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Date: June 19
Comparative Study of Fibre Tools for Blending Colour Tweed

Master Spinners Program

Submitted to: Olds College
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A comparative study of fibre preparation hand tools including hand cards, drum carder, hackles, mini combs and wool combs.
Abstract:

This study compares hand carders, drum carder, hackles, mini combs and wool combs to blend 23 colours of merino commercial top from Ashford Handicrafts Ltd. into a homogenous blend. The factors that were considered were effectiveness (how well the fibres were blended by sight), efficiency (how much time it took to blend), and how much waste each tool produced.

It was interesting to see how well each blending tool did in effectiveness. The tools were equally effective, however, the five tools did differ in efficiency.

Since all five tools were equally effective to blend 480 grams of fibre, efficiency was the only way to determine the most efficient tool and least efficient tool for blending colored tweed. The most efficient tool was hand carders, taking 14 hours, 48 minutes to complete the task with 0.8 grams of waste. The least efficient tool was the mini combs taking 28 hours, 27 minutes due to the amount of fibre preparation required to complete the task with 177.225 grams of waste. In accordance with the criteria established, hand carders took the least amount of time as well as produced the least amount of waste.
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History of Tools:

The history of tools was a difficult subject to research as time erased evidence in that the tools did not survive or have not been found from prehistory. Written records of tools have been lost or had not been written down due to the lack of literacy prior to 1800’s.

Oftentimes art was used to put a tool on a time line. Paintings and tapestries depicting people using the tools have been found to date some of the history of tools.

**Hand carders:** Hand carders have a very long history dating back to prehistoric times. Hochberg (1979, p. 31) states, “Thorns set into leather back formed the unusual carders found in a prehistoric lake village discovered in Glastonbury, England.”

Leadbeater (1992, p. 22) states that “The preparation methods of combing and carding were practiced by medieval times.” Medieval time was from the 5th to the 15th century. “It is not until the 13th century that there is evidence that teasels or thorns were replaced by wire teeth.” Leadbeater (1992, p. 23).

According to Leadbeater (1992, p. 24), hand making carders was done “...until 1797 when a machine was invented by an American, Amos Whellemore...”

Since 1797 the hand carders continued to evolve until we have the carders that one can buy today.

**Drum carder:** When the drum carder was first in use is not known. According to Hochberg (1979, p. 53) “The first drum carder was patented in 1784 by Lewis Paul of Birmingham, England. The patent drawing shows that it is similar in principle to the drum carder being used by today’s handspinners.”

**Wool hackles:** Wool hackles use was a very difficult topic to write about since there is not a clear history or time frame. Art shows flax hackles being used very early in history, but wool hackles are not shown. Egyptians used hackles and did use wool, but did they use wool hackles? The only way to get dates was to look up the etymology of the word “hackle”. According to Hendrickson (2004, Heckle), Heckle – “To heckle (was) recorded as early as the 13th century....”
Barnhart (1988, p. 472) wrote, “Heckle (v)....both verb and noun being respectively transferred uses of hekelen to comb (flax or hemp) with a hackle (1325)....”

**Wool combs:** The exact time of when wool combs were invented or used is unknown. It is believed that wool combs were used in medieval times (5th to 15th century) according to Leadbeater (1979, p. 22).

Leadbeater (1979, p. 30) states, “Early in the Middle Ages, Flanders and Florence outshone all others for the making of fine woolens....” According to Snell (2014) “The Early Middle Ages are also sometimes referred to as Late Antiquity. This time period is usually viewed as beginning in the third century and stretching to the seventh century, and sometimes as late as the eighth.”

Leadbeather (1979, p. 31) states, “When combed – the earlier of the methods-....” This reference would place the use of wool combs back at least to the second century or earlier.

**Mini combs:** There is not a lot of history on mini combs, however, there are many companies that make them today.

Leadbeater (1979, p. 35) states, “Wool combing was done in rural areas in places as far as Scotland and Greece, not as an organized trade, but by women holding the combs one in each hand (rather like carders).”

