickly developed a reputation for being an appropriately industrious way for the lower classes to spend leisure time. Many cottage knitters, who started out knitting stockings, went on to develop knitted garments such as shawls and warm vests, which evolved into what we now call sweaters.

On the European Continent, where stockings had originated, knitting stockings by hand remained a major industry. In the mid-15th century CE, professional knitting guilds were formed in France and Germany. Only master knitters who had trained and apprenticed within a guild were allowed to sell stockings to the nobility. This kept the price of stockings out of the reach of most commoners, who simply copied the masters’ patterns with whatever materials they had at hand, most commonly wool or linen.

Knitted stockings, whether manufactured or handknit, remained a fashion
staple for both men and women until the introduction of gentlemen’s trousers in the early years of the 19th century CE. Trousers were the first garment to cover the full length of the male leg and their popularity soon made men’s knee-length stockings obsolete. However, the fashion for wearing military-styled hard leather boots still necessitated a protective garment for the foot and calf of the well-dressed gentleman. Thus a shortened version of the stocking was adapted. These hose were held in place at the mid-calf by means of a buckled rubberized strap referred to as a garter in reference to the ribbons used to hold the original stockings in place. The term “sock” first appears in fashion literature from around 1840, referring to these shortened stockings. Socks were considered a men’s garment, but by 1880, the term was also applied to the short stockings worn by both boys and girls.¹³

A Victorian sportsman showing off his socks.
Image from woodbourough-heritage.org.uk

The knitting industry adapted to the changes and the manufacture of socks evolved from the stocking factories. Socks were still constructed in the traditional manner that stockings had been made, that is, knitted flat, then sewed into a tubular shape. During the Victorian Era and into the early 20th century, as in earlier eras, the fineness of a gentleman’s sock could be determined by the detailed stitching of the clocks at his ankle.

The materials used in Victorian-era socks varied according to class. The upper classes in England, Europe and the Americas still wore silk stockings and socks. Fashion dictated that only silk should be worn on one’s legs and feet for evening, but that for more casual occasions, cotton socks were acceptable. Wool was only acceptable for the working classes, or for gentlemen’s outdoor pursuits.
As textile manufacturing became industrialized, the mechanical rotary frame patented in 1857 made hand knit stockings and socks a luxury rather than a necessity. So, during the Victorian era, hand knitting became a popular leisure activity for ladies of all classes. Young girls were educated in the needle arts, and a lady was expected to have piece of parlor knitting at hand for visiting days or quiet evenings at home. The first widely published books of knitting "recipes", such as Weldon’s Practical Needlework, appeared and offered genteel knitters a wide variety of styles and stitch patterns to choose from. A lady could knit her gentleman a fine pair of evening socks, or produce woollen stockings for the less fortunate. Sock knitting as a leisure activity became even more popular with the advent of spinning mills that made inexpensive yarns available to all classes.

![Image from oldtymestockings.co](Image from oldtymestockings.co)

Knitting socks was a virtuous Victorian pastime.

During the middle to late 19th century, colonial expansion and increased trade with other countries exposed Western Europeans and the English to a wider variety of ethnic groups than ever before. The influence of this exposure can be seen in the changes in sock knitting, with the introduction of circular knitting techniques and color and pattern, especially influenced by the traditional bright socks of the people of Turkey and the Black Sea region of Eastern Europe.

The emigration of people from these regions, as well as from Western Europe and England, to North America brought all of these influences together in a place where self-sufficiency was still necessary for survival. The harsher Northern climates of most of North America made warm, sturdy footwear a crucial consideration. And the relative difficulty of distributing manufactured goods to much of the population made hand spun and hand knit socks an element of everyday life. As more and more
settlers travelled into the wilderness, more and more hand knit wool socks were made and simple, standardized patterns were passed around. While materials and knitting skills varied widely from area to area, the sock as we recognize it today, with its continuous circular construction and turned heel, evolved.\textsuperscript{12}

The advent of World War I in 1914 created a frenzy for sock knitting. The women of all of the Commonwealth nations were prevailed upon to support the troops by sending them practical comforts such as hand knit woollens. Mittens, scarves and socks were the most popular items. The Red Cross in England and Canada published a one-page sock pattern that became so commonly used that it is still the basis for almost all Western-style sock patterns today.

![World War One volunteer recruitment poster promoting knitting for the troops. Image from historylink.org](image)

While sock knitting fell out of favor during the prosperous 1920s, it was revived again as a thrift measure during the Depression of the 1930's. Women were once again called to take up their needles and knit “for the Boys” during World War II, but after the war, the industrial boom brought not only affordable textiles but exciting new fibres to the marketplace and relegated hand spun and hand knit garment to the realm of the overly frugal or the old-fashioned.

It was not until the hippy-inspired craft Renaissance of the 1970's that hand spun yarns came back into vogue, but even then hand knit socks were not overly popular. However, with the surge in the popularity of knitting that occurred in the 1990's, sock knitting has once again become the preferred leisure-time pursuit of women, and men, everywhere.
Materials

Traditionally, stockings and socks have been made from whatever materials have been available locally. With the exception of the noble classes, who could afford precious silk stockings, this usually meant the wool of whatever breed of sheep were raised in the region. Wool was readily available, easily spun and dyed, and warm and insulating for winter wear. However, depending upon the breed, wool could also be scratchy and not very long wearing, which meant that stockings and socks required constant repairs.

Modern hand spinners, on the other hand, are faced with an overwhelming variety of materials for spinning and knitting socks. Not only do we have access to the wool of hundreds of different sheep breeds, but any number of exotic and man-made fibres as well. At any gathering of hand spinners, the virtues of longwools versus down breeds, pure woools versus blends, and non-itching alternatives are heatedly debated. Alpaca, silk, nylon, cotton, mohair, and acrylic are all frequently touted as the best addition to wool, or even as sock materials themselves. Every book, website and individual spinner offers a suggestion of the “perfect” sock yarn material.

For the purposes of this study, a survey of commercially-spun sock yarns will act as a starting point. Most modern-day sock knitting patterns are based upon the grist of these yarns and the resulting knit gauge, so these will be the yarns that most consumers will be most familiar with.