According to Leadbeater (1979, p. 35) In Scotland one row of tines were used and in Greece two rows of tines were used.
opposite to the handle and there carry pulleys over which pass a driving belt (C), in such a way that the rotation of the large drum by its handle also rotates the smaller one in the opposite direction.

Carefully adjust the spacing of the cylinders so that the teeth of the two drums only just do not mesh, i.e. as close as possible without the teeth clashing. Tease the wool lightly. Lay the teased wool a little at a time on the tray (D) near the licker-in (i.e. the smaller cylinder (B)) and turn the handle (H) clockwise. The licker-in will draw the wool towards itself and almost immediately, as the drum turns, transfer it to the larger drum. The surface of the large drum is travelling faster than that of the small so carding of the fibres takes place at the point of transfer, and the fibres are spread on to the large drum. Provided the wool has been sufficiently opened (teased), this one operation does quite a good job.

Ross (2001, p. 41) notes for blending with the drum carder:
Methods and Materials:

Part of the description of each of the tools used for this study was a reference to two weights. These weights refer only to the type of fibre used for this study which was 22 micron count coloured Merino from Ashford. The first weight was the maximum the tool could hold and the second weight was the maximum the tool could hold for working the fibres comfortably.

**Diz:** The diz used was hand made by Charles Vereshagen out of cow horn. There were three holes of which only the middle one was used. The measurement of the hole was 12 mm high by 6 mm wide. This hole was chosen as worsted to bulky weight yarn was desired in preparation for spinning. Teal (2005, p. 30) states: “The originals were made of horn, cow horn mostly, which is not easy to purchase these days.” A diz is used to draft fibres from a tool, through a hole in the diz in order to prepare a consistent sliver for spinning.

**Drum carder:** The drum carder was Ashford’s fine cloth, which has 72 point cloth. The drum carder has two rations (6:1 and 4:1). The 4:1 ratio was used. This drum carder could handle up to 23.5 grams of fibre, but 20.6 grams or less is best for blending purposes and having fewer neps.

Ross (2001, p. 38) notes:

Another method of preparing wool is to use a Drum Carder (fig.35). This article takes its name from the large cylinder or drum (A) which is covered all round its curved surface with fine-card clothing’ (i.e. the material used in the making of hand-carders). This drum, which is supplied with a handle (H) to turn it, is mounted on a framework (F) so that it can rotate close to another smaller cylinder (B) carrying coarse card clothing. The axles on which the two cylinders rotate and which are parallel, project on the side
For colour blending with approximately exact proportions of two colours, drum card the two colours separately, stack the batts in alternate colours (if equal parts are wanted) then re-card bits of several batts together - a vertical section down through the stack of, say, four or six batts.

A method of random yarn production is to start at one edge with one colour and gradually introduce the other as one works across the drum, finishing up with only the second colour. The resulting batt, divided up lengthwise offers a selection of different colours of roving material which can be spun in any order, while divided up cross-wise can make random rolags.

Menz (2005, p. 139) states for blending multi coloured yarns, “Carding each color separately is the first step in the multi-color process.” This was not the procedure followed in this study. Instead the following process was used. First lay the fibre bundles on a table. Take the dominant hand putting it so the edge (baby finger running up to the wrist) hold down the fibre and the other hand held eight inches down the fibre bundle, pull the excess fibres away. The amount of fibre pulled off should be as little as possible since the act of rearranging the fibres assists in the blending process as well as having all colours present in each batt. When there was enough pulled off in small batches of fibre to fill the drum carder, the fibres went through the drum carder. The second set and all other passes and sets were done in a similar fashion, however, part of the dominant arm was needed to be used along with the hand due to the width of the batt.

**Hackles:** Ray Thomas’ hackles were used for this study. These hackles are two-pitch with tines that are approximately ¼ inch apart. The maximum amount of fibre the hackles could hold was 85 grams, however, 78 grams or less was best, otherwise the fibres became too compact to diz off comfortably, the resistance would cause the fibre to come off the tines. Menz (2005, p. 172) shows a series of pictures of blending colours on hackles. She uses the stacking method. This method adds more steps
than striking or lashing on of all colours (23) at the same time. By rotating the fibre bundles, the blending process began as they were lashed on to the hackles.

**Hand Carders:** Ashford’s 108 point hand carders were used in this study. The range for weights of fibre was 3.5 grams to 2.2 grams. When using 3.56 grams of fibre it was hard to get a good blend, the fibres were damaged and more nepes were created. The maximum load for a good blend was approximately 2.2 grams or less. Field (1992, p. 34) notes:

> Hand carders ....are also useful for blending different fibres or colours together.

> Worsted spinning ... usually needs only combing or flick carding to prepare the fleece.

> For woolen spinning, however, the yarn is spun from a rolag which is a sausage-like roll of wool. The wool is carded, then rolled so that the fibres are coiled around a central core of air. Hand carders are large wooden battens, with metal teeth embedded in a leather backing.

**Mini combs:** Louet Mini Combs were used in this study. These mini combs are two-pitch with tines approximately 1/8 inch apart. The maximum amount the mini combs could handle was 5.36 grams, but the best was 4 grams or less. At 5.36 grams the tines had problems holding the fibres on and it was difficult to diz off the combs. Field notes (2002, p. 89), “Mini-combs are easy to use and I produced well-combed wool at my first attempt. They are also a good stepping-stone for those who want to go on to buy the larger combs as they not only cost much less, but also require less energy and muscle power.” Menz (2005, p. 171) states, “Distribute a thin, even layer of this first color across the bottom of teeth.” She proceeds to layer the colours.

**Wool combs:** The Wool Combs that were used were Ray Thomas Fine Wool Combs. These combs are five-pitch with tines approximately ¼ inch apart. The range of fibre weight the comb could handle was 18.5 grams, but preferred 16 grams or less for effectiveness.

Menz (2005, p. 170) notes:
... combing to blend colors thoroughly: The possibilities for thorough color blending with combs are the same as for blending on a drum carder, and relate back to the color theory ... A combed color can be changed in the same six ways. You can make it warmer or cooler, darker or lighter, brighter or duller. ....There is one important difference between blending on a drum carder and blending on combs. Carding can thoroughly blend dyed fibers of varying lengths but combing can’t. If the fibres of color A are even a half-inch longer than the fibers of color B, color A will pull off the combs before color B, and the result will be a progression from one color to the other, not a uniform blend. This can happen even if you start with two batches of dyed fiber from the same fleece, because fibre length often varies from one part of the fleece to another. Check fiber lengths to be sure they match before you try to blend colors by combing.
History of Tweed:

Historically, the term tweed has been used to describe a cloth, a weaving term, a type of textured yarn or a type of coloured yarn. Two main types of tweed yarn are often referred to as Donegal and Harris. Donegal comes from the County of Donegal, Ireland and has flecks of colours in a solid colour yarn or nep in the yarn (Hed, 2014). The yarn created within this study is Harris Tweed, which is a blended colour tweed. While some Harris Tweed may have flecks of colour in it, generally Harris Tweed is a homogenous blending of colours. There is very little information on Harris Tweed yarns since they are protected by the “Harris Tweed Act of 1993” according to Glibbery (2014, p. 9).

Harris Tweed was produced in family cottages and was known as “Clo-Mor” for centuries (Macleod, 1975). The fibres of some of the sheep were kept natural while the other sheep fibres were dyed with lichens “(genus Parmelia)” (Wikipedia, 2014). The coloured fibres were then prepared woollen and spun next to each other to make the new colour, tweed. (Wikipedia, 2014).

Around 1840 the production of tweed came under one roof at the Harris estate, thus the name Harris Tweed was established (Macleod, 1975).