A survey of ball bands on the most readily available and popular commercial sock yarns shows a strong consistency in materials. Appendix A provides a detailed chart of this information, but the yarns almost always contain a blend of wool and nylon (also known as polyamid). Let us explore these materials in a little more detail. (See Appendix A for more detailed information.)
Wool

Wool is the most easily available material to the hand spinner, and is available in a wide variety of sheep breeds and preparations. In historical times, wool and flax were the most readily available materials to the vast majority of the people. In modern times, wool is still easily found and inexpensive to the average hand spinner. Wool is easy to spin and takes dyes well, making the production of wool yarns fast and simple enough for even the beginning hand spinner.

Many of wool's fibre characteristics also serve to make it the ideal fibre for socks. Wool is insulating, keeping body heat in. The hollow structure of each wool fibre acts as an air pocket that buffers the transfer of heat away from the body. As wool is spun into yarn, the scales on the fibre's outer surface also overlap to create more tiny air pockets to further enhance this characteristic. This makes wool ideal for socks in cold climates. Wool also breathes, allowing air passage through those tiny air pockets, so that the trapped heat does not become overwhelming and make the wearer's feet too hot.

Wool is highly absorbent, without feeling wet to the touch. Garments made from wool yarns can absorb up to 30% of their weight before feeling damp. This means that a wool sock can be worn comfortably in wet weather, keeping the feet dry and protecting them from infections and diseases caused by prolonged dampness. The absorbent characteristic of wool also wicks moisture away from the body. Perspiration is absorbed and carried out through the wool, keeping feet dry and cooling the body on hot days.

The crimp in wool fibres will always try and spring back to its original shape, giving wool a natural elasticity. This is useful in socks, maintaining a close fit in a garment that is constantly being stretched and moved around with the movement of the foot. A close fit ensures that the sock does not rub uncomfortably on the foot causing blisters, and it also ensures that the fibres are not rubbing against each other causing wear to the sock.

Felting is another important wool characteristic to consider when discussing sock yarns. The scales on the outer cuticle of the fibre make all wools prone to felting. In the case of a sock, where the fibres are submitted to constant abrasion, moisture and heat, felting can easily take place, especially on the soles. Some traditional sock makers have taken advantage of this characteristic to make boot-like garments of felted wool or fullled knits, but generally wools that are more prone to felting are considered poor candidates for sock yarns.
Different sheep breeds lend different characteristics to wool yarns. Fine wool breeds such as Merino produce fibres that are soft and lustrous, but are not as strong and durable as longwools such as Lincoln. Merino is more prone to felting than most other breeds, as well, which makes shrinkage a serious concern for the sock maker.

Down breeds, such as Dorset and Hampshire, produce a naturally elastic fibre, but the short staple length often means that the yarn produced is not as smooth as that from a longer wool. This can lend itchiness to the sock and can lead to pilling and early wear.

Ideally, the wool used for sock yarn should be long enough to spin into a smooth yarn, sturdy enough to stand up to the abrasion that a sock takes, and fine enough to feel comfortable against the wearer’s foot. As a general rule, many longwools such as Wensleydale or Lincoln are both smooth and durable, but they can often be very coarse, with counts as low as 40s. Fine wools such as Merino and Rambouillet have much higher counts of 70-80s, giving comfort and smoothness, but not durability. A finer longwool such as Romney, or a crossbreed such as Corriedale, are more likely to suit all of the criteria for a smooth, durable and comfortable yarn. As well, many double-coated breeds such as Shetland and Spelsau can provide the best of both worlds with a blend of long, durable fibres and soft down to lessen harshness.

For the purpose of this study, a fine Romney fibre was chosen. Romney is characteristically a medium longwool with a count range of 48-60s and a staple length of 3-4”. The fibre strikes the middle ground between a finewool and a longwool while maintaining staple length, durability and fineness for comfort. Romney is also readily available to most handspinners, and very affordable.
Nylon

Nylon was the world’s first true synthetic fibre. Discovered by DuPont chemist, Wallace Carothers in 1935, nylon was introduced as a low-cost alternative for ladies’ hosiery and was an instant hit. More affordable and durable than silk, more comfortable and light-weight than wool, nylon stockings were the fashion sensation of the Depression Era.

When America became involved in the Second World War, nylon production was diverted to the war effort and the majority of nylon produced was used to make sturdy parachutes for the military, but immediately after the end of the War, DuPont went to work to find new an innovative uses for its wonder-fibre. Nylon was soon found in waterproof clothing, carpets, stockings, and manufactured socks, among other things.

Nylon is the result of the chemical interaction between two types of molecules derived from petrochemicals. The chemicals are combined, then dried to create a chemical salt. The salt is dried in a vacuum to remove all water and create the nylon polymer. This dried polymer is then melted and extruded through spinnerettes to produce long strands of fine fibres.

Nylon’s greatest virtue is its strength. It has the greatest tensile strength of all of the synthetic fibres and makes any garment less prone to wear and tearing. Nylon is also highly resistant to abrasion and will not pill or fray.

One of the reasons that nylon has become so popular for stockings and socks is its elasticity. Nylon will stretch but will naturally return to its original shape when tension is released. This stability also means that nylon prevents shrinkage in garments, as it retains its shape well. Nylon releases dirt well, adding to the washability of the garment.

Some of nylon’s other attributes also include its light weight. Due to the strength of the fibres, they can be spun almost microscopically thin and yet still lend strength to a garment without adding bulk. The petrochemical composition of nylon makes it unappealling to insects, as well.

All of these characteristics, plus its low cost, make nylon the ideal fibre to blend into sock yarns. In fact, a survey of most modern sock yarns seems to indicate that it is the only fibre to blend into sock yarns.
Silk

Like nylon, silk is a lightweight, extruded fibre with great tensile strength. It is not, however, a synthetic fibre but naturally produced by any number of moth species around the world. Since its discovery over 2500 years ago in China, silk fibre has been regarded as one of the most valuable luxury fibres in the world.

Most commercial silk is the result of intensive sericulture, or the raising of silkworms. The “worms” are actually the caterpillars of the *Bombyx mori* moth, a moth indigenous to southern China. These moths are bred to produce larvae, which are then fed leaves from mulberry trees to ensure that their silk is white. An average silkworm will consume 10,000 times its own weight before maturity. When these caterpillars enter their pupal stage, they wrap themselves in a cocoon made from a fine filament extruded from spinnerets located near their mouths. These cocoons are then stifled by being cooked in an oven or steamed to kill the pupae inside and the silk is reeled off the cocoons. Broken cocoons, from which the adult moth has already emerged, are degummed and processed into silk bricks and rovings. These preparations have shorter staples and are preferable for blending over reeled silk. They are also considerably more affordable.