Today many people refer to tweed yarns as a generic term for yarns with different colours combined to make a new colour whether it is semi-homogenous or a homogenous blend. Although today Harris Tweed now has one milling plant for milling yarn and there are a couple of dozen colours that are available for different colour recipes that the mill uses according to Rick Fiddes (Fiddes, 2010), the beauty and richness of tweed still lives on.
The company Brooklyn Tweed uses similar techniques as Harris tweed, however, it is more blended and Brooklyn Tweed uses seven to ten colours for tweed. (Brooklyn Tweed, 2014)

Historically there have been many definitions and descriptions of tweed, fibre, yarn and cloth.

Amos (2001, p. 467) says, "...any cloth woven in a twill, using tight natural fleece colors in single yarns may be styled tweed."

To quote Varney (1987, p. 49):

You can take your smooth blends even further. Everyone loves tweed yarns. They have a rich, earthy feeling. Often tweeds are made from heathered yarns sparked with garneted fibers. Garnets are small nubs of fibre, felt, or slightly felted yarn which are added to the fibre supply during carding.

Varney is referring to two kinds of tweed. The homogeneous blend described is similar in appearance to Harris tweed and the blend with garnets is similar in appearance to Donagal tweed.

Ross (1989, p. 97, p. 185) defines two types of tweed:

Harris Tweed of today has its origins in the cloth, handspun and handwoven, which the islanders of Outer Hebrides off the coast of Scotland wove for themselves from the sheep which were farmed on these wild and picturesque islands. Its colours came from the plants which could be gathered there and reflects the soft colours of the landscape.

Tweed: a type of cloth woven from woolen-spun singles, often in a twill weave. The name is reliably reported as being a corruption of the Scots word 'tweel' meaning twill and does not refer to the River Tweed.

Boyd (2014, p. 63) notes that:
Colors can be blended on a drumcarder or with handcards to create the tweed effect. Blend complex colors to make rich, earthy browns and grays in tweeds. Only three colors (can) create a warm brown yarn. Blending more colors will give a more complex result.

Menz (2005, pp. 119 - 120) notes:

Thoroughly blending color in carding is different than blending colors of paint. No matter how many times fibers are carded, the same number of colors are present when you are done, even though they visually blend to form what appears to be a new color. That principle is called a pointillist effect and is achieved through optical mixing. Optical mixing is the visual blending of small dots of colors so that, when seen from a distance, they give the impression of a new color. The blended color tends to be an average of the hues and values of the parent colors, depending on the quantity of each employed.

Blending colors by carding is a good way to broaden the range of your yarns without dyeing more fiber. Colors produced by blending are richer than their solid counterparts.

Hoad (1987, p. 30) notes:

An apparently brown flannel might have been made from yarn in which yellow, red, green and brown dyed fleece had been carefully mixed before carding. This blending was used only for the weft while the warp was left a natural white.

With the dawn of synthetic dyes, hand spinners have more options in blending colours from commercial slivers as well as dyeing their own fibres.
A decision to use 23 colours to create a new desired shade and colour was made to achieve a richer more complex result, and also to standardize the blending process, giving no one tool an advantage.
Defining Tweed and Heathered yarn:

Today, there are many different types of fibre, yarn and cloth referred to as tweed or heather, and it is common vernacular to refer to any multi-coloured yarn. Many commercial yarns have named various colourways tweed or heather. The term tweed has been used in many ways by many hand spinners and for the purpose of this study, tweed will refer to a homogeneous blend of 23 colours to create a new colour, whereas the first set of blending will be referred to as heather.

Menz (2005, p. 25) calls yarns made from well blended colours “Optical mixing”.

When you place small quantities of two or more distinct colors side by side it looks from a distance like a single new color. If you look closely, you see that the original colors remain separate, but when you stand back the colors seem to mix.

Menz (2005, p. 25) also states that “Another consideration of optical mixing involves the size of the dots of color in the final yarn.”

Tweed coloured yarn looks like a solid new colour from a distance or a homogeneous blend while heathered yarn tends to have distinct streaks of individual colours running through the blend. Menz (2005, p. 119) calls the visual blending to create a new colour is “pointillist effect”.

Varney (1987, p. 49) describes tweed “You can take your smooth blends even further. Everyone loves tweed yarns. They have a rich earthy feeling.”

Heathered yarn described by Forestgnome (2011, section 3) sites “A third way of creating heathered yarn is to dye several complementary colors separately and then combine them in a way that distributes them evenly throughout your batt.”

Bradberry (2008) states, “If you were to put this multicoloured batt through your carder again at this stage, you would lose a lot of the bold heathered effect.” (2008, step 5).

“A closeup of my finished yarn. You can see the subtle changes of colour throughout.” (2008, after step C).
Bradberry (2010) states, “I have used 20 grams each of seven different colours.” She goes on to describe drafting out the seven colours together until the coloured top is the right thickness to spin. One can see all the colours running through the yarn.
Discussion:

The method of starting this study was to find fibre that would give each tool a fair chance when it came to waste. Ashford has one of the best selections for fibres and colours on the market today, so their fibre was chosen. Merino top (22 micron) was selected since it was top and has over 40 colours to choose from.

The second phase was to decide on an end product colour. The colour selection was a greyish brown or brown. To achieve this, colours had to be closely matched across the colour wheel. There were more blues and greens chosen to give the coloured tweed more of a greyish rather than a rusty appearance. Reds and oranges were very powerful colours that could overpower some of the other colours.

Twenty-three colours were chosen for several reasons: with more colours the blending process could be seen better; with more colours the tools would show their effectiveness better; and with more colours the tweed looks richer and one can get closer to the colour and shade desired.

Each of the 23 colours chosen (see Sample Chart 1, p. 29) came in 100 gram lots which were then split into 20 gram segments using a scale that could weigh 1/1000 gram. After each colour was weighed it was divided into 5 separate piles (480 gram total weight for each tool). The next step of blending could now begin.

Some of the varying factors were:

1. Colour differences – processing a fleece from the raw, then dyeing it may cause a slight difference in intensity or hue.
2. Fibre length - different length staples in raw fleece and variance in sliver fibres increase waste on some tools. When using hackles, wool combs or mini combs, the shorter fibres are left behind on the tools, hence the colours may not have the same ratio on all the tools.

3. Fibre diameter – with different fibre diameters, the colours may appear different or have a different impact on the final blend. An example is if a blue fibre has a larger diameter than a red fibre, blue will appear more dominant.

It does not seem that the variations would make a difference, however, small changes will amplify in the yarns.

The purpose of this study was to minimize varying factors so that the five tools (mini combs, hackles, wool combs, hand carders and drum carder) could compete for the best blending tool for coloured tweed rovings.

The most desired factor for blending was to have the same method of loading fibre onto the five different tools. This could not be achieved. The fibre was pulled in small lots for the drum carder, while the fibre was lashed on directly from the top on the remaining four tools.

Menz (2005, p. 116) states “A drum carder can process a larger amount of fibers in a shorter time than hand carders.” Menz (2005, p. 114) also states:

Although you can blend colors and fibers with hand cards, I prefer to use a drum carder.

Drum carding is more efficient and thorough, and it’s easier to consistently produce repeatable results with a drum carder than with hand cards.

In this study, the fibre blended on the drum carder was weighed in 20 gram per colour lots to ensure consistency in the blend. Then the fibre was pulled into small amounts of each colour prior to loading the tray. This process enabled the blending of colour to begin immediately by the placement of randomly selected colours of fibre on the tray.
The second phase of blending occurred when the fibre was drawn onto the large drum by the licker. As the licker is stationary and cannot move from side to side the ability of the drum carder to blend is restricted, whereas small manipulation of hand carders is possible to move from side to side.