Historically, one of the major uses of silk in Europe was the manufacture of silk stockings for the nobility. Originating with the Moorish and Sephardic craftsmen in Spain, these stockings were highly prized by European nobility for both their soft comfort and their durability. This historical connection suggests that perhaps silk would be an appropriate fibre to use in hand spun sock yarns.
Silk has many characteristics that make it ideal for blending into sock yarns, the most important being its strength. Silk has the greatest tensile strength of any natural hand spinning fibre, equal to the strength of a steel wire of the same diameter. When spun firmly, a silk thread is virtually unbreakable, lending great durability to any garment made from it.

While silk is less elastic than nylon, it will still expand to 20% of its length and return to its shape again when washed. When blended with wool, silk’s elasticity will prevent the wool from shrinking to the degree that unblended wool will. Silk is also very lightweight and will not add any bulk to the blended yarns.

The insulating character of silk will improve the warmth of silk-blend garments, as well. Silk is a natural insulator, keeping the heat on the warmer side of the garment. This makes it ideal for wear in both winter and summer and an excellent fibre for sock yarns as warmth is often an important consideration.

Yarns made from silk or silk blend have a very soft, smooth hand and excellent drape, making them very comfortable to wear. Silk fibres are extremely flexible, lending a relaxed quality to the fit of the garment.

Silk fibres do not appear to attract pests such as moths and is mildew-resistant, but the fibre is vulnerable to alkali, which is found in human perspiration. Fortunately, though, silk is washable, making it possible to prevent damaging alkali build-up with little effort or special care.

Blending silk into wool sock yarns will take advantage of all of these characteristics to make a durable, soft yarn of 100% natural origins.
Spinning Notes

Every effort was made during the preparation and spinning of the fibres to keep the blend percentages and grists consistent. The blending of each of the fibre combinations was done all at once in order to guarantee that the percentages remained consistent throughout the samples spun from that blend. Likewise, each yarn was spun as closely as possible to the grist and twist per inch of each of the others, regardless of the spinning method or number of plies.

Fibre Preparation

The fibres used in this study were Romney wool, nylon and silk. The Romney wool was supplied by Silver Valley Fibres in the form of roving; the nylon was from Louet, labelled and marketed as “fake cashmere”; the silk was supplied by Treenway Silks as Bombyx silk sliver.

To create the fibre blends for samples, the initial blending was done on a drum carder. All blends were measured by weight, then fed in small amounts through the carder, sandwiching the finer fibres between the wool on the first pass. Each batt was then split into four sections and each section was stacked with a section from another batt and passed through the carder again. The resulting batts were split and recarded a third time to ensure a consistent mix of fibres throughout.

In order to properly prepare fibres for either woollen or worsted spinning, further preparation was necessary. For the samples to be spun woollen, sections of the batt were handcarded into rolags. To make the rolags, each section of fibre was caught into the teeth of one hand carder, then the other carder was gently placed against the fibre in a gentle rocking and lifting motion repeatedly until all of the fibre had been transferred to the second carder. Each rolag was transferred three times before being rolled from the top of the paddle down toward the handle into a loosely-rolled bundle of fibre.

To prepare the fibre for worsted spinning, mini wool combs were used. The fibre was lashed onto the tines of the wool combs, but because the fibre had already been prepared in a woollen manner, it was not possible to align the tips and cut ends for a true worsted top. The second comb was applied in a chopping motion to open and align the fibres. The fibre was passed through the combs twice, then spun directly off the tines of the combs, eliminating the step of drawing the top off through a diz.
Spinning the Woollen Samples

A woollen yarn is produced when the fibre is drafted so that the twist enters the fibre as it is being stretched. When the twisted fibre is released from the pressure of the drafting, the fibres spring back to their original state and the resulting yarn is soft and airy.

Woollen yarns are spun from a roving or rolag preparation, where the fibres are not aligned. The various angles of the fibres create air pockets, which increase the insulating qualities of the yarns. This also means that there will be ends of the fibre sticking outward from the yarn that can give the yarn a soft fuzziness or a prickly-feeling finish, depending upon the fibre. The airiness and fuzziness of woollen yarns tend to make them weaker and more prone to pilling.

To spin a woollen yarn, the drive band on a spinning wheel should be set at its lowest ratio, using the largest whorl. The brake-band should be tightened to create a fairly strong pull-in.

The fibre should be drafted in an unsupported long draw, where the front hand pinches to allow twist to build up as the back hand drafts out a fairly even length of fibre. The front hand then releases to allow the twist to travel up into the drafted fibre as the back hand pinches to prevent the twist from travelling up into the fibre source. When the twist has reached the back hand, the full length of the twisted fibre is fed onto the bobbin and the process is repeated. Woollen spinning is fairly fast, allowing little twist to accumulate in the fibres. The resulting single should be loose and airy and will tend to pull apart easily if pulled back off the bobbin. The strength in woollen yarns comes from the twist added during plying.

Woollen yarns are usually best put to use in making blankets and garments for outer wear, such as knitted sweaters or jackets. They are less structurally sound than worsted yarns and tend to wear through more easily, which makes them less appropriate for hard wearing items such as socks. Many hand spinners prefer to use a woollen yarn for socks, as woollen yarns are also insulating and cushioning. However, the nature of woollen yarn would be better suited to socks that do not see hard wear, such as bed socks.

Unsupported long draw for woollen spinning.
Photo by Stephen Boyd.
A worsted yarn is created when the entry of the twist into the fibre source is firmly controlled, allowing more twist to build in the drafted yarn. The twisted yarn is then compressed to further smooth and strengthen the yarn.

Worsted yams are spun from fibre preparations where the fibres have been aligned, such as a sliver or top. Traditionally, the fibres are combed or flicked and spun from cut end to tip to reduce the opening of the scales on the fibres, but many modern preparations do not allow for that precision. The directional alignment of the fibres allows the individual fibres to twist more closely and does not create the air spaces and free ends of a woollen yarn. The finished yarn will be smoother and stronger than most woollens.