Hand carders hold less fibre than the drum carder, however, moving the working carder across the stationary carder, blends the fibres with every stroke the working carder makes. With less fibre on the carders, the blending is more complete and fewer passes are necessary.

The time noted for set up did not include getting the tools out and ready for use. The set up time referred to was the time taken to gather the top together so the fibres were in a bundle running parallel to each other, plus the time it took to unroll and align the dizzed off sliver.

The method for loading mini combs, hackles, wool combs and hand carders was striking the fibres onto the tines or teeth of the tool. The best way the writer found to do this was to put the complementary colours of top (colours opposite on the colour wheel) next to each other, then grasp the bundle with the dominant hand. Move the hand down about eight inches from the top of the fibre bundle, striking the tines or teeth with the fibre, then pulling the bundle straight away from the tool. Turning of the colour bundle 1/8 to 1/4 turn was essential to get all the different coloured merino fibres on the tool. This was done until the tool was filled. The fibres were then dizzed off or carded.

The small lot method of laying the fibre bundles on a table was used on the drum carder. Taking the dominant hand putting it so the edge (baby finger running up to the wrist) holds down the fibre and the other hand held eight inches down the fibre bundle, pulls the excess fibres away. The amount of fibre pulled off should be as little as possible since the act of rearranging the fibres assists in the blending process. When there was enough pulled fibre to fill the drum carder, the fibres were fed into
the carder. The second set and all other passes and sets were done in a similar fashion, however, part of the dominant arm was needed to be used along with the hand due to the width of the batt.

In the first set of each tool one can see different colours running through the sliver. This was very evident with hackles and drum carder. Wool combs and mini combs had less distinction and would be a nicely heathered sliver at this point. Hand carders are better blended, but each batt came out a different colour (see Sample Chart #2 A First Set, pp. 30 - 31).

During the first set, the writer developed a blister from dizzing off the mini combs seven hours and 12 minutes into the blending. Bandages and tape were added to blistered right index finger until the dizzing off of all tools was completed. Hand carders caused soreness in hands and wrist of writer after four hours and 20 minutes of carding. Wool combs cause pain or soreness in shoulders after four hours, 35 minutes. Drum carding caused issues of soreness in elbow and wrist after three hours and 10 minutes. Hackles were easy to blend on, although like the mini combs, dizzing the fibre off for extended periods of time caused sore fingers.

The amount of time for each set was added up since there were breaks while blending. The time was recorded by minutes instead of seconds using a wrist watch. The shortest time was two minutes and the longest time blending at one sitting was 81 minutes.

In the second set (see Sample Chart #2 B Second Set, pp.32-33) one can see the more homogenous blending. The hackles and drum carder still have lines of single colours running through the slivers and batts. Wool combs and hand carders had a slight difference in colours with the sliver, however, they were almost blended. Mini combs sliver at this point was blended to a homogenous blend.
The third set (see Sample Chart #2C Third Set, p.34) the hackles and drum carder still had strands of some colour running through the slivers and batts. This was the point where the sliver and batts were changing from a heather blend to a tweed blend. The wool comb sliver and the hand carder batts became a homogenous blend (all sliver and batts looked the same).

The fourth set (See Sample Chart #2D Fourth Set, p.35) of hackle slivers did not look homogeneous, however, the drum carder batts were a homogenous blend.

The fifth set (see Sample Chart #2 E Fifth set, p. 35) hackle slivers did become a homogenous blend. All the slivers and batts had the same colour and shade no matter which tool was used.

During the blending of fibre, each tool did have waste product. The hand carders and drum carder had very little waste, some that did not register on a scale that would read weights to 1/1000 g. The waste produced from both the hand carders and the drum carder was in the form of nepes (see Sample Chart #3 Waste p.37). The drum carder did produce lint and a lot more nepes. The extra nepes may have been caused by the 72 point cloth whereas a finer cloth would produce fewer nepes. The hackles, wool combs and mini combs produced fewer nepes, but short fibres were left behind on the tools. Wool combs produced the most waste at 177.225 grams; hackles produced 174.2 grams with no nepes; mini combs produced 121.1 grams and 0.08 grams of nepes; drum carder produced 0.825 grams of lint with 2.175 grams of nepes, but the least amount of waste was with hand carders with 0.8 grams of nepes. (See Final Result Chart, p. 23).