Spinning a worsted yarn begins with a worsted preparation. In the case of the worsted samples in this study, the fibre was first blended on a drum carder, which is a woollen preparation. These fibres were then realigned using wool combs. Traditionally, combed fibre is pulled through a diz to create a length of sliver, which is then planked with other lengths and lightly twisted to create a top. However, time and space constraints made it more desirable to spin the yams for this study directly off the tines of the mini wool combs.

To begin spinning worsted, the drive band should be set on a higher ratio to increase the amount of twist that enters the drafted fibre, but worsted yams may be spun on low ratio wheels as well. The speed of treadling should be adjusted upward to compensate for the slower movement of the larger whorl. There should be just enough tension to pull the singles onto the bobbin without stretching the fibres.

The draft used in worsted spinning is a short forward draft. The back hand holds the fibre source, in this case the wool comb, and the front hand pulls a short group of fibres forward, pinching firmly to ensure that no twist enters the drafted fibres. The front hand then travels back to the end of the drafted length, allowing the twist to follow it up the length. The front hand will compress the drafted fibres as it travels back, further strengthening the single. The twisted length is then fed onto the bobbin and another length is drafted forward.

Spinning the yarn directly from the wool combs requires a slight adjustment in how the fibre is held. The comb itself will act as the back hand, keeping the fibre source tensioned. The fibre may then be drafted forward off the tines of the comb, ensuring that the fibre is worked from both sided of the comb by using a slightly sideways pull in each draft.
Spinning worsted directly from a wool comb.

Photo by Stephen Boyd.

Worsted spinning is a slower process than woollen because the twist is more carefully controlled and the yarn is spun only a few inches at a time. The resulting single will be strong and fairly well twisted and should not drift apart if pulled back off of the bobbin. This strength is only reinforced by plying.

Worsted yarns are well suited to hard-wearing garments such as socks, or to garments that will be worn next to the skin. Lace and Guernsey patterns show well when knitted with a smooth worsted yarn, as well as color work. The smooth surface of a worsted yarn is less prone to pilling and wear than a woollen and will make for a longer-lasting, more durable garment.

Plying

Simply put, plying is the twisting of two or more spun singles to create a stronger yarn. The twisting is done in the opposite direction to that in which the singles have been spun, counteracting the live twist that has built up in them. This creates a balanced yarn that does not skew in the direction of the spinning twist and creates a stable fabric in the end product.

The number of plies in a yarn will affect its strength and grist. The more plies that appear in a finished yarn, the stronger the combined twist will be, making even the softest woollen more durable. Of course, more plies will add thickness to the yarn, as well, adding to its strength.

Historically, yarns for many uses were simply unplied singles, as spinners did not have the luxury of the time to spin a second singles. As commercial yarn production took over, the singles produced mechanically were much finer and more quickly spun than handspun. Plying became a way to make a yarns with a variety of thicknesses and strengths from one setting on a mill spinning machine. Hand spinners have adopted
many of the standards of commercial yarn production and plying has now become the norm instead of a luxury reserved for special garments.

For the purposes of this study, two types of ply were used: two-ply and three-ply. A two-ply yarn consists of two singles plied together and is generally beadlike in its appearance. In a two-ply yarn, the twist of the singles is clearly visible and, depending upon the fibre and spinning technique, there may be small bumps at the places where the two singles cross. In a three-ply yarn, there are three singles twisted together, making for a tighter and smoother finished yarn. The separation of the singles is less distinct and the appearance of bumps is diminished.

A cross-section view of the two different plies will also illustrate the difference in the structure and shape of the yams. A two-ply creates a flat, figure-eight shape when studied in cross-section and a three-ply creates a rounded structure.

A two-ply yarn will feel rougher when run between a hand spinner’s fingers due to the small bumps created by the twist, and in knitting, the plies will show clearly in opposite directions in each loop, making the surface look rough. Plying will make a stronger and more balanced yarn than just a single, and adding the two plies together will make for a thicker yarn.

The structure of the three-ply yarn makes it feel smoother and the closer twist of the singles creates a smoother surface appearance in knitted pieces, as well. In addition, the extra single adds structural integrity to the yarn. In order to keep the grist the same as that of a two-ply yarn, three-ply yams must be created using finer singles, but the higher the number of singles in a yarn, the stronger it will be, regardless of the grist of those individual singles.
Sample 1
100% Romney
Woollen 2-Ply
3 TPI 18 WPI

Sample 2
100% Romney
Worsted 2-Ply
3 TPI 18 WPI
Sample 3
80% Romney 20% Nylon
Woollen 2-Ply
3 TPI 18 WPI

Sample 4
80% Romney 20% Nylon
Worsted 2-Ply
3 TPI 18 WPI
Sample 5
80% Romney 20% Silk
Woollen 2-Ply
3 TPI 18 WPI

Sample 6
80% Romney 20% Silk
Worsted 2-Ply
3 TPI 18 WPI
Sample 7
100% Romney
Woollen 3-Ply
3 TPI 18 WPI

Sample 8
100% Romney
Worsted 3-Ply
3-Ply 18-Ply
Sample 9
80% Romney 20% Nylon
Woollen 3-Ply
3 TPI  18 WPI

Sample 10
80% Romney 20% Nylon
Worsted 3-Ply
3 TPI  18 WPI
Sample 11
80% Romney 20% Silk
Woollen 3-Ply
3 TPI 18 WPI

Sample 12
80% Romney 20% Silk
Worsted 3-Ply
3 TPI 18 WPI
The Socks

All 12 samples of yarn were knit following the same sock pattern (Appendix B).
Sample 7 Sock

Sample 8 Sock

Sample 9 Sock

Sample 10 Sock

Sample 11 Sock

Sample 12 Sock

All photos by Michelle Boyd.
When the socks were all knit, they were distributed in pairs to 6 testers. Each tester wore each of the socks for a day. The socks were then washed and passed along to another tester. The testers wore the socks during the course of their daily activities and were then asked to complete a short survey about each sock. This survey asked the testers to offer their opinions on the fit, comfort and warmth of each sock.

The testers ranged in age from 17 to 57, and had a wide range of daily activities. There were students, a school administrator, a retired engineer, and a project manager. All testers were asked to wear the socks with their normal foot wear for a full day. They wore predominantly casual or running shoes, though one tester also wears a foot brace. Others noted that they wore no shoes for the majority of the test day. The test period spanned both winter and spring conditions.

Each sock was worn and washed 6 times. The socks were machine-washed in warm water with a mild detergent and hung to dry. At the end of the testing period, the socks were examined for pilling, staining, felting or shrinkage and overall signs of wear.

An overview of test responses follows, along with comments about the signs of wear observed after testing was complete. A detailed summary of the results can be found in Appendix C.
Analysis

Comfort

An overview of the test results shows that testers had some distinct preferences in the areas of comfort surveyed: fit, itchiness, smoothness, warmth, and breathability. The results seem to indicate particular patterns in comfort preferences in the testers, notably a preference for worsted yarns over woollens, blends over 100% wool, and a strong preference for 3-ply yarns over 2-ply. These results are discussed in more detail below, along with possible explanations for the results achieved.

It should be noted that the testers were also surveyed about the type of footwear worn with the socks and the activities engaged in during the test period. There did not appear to be any difference in the responses that could be attributed to a difference in footwear or activity. The majority of the test survey responses were consistent regardless of the footwear or activity of the testers.

Fit: While all socks were knit to the same gauge, socks knit from the woollen samples were more likely to be rated a nearly perfect fit, or even slightly tight. One tester also commented that the woollen socks felt bulkier and that they made her shoes feel tight. This result is likely because woollen yarn will generally be bouncier, therefore more elastic, lending to the sensation of a firmer fit. The added bounce and the fuzzier surface would also lend to the bulkier feel of the socks.

Itchiness: The majority of testers rated the socks from woollen samples itchier than those from the worsted samples. The blended woollen samples were more likely to be itchy than the 100% wool samples, but the 3-ply samples were generally found to be less itchy than the 2-ply. The worsted samples, regardless of blend or ply were rated less itchy. This would suggest that the softer, fuzzy finish of the woollen yarns, with the tiny protruding fibres, lend to an itchier sock yarn.

Smoothness: Testers rated the 3-ply socks as smooth more frequently than the 2-ply. In fact, the only socks rated as rough were from 2-ply samples. In addition, the worsted samples were consistently rated smoother than the 2-ply. It is likely that the rounder structure of a 3-ply yarn contributed to the smoother feel of the yarns. A 2-ply yarn’s structure creates a series of small bumps where the plies cross, making the yarn feel rougher against the foot. Additionally, the observation that woollen yarns were rated smooth less frequently than the worsted suggests that the fuzziness of the woollen yarns contributes to the sensation of roughness in the socks.

Warmth: The overwhelming number of responses in this category found the majority of the samples to be just right—neither too warm or too cool. The only exceptions to this trend were most of the nylon-blend samples, both of the 2-ply samples and the worsted 3-ply. This would suggest that perhaps the nylon added a little too much to the insulating quality of the wool and trapped more heat inside the sock.
Breathability: Very few of the testers commented that their feet felt sweaty or sticky in any of the samples. Those samples that caused sweating sometimes were all of the nylon blends and the 2-ply silk-blends. As with the warmth testing, it is presumable that the nylon’s insulating quality kept warmth and moisture from passing as easily through the sock, contributing to the build up of heat and sweat. The same factor could be applied to the silk-blend samples, though would not account for the apparently better breathability of the silk-blend 3-ply samples.

Overall Comfort: Almost half of the socks had a high percentage of ratings of fairly comfortable. The glaring exceptions were the two 2-ply nylon blends and the 2-ply woollen silk blend. These three socks were consistently rated fairly uncomfortable to very uncomfortable by all testers. The nylon blends in the 3-ply yarns were rated as so-so to fairly comfortable, while all other 3-ply samples rated fairly comfortable to very comfortable. This would suggest that the nylon blends in general were less comfortable than the 100% wool or silk-blend samples. One explanation for this result may be that the nylon blends rated poorly in the warmth and breathability categories. Overly warm socks that cause sweaty feet are definitely less desirable than those which keep the feet at a comfortable temperature. Perhaps decreasing the percentage of nylon used in this blend would solve the problem of excessive warmth and make for a more comfortable sock.

It is also interesting to note that the 2-ply silk-blend woollen sample was poorly rated for comfort and that the 3-ply silk-blend woollen rated well below its worsted counterpart. In addition, the woollen versions of the nylon-blend samples were rated less comfortable than the worsteds. One may conclude that perhaps the stronger and straighter structures of both silk and nylon that make both fibres desirable for blending to increase a yarn’s tensile strength also make these fibres less desirable for woollen spinning. The less flexible structures of nylon and silk create more stiff ends to protrude from the yarn’s surface, adding to the itchiness and roughness of the yarn.

The socks best rated for comfort were the nylon-blend 3-ply worsted and the silk-blend 3-ply worsted, suggesting that for overall comfort, a blended 3-ply worsted yarn is most desirable. The lower breathability rating of the nylon blends would point to the silk blend as being the optimum choice among the yarn samples tested in this study, with the nylon-blend a close second.
Durability and Washability

Each of the sample socks was worn for one day by each of six testers for a total of six wearings per sock. The socks were washed between wearings in a warm water machine wash using a mild detergent. The socks were then hung to dry thoroughly before the next wearing.

At the end of the testing period, each sock was visually inspected for signs of compromise. Notes were made on signs of wear, pilling, staining, felting, and shrinkage.

Most of the samples showed little to no deterioration from being worn and washed, but there were some minor differences that suggest that some socks may prove more durable than others after longer wear. These results are discussed below, along with possible explanations for each outcome.

Wear: Most samples showed little to no sign of thinning or snagging as a result of friction. The only consistent sign of friction wear was the presence of felting in a pattern of specific areas, and will be discussed later.

Only 3 samples showed any sign of thinning due to friction. These were both the 2-ply nylon-blend woollen and the 2-ply silk-blend woollen. These socks showed minor but noticeable wear patterns on the bottom of the heel and the ball of the foot. This wear would be consistent with the areas where the greatest amount of pressure would be applied while the sock was being worn.

There are two possible reasons that these particular samples would show wear more readily than the others. Perhaps the woollen structure of two of the yarns contributed to their wear by not providing a strong enough structure to hold all of the fibres together under pressure. It is also possible that the stronger fibres that were blended in, nylon and silk, actually contributed to the wear by abrading the weaker wool fibres and caused them to break away.