The fibres were prepared for woollen spinning. The hand carder and drum carder fibres were rolled into rolags. The hand carder batts were rolled from the heel of the carder to the toe. The drum carder batts were rolled from the top of the batt to the bottom. Wool combs, hackles and mini combs were done the same way. The fibre was lashed onto the tines, then the excess sliver was pulled away.
The fibre left on the tines was carefully taken off and rolled into rolags. The fibre was rolled from the heel to toe of the carder to make the rolags.

When making sliver the only tools that needed to be worked with were the hand carders and drum carder. Sliver was achieved with the hand carders by rolling the batts from side to side. Drum carder batts were also rolled from side to side, so the fibres ran parallel to each other.

The woollen spinning was done first. All skeins both woollen and semi-worsted were spun with the same wpi, tpi and angle.

The formulas used to achieve the desired 4.5 tpi in a 2 ply yarn were:

\[ Tpi \times ply + \frac{1}{ply} = 4.5 \times 3/2 = 6.75 \text{ tpi for singles.} \]

\[ Tpi \times \text{draft/ratio} = 6.75 \times 4.1''/5.5 = 5 \text{ treadles per 4.1'' draft for singles.} \]

\[ Tpi \times \text{draft/ratio} = 4.5 \times 5''/5.5 = 4.09 \text{ or 4 treadles for ply.} \]

The yarn was 8 wpi, the angle was 21 degrees, and the tpi was fairly consistent at 4 – 4.5 tpi.

The woollen and semi-worsted yarns all had a nice soft bouncy hand no matter which tool was used for blending. The semi-worsted and woollen look identical in their blends, and each spinning method looks like they came from the same skein of yarn. (See Yarn Sample Charts #1 Semi-Worsted and Yarn Sample Chart #2 Woollen, pp. 39-42)

All the fabric samples were knitted on 4 mm needles. There were 26 stitches cast on using the long tail cast on. The first four rows and last four rows were knitted in seed stitch. The main body of the samples was created by knitting the seed stitch for the first and last four stitches with the centre 18 stitches stockingette. Margaret Sjostrom and Maria Lougheed helped knit the samples.
The yarn was easy to work with, and had nice stitch definition. The fabric would be suitable for a sweater, scarf or hat (See Fabric Sample Chart #1 Semi-worsted and Fabric Sample #2 Woollen, pp. 43-52).
<table>
<thead>
<tr>
<th></th>
<th>Hackles</th>
<th>Drum Carder</th>
<th>Wool Combs</th>
<th>Hand Carders</th>
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<td>2</td>
</tr>
<tr>
<td>Number of sets</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Waste (g.)</td>
<td>174.2 g.</td>
<td>0.825 g.</td>
<td>177.225 g.</td>
<td>0</td>
<td>121.1 g.</td>
</tr>
<tr>
<td>Neps (g.)</td>
<td>0</td>
<td>2.175 g.</td>
<td>0</td>
<td>0.8</td>
<td>0.08</td>
</tr>
<tr>
<td>Percentage Waste</td>
<td>36.29%</td>
<td>0.625%</td>
<td>36.92%</td>
<td>0.17%</td>
<td>25.25%</td>
</tr>
<tr>
<td>Time:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set up</td>
<td>40 min.</td>
<td>1 hr.3 min.</td>
<td>33 min</td>
<td>30 min</td>
<td>29 min.</td>
</tr>
<tr>
<td>Blending</td>
<td>13 h 55m</td>
<td>26 h 16m</td>
<td>21 h 14 m</td>
<td>14 h 29 m</td>
<td>26 h 56 m</td>
</tr>
<tr>
<td>Woollen preparation</td>
<td>37 m</td>
<td>35 m</td>
<td>38 m</td>
<td>12 m</td>
<td>1 hr 2 m</td>
</tr>
<tr>
<td>(rolags 80 g. each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worsted (semi) preparation</td>
<td>50 m</td>
<td></td>
<td></td>
<td>7 m</td>
<td></td>
</tr>
<tr>
<td>(sliver 80 g. each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Waste</td>
<td>174.2 g.</td>
<td>3 g.</td>
<td>177.225 g.</td>
<td>0.8 g.</td>
<td>121.18 g.</td>
</tr>
<tr>
<td>Total Time</td>
<td>15 h 12 m</td>
<td>27 h 20 m</td>
<td>22 h 35 m</td>
<td>14 h 48 m</td>
<td>28 h 27 m</td>
</tr>
</tbody>
</table>
Conclusion:

Hand carders came in first with the least amount of waste (0.8 grams) and the least amount of time (14 hours, 48 minutes). The hackles would be the second choice since the time (15 hours, 12 minutes) is low, but the setback would be the high amount of waste (174.2 grams). Third place was the drum carder which took 27 hours, 20 minutes, but only had 3 grams of waste. Fourth place was wool combs with 22 hours 25 minutes however it had 177.225 grams of waste. Last place was the mini combs that took 28 hours, 27 minutes to complete the blending preparation of woolen and set up time, plus it had 121.18 grams of waste. (See Final Result Chart for details, p.23).

This study was an informative journey, and could be repeated changing a couple of variables. The first change would be having the same number of passes throughout the sets for each tool. The second would be to complete the same number of sets on each tool despite the degree of optical blending.
Glossary

► Batt: A mass of carded fibres from a carding machine, hand carders or drum carder.

► Blending load(s,ing): Placing fibre on a tool usually filling the tool to its limit.

► Blending pass: The process of blending fibre by moving the fibre from one comb (mini comb, wool comb) or paddle (hand cards) to the other, or running the fibre through the drum carder.

► Complementary colour: A colour that is opposite on the colour wheel.

► Diz: A concave disc with one or more holes available to draft fibres consistently for worsted spinning.

► Drum carder: Machine used to card or blend fibre consisting of a small drum and a large drum and infeed tray and a crank.

► Hackles: Wool hackles are a smaller version of the finer gauge flax hackles. They consist of one to two rows of sharp metal tines set into a wooden base and can be used for combing wool locks, colour blending, and blending fibres of different length. The blending occurs as it is drawn through the diz.

► Hand carders: Two paddles with carding cloth, used to straighten or blend fibres. Carded batts may be rolled side to side (sliver) or toe to heel (rolags).

► Heather: A blend of two or more colours where distinct streaks of colour are visible.

► Homogenous blend: Two or more colours thoroughly blended together to create a new colour as seen from a short distance.

► Lint: Small bits of broken fibre that appears like dust under a drum carder.

► Mini combs: A smaller and lighter version of wool combs with one or two rows of tines. Used to prepare sliver or to blend fibre.
- Neps: Little tangled knots in the wool that are impossible to get out. They are caused by bits of broken and damaged fibers that tangle and cling together.
- Rolags: A carded batt rolled from heel to toe creating a circle of fibre around an airy core.
- Roving: A long even strand of carded or combed fibres which are drawn out then slightly twisted.
- Set: One pass of processing on a tool.
- Semi-worsted: Levels One through Five note it is worsted preparation of fibres and worsted draw to make smooth yarn.
- Sliver: Commercial or hand processed fibres wherein the fibres run parallel to each other but may have varying lengths without twist.
- Strike: The process of placing fibres on a tool by holding fibres parallel in a bundle and touching the fibres to the tool, then pulling the unattached fibres away from the tool. This process was used for hackles, mini combs, wool combs and hand carders.
- Top: Commercial or hand processed wherein the fibres are parallel and the fibre