Pilling: Pilling is the formation of tiny, firm balls of fibre on the surface of a fabric caused by individual fibres breaking and tangling and is a common problem in hand knit wool socks. All of the sample socks showed some evidence of pilling, though it was generally minimal. The exceptions to this were the 2-ply nylon-blend woollen and 2-ply silk-blend woollen samples. These two sample socks exhibited moderate to heavy pilling. It is possible that the pilling is as a result of the same processes that created the wear pattern discussed above and that the pilling in these samples is as a direct result of the wear. The small ends broken off of the worn areas would have tangled with each other, creating a noticeable build-up of pills.
Staining: Staining is perhaps the only test category that has been affected by the footwear choices and activities of the testers. Testers who wore no outer footwear for a large part of the testing, or those who were involved in more vigorous activities may have contributed more heavily to the stains on the sample socks. For the most part, however, the staining observed on the sample socks was minimal. It was noted that the 100% wool sample socks were most heavily stained after washing, with the woollen samples staining quite noticeably. It is likely that the looser fibre configuration made more areas available for dirt to adhere to the wool and held the dirt in place even during washing.

The silk-blend samples were also more likely to show staining, but the staining was less concentrated and minimal. It is likely that the silk did not release dirt as readily as the nylon in the nylon-blend samples and therefore contributed to a more stained appearance in the silk-blend sample socks.

Felting: As discussed earlier, any felting observed appears to have been the result of friction during wear rather than during washing. The felting is confined to areas where friction would occur during wear and not all over the sample sock, as would be expected if the felting occurred during washing. It should also be noted that the sample socks with the greatest amount of felting were also those that were rated as most likely to make the testers' feet sweat. These socks were the 2-ply nylon-blend woollen and worsted and the 2-ply silk-blend worsted. The combination of the testers' perspiration and the friction of wear most likely contributed to the felting of the heel area and the ball of the foot.

Minimal areas of felting were also observed on the heels 2-ply 100% wool woollen and 3-ply 100% wool woollen sample socks. It is likely that the friction of wear against the back of the testers' shoes compacted the fibres to create felted spots.

Shrinkage: All samples were washed under consistent conditions. Sample socks were cleaned using a warm water wash, followed by a cold water rinse on the regular cycle of a home washing machine. All socks were hung to dry. As a result, no shrinkage was observed in any of the sample socks. It is highly likely that any of the sample socks will shrink if they are placed in a dryer.

Overall, the 3-ply yarns showed fewer signs of damage from wear and washing. The silk-blend 3-ply yarns tended to show stains more than the nylon-blend 3-plies, but the durability of both yarns is otherwise almost identical. Neither the silk-blend or the nylon-blend 3-ply yarns showed any significant amount of wear, pilling, or felting. The worsted 3-ply blended sample socks kept their original appearance, aside from some minor staining on the silk-blend. The nylon-blend 3-ply worsted barely shows any sign of having been worn, which appears to make it the optimum yarn in the study for durability, followed by the silk-blend 3-ply worsted.
Conclusion

The results of this study indicate that some sock yarns are definitely superior to others. There was, for example, a clear comfort preference amongst the testers for any sock made from a 3-ply yarn, regardless of the fibre blend or spinning technique. The 3-ply yarns also proved more durable. Worsted yarns withstood wear better than woollens, as a rule, and were rated smoother by the testers. The nylon-blend yarns seemed to be more prone to overheating the wearer’s foot and less breathable, making the sock less comfortable than desired.

Each yarn in the study proved to have its own virtues, as well as its weaknesses. Woollen yarns proved to make a snugger, better-fitting sock than their worsted counterparts, in spite of being found itchier and less durable. Nylon-blend yarns equalled the silk-blend yarns in durability and comfort, and had a lower materials cost, but were ultimately ranked lower because of their overheating problem.

There were two sample socks that were consistently rated poorly in comfort and durability, and we can learn from these yarns as well. It appears to be less than optimal to spin fibre blends containing fibres with a strong, extruded structure (ie. silk or nylon) in a woollen style. The linear structure of the fibres is not well suited to the unaligned structure of a woollen yarn, leading to a prickly and rough finish. It appears that this problem can be reduced by plying 3 or more singles, though.

Many of the other yarns were deemed to be acceptable, but not superior, in most categories. This would suggest that any of these yarns would be perfectly fine to use in socks. The 100% wool yarns were all favourably rated by the testers and stood up well to wear. This was the one type of yarn where the woollen versions actually rated higher in comfort than the worsted, but that was countered by poorer ratings for durability and washability.

In some cases, durability far outweighed the comfort results, especially the 100% worsted samples. However, it seems impractical to hand spin and hand knit a sturdy sock that will not be worn because it is uncomfortable. Time spent making an article of clothing is valuable, and it would seem reasonable to set forth on a project expecting the best results possible.

So, which of the yarns studied here will yield the best results?

After compiling all of the factors, the testing would seem to indicate that, while each yarn tested in the study had its strengths, the best overall hand spun yarn for use in socks would be a 3-ply silk-blend worsted yarn. The only test that this yarn did not prove superior to all others in was the observation of staining on the sock bottom. However, even this staining was minimal compared to that on some of the other samples. In the end, the comfort and durability of this sock yarn makes it the best choice for the ultimate pair of hand spun, hand knit socks.
### Appendix A

**A Survey of Commercially Spun Sock Yarns**

<table>
<thead>
<tr>
<th>Brand</th>
<th>Fibre Content</th>
<th>Plies</th>
<th>Grist</th>
<th>Knitted Gauge*</th>
<th>Needle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schachenmayr Regia</td>
<td>75% Wool-25% Nylon</td>
<td>4</td>
<td>18 wpi</td>
<td>30 st-42 rows</td>
<td>2.3 mm</td>
</tr>
<tr>
<td>Patons Kroy Socks</td>
<td>75% Wool-25% Nylon</td>
<td>3</td>
<td>16 wpi</td>
<td>28 st-36 rows</td>
<td>3.25 mm</td>
</tr>
<tr>
<td>Lang Jawoll</td>
<td>75% Wool-18% Nylon-7% Acrylic</td>
<td>4</td>
<td>18 wpi</td>
<td>30 st-42 rows</td>
<td>2.3 mm</td>
</tr>
<tr>
<td>Sandnes Sisu</td>
<td>80% Wool-20% Nylon</td>
<td>4</td>
<td>16 wpi</td>
<td>27 st-42 rows</td>
<td>2.5-3 mm</td>
</tr>
<tr>
<td>Trekking</td>
<td>75% Wool-25% Nylon</td>
<td>4</td>
<td>18 wpi</td>
<td>30 st-40 rows</td>
<td>2.3 mm</td>
</tr>
<tr>
<td>Opal Sock Yarn</td>
<td>75% Wool-25% Nylon</td>
<td>4</td>
<td>18 wpi</td>
<td>28 st-36 rows</td>
<td>2.25 mm</td>
</tr>
</tbody>
</table>

*Knitted Gauge is measured over 10 cm/4 Inches.

Needle size is as recommended by the manufacturer.
Appendix B
Basic Ribbed Sock

Materials:
100 yards yarn per sock (approximate)
Set of 4 2.5mm double pointed needles
Yarn needle

Gauge:
8 st per inch over stockinette stitch

Abbreviations:
K-knit
P-purl
CO-cast on
SSK-slip, slip, knit
P2tog-purl 2 together
K2tog-knit 2 together

Cuff:
Using long-tail cast-on CO 60 st.

Divide stitches evenly onto three needles (20 stitches on each needle) and begin to work K2P2 rib.

Work ribbing until piece measures 4 inches. Change to stockinette stitch and knit 6 more rounds.

Heel:
To make heel flap, redistribute stitches evenly onto two needles (30 stitches on each needle).

Working back and forth on ONE NEEDLE ONLY, make heel flap ribbing as follows:
Row 1: (RS) *Slip 1, K1*, repeat to end.
Row 2: (WS) Slip 1, P to end.

Continue in this manner for 35 more rows, ending with a RS row.

To turn the heel, work as follows:
Row 1: P 15, P2tog, slip 1, TURN.
Row 2: K2, SSK, slip 1, TURN.
Row 3: P3, P2tog, slip 1, TURN.
Row 4: K5, SSK, slip 1, TURN.
Continue in this manner, increasing 1 stitch between decreases until all stitches have been worked, ending with RS facing (16 stitches).

With a third needle, pick up and K 18 stitches along side of heel flap. Work 30 stitches on next needle, then pick up and K 18 stitches along opposite side of the heel flap (82 stitches). Distribute the 16 stitches evenly over the two needles with 18 picked-up stitches (24-30-24 stitches).

Working in stockinette stitch, work gusset as follows:
Round 1: K21, K2tog, K32, SSK, K21.
Round 2: K all stitches.
Round 4: K all stitches.

Continue working in this manner, decreasing the number of stitches before K2tog and after SSK by one on every alternate round until 15 stitches remain on the first and last needles (15-30-15 stitches).
Knit every round until piece measures 9 inches from back of heel.

**Toe:**
Round 1: On first needle, K12, K2tog, K1; on second needle K1, SSK, K24, K2tog, K1; on third needle, K1, SSK, K12.
Round 2: K all stitches.
Round 3: On first needle, K11, K2tog, K1; on second needle K1, SSK, K22, K2tog, K1; on third needle, K1, SSK, K11.
Round 4: K all stitches.

Continue in this manner, decreasing as set, until 16 stitches remain (4-8-4 stitches).

Transfer the stitches from needle one to needle three and using Kitchener stitch, graft toe stitches together. Sew in ends.
Appendix C
Sample Sock Testing Results

Sample 1 Sock: 100% Romney Two-Ply Woollen

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did the sock fit?</td>
<td>Nearly perfect (50%)</td>
</tr>
<tr>
<td>Was the sock itchy?</td>
<td>Slightly loose (50%)</td>
</tr>
<tr>
<td>Did the sock feel smooth or rough?</td>
<td>Slightly itchy (50%)</td>
</tr>
<tr>
<td>Did the sock feel warm?</td>
<td>Not itchy at all (50%)</td>
</tr>
<tr>
<td>Did your foot feel sweaty or sticky?</td>
<td>Neither (100%)</td>
</tr>
<tr>
<td>What was your overall impression of the sock?</td>
<td>Fairly comfortable (100%)</td>
</tr>
</tbody>
</table>

Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back
Staining: none
Area(s) staining observed: none
Felting: none
Areas felting observed: none
Shrinkage: none

Sample 2 Sock: 100% Romney Two-Ply Worsted

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did the sock fit?</td>
<td>Slightly loose (100%)</td>
</tr>
<tr>
<td>Was the sock itchy?</td>
<td>Not itchy at all (100%)</td>
</tr>
<tr>
<td>Did the sock feel smooth or rough?</td>
<td>Smooth (100%)</td>
</tr>
<tr>
<td>Did the sock feel warm?</td>
<td>Just right (100%)</td>
</tr>
<tr>
<td>Did your foot feel sweaty or sticky?</td>
<td>No (100%)</td>
</tr>
<tr>
<td>What was your overall impression of the sock?</td>
<td>Fairly comfortable (100%)</td>
</tr>
</tbody>
</table>

Evidence of wear: moderate
Area(s) wear observed: heel bottom, ball of foot
Pilling: minimal
Area(s) pilling observed: ball of foot, heel back
Staining: moderate
Area(s) staining observed: ball of foot
Felting: none
Area(s) felting observed: none
Shrinkage: none
Sample 3 Sock: 80% Romney/20% Nylon Two-ply Woollen

How did the sock fit? Slightly loose (100%)
Was the sock itchy? Very itchy (66%)
Did the sock feel smooth or rough? Not itchy at all (33%)
Did the sock feel warm?
Did your foot feel sweaty or sticky?
What was your overall impression of the sock? Very uncomfortable (83%)
Evidence of wear: minimal
Area(s) wear observed: heel bottom, ball of foot
Pilling: moderate to heavy
Area(s) pilling observed: all over, heavy on ball of foot and toe area
Staining: minimal
Area(s) staining observed: heel bottom
Felting: heavy
Area(s) felting observed: heel back and bottom
Shrinkage: none

Sample 4 Sock: 80% Romney/20% Nylon Two-Ply Worsted

How did the sock fit? Slightly loose (33%)
Was the sock itchy? Slightly tight (66%)
Did the sock feel smooth or rough? Slightly itchy (100%)
Did the sock feel warm? Rough (66%)
Did your foot feel sweaty or sticky? Neither (33%)
What was your overall impression of the sock? Fairly uncomfortable (83%)
Evidence of wear:none
Area(s) wear observed:none
Pilling: minimal
Area(s) pilling observed: ball of foot, toe
Staining: minimal
Area(s) staining observed: heel back, heel bottom, ball of foot
Felting: minimal
Area(s) felting observed: heel bottom, ball of foot
Shrinkage: none
Sample 5 Sock: 80% Romney/20% Silk Two-Ply Woollen

How did the sock fit? Nearly perfect (83%)
Slightly loose (16%)
Was the sock itchy? Slightly itchy (100%)
Did the sock feel smooth or rough? Rough (100%)
Did the sock feel warm? Just right (100%)
Did your foot feel sweaty or sticky? No (66%)
Sometimes (33%)

What was your overall impression of the sock? Fairly uncomfortable (66%)
So-so (33%)

Evidence of wear: heavy
Area(s) wear observed: heel bottom, ball of foot
Pilling: heavy
Area(s) pilling observed: heel back, heel bottom, toe
Staining: moderate
Area(s) staining observed: heel back, heel bottom
Felting: moderate
Area(s) felting observed: heel back
Shrinkage: none

Sample 6 Sock: 80% Romney/20% Silk Two-Ply Worsted

How did the sock fit? Nearly perfect (50%)
Slightly tight (33%)
Slightly loose (16%)
Was the sock itchy? Not itchy at all (66%)
Slightly itchy (33%)
Did the sock feel smooth or rough? Smooth (50%)
Neither (50%)
Did the sock feel warm? Just right (100%)
Did your foot feel sweaty or sticky? No (66%)
Yes (33%)

What was your overall impression of the sock? Fairly comfortable (83%)
Fairly uncomfortable (16%)

Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel bottom, ball of foot
Staining: minimal
Area(s) staining observed: heel bottom, heel back
Felting: minimal
Area(s) felting observed: heel back
Shrinkage: none
Sample 7 Sock: 100% Romney Three-Ply Woollen

How did the sock fit? Nearly perfect (50%)
Slightly loose (50%)
Was the sock itchy? Slightly itchy (66%)
Not itchy at all (33%)
Did the sock feel smooth or rough? Neither (100%)
Did the sock feel warm? Just right (50%)
Too warm (50%)
Did your foot feel sweaty or sticky? No (66%)
Sometimes (33%)
What was your overall impression of the sock? So-so (50%)
Fairly uncomfortable (33%)
Fairly comfortable (16%)

Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back, ball of foot
Staining: moderate
Area(s) staining observed: heel bottom, ball of foot
Felting: none
Area(s) felting observed: none
Shrinkage: none

Sample 8 Sock: 100% Romney Three-Ply Worsted

How did the sock fit? Nearly perfect (66%)
Slightly loose (33%)
Was the sock itchy? Not itchy at all (100%)
Did the sock feel smooth or rough? Neither (100%)
Did the sock feel warm? Just right (83%)
Not warm enough (16%)
Did your foot feel sweaty or sticky? No (100%)
What was your overall impression of the sock? Fairly comfortable (50%)
Very comfortable (50%)

Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back
Staining: moderate
Area(s) staining observed: ball of foot, toe
Felting: none
Area(s) felting observed: none
Shrinkage: none
Sample 9 Sock: 80% Romney/20% Nylon Three-Ply Woollen

How did the sock fit?            Slightly loose (83%)
Was the sock itchy?             Nearly perfect (16%)
Did the sock feel smooth or rough?  Slightly itchy (66%)
Did the sock feel warm?          Not itchy at all (33%)
Did your foot feel sweaty or sticky?  Smooth (100%)
What was your overall impression of
the sock?                        Just right (100%)
Evidence of wear: minimal
Area(s) wear observed: heel bottom
Pilling: minimal
Area(s) pilling observed: heel back, ball of foot
Staining: none
Area(s) staining observed: none
Felting: minimal
Area(s) felting observed: heel back
Shrinkage: none

Sample 10 Sock: 80% Romney/20% Nylon Three-Ply Worsted

How did the sock fit?            Nearly perfect (100%)
Was the sock itchy?             Not itchy at all (100%)
Did the sock feel smooth or rough?  Smooth (100%)
Did the sock feel warm?          Just right (66%)
Did your foot feel sweaty or sticky?  Too warm (33%)
What was your overall impression of
the sock?                        No (83%)
Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back
Staining: none
Area(s) staining observed: none
Felting: none
Area(s) felting observed: none
Shrinkage: none
Sample 11 Sock: 80% Romney/20% Silk Three-Ply Woollen

How did the sock fit? Nearly perfect (66%)
Was the sock itchy? Not itchy at all (83%)
Did the sock feel smooth or rough? Smooth (100%)
Did the sock feel warm? Just right (100%)
Did your foot feel sweaty or sticky? No (83%)
What was your overall impression of the sock? Very comfortable (83%)
Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back, ball of foot, toe
Staining: minimal
Area(s) staining observed: heel bottom, ball of foot
Felting: none
Area(s) felting observed: none
Shrinkage: none

Sample 12 Sock: 80% Romney/20% Silk Three-Ply Worsted

How did the sock fit? Nearly perfect (100%)
Was the sock itchy? No (100%)
Did the sock feel smooth or rough? Smooth (100%)
Did the sock feel warm? Just right (83%)
Did your foot feel sweaty or sticky? No (83%)
What was your overall impression of the sock? Very comfortable (83%)
Evidence of wear: none
Area(s) wear observed: none
Pilling: minimal
Area(s) pilling observed: heel back
Staining: moderate
Area(s) staining observed: heel bottom, ball of foot, toe
Felting: none
Area(s) felting observed: none
Shrinkage: none
Endnotes

1. american.edu/ted/iceman.htm tells of the discovery of the Otlun ice mummy and describes his garments and tools.

2. Barber, Elizabeth Wayland, The Mummies of Urumchi, 1999, p. 25

3. Ibid

4. Ibid


7. regia.org/life/naalbind.htm offers a discussion and description of Nallbinding socks found at Coppergate in York, England UK.

8. Rutt, pp. 33-36 describes these socks in detail and discusses their origins.

9. podiatry.curtin.edu.au/tight.html offers a detailed description of the various forms of hose worn during this period.


11. Rutt, p. 68

12. Rutt, p. 69

13. podiatry.curtin.edu.au/tight.html

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http://woolworks.org/sockheels.htm
World War II Red Cross poster promoting sock knitting.
Image from historylink.org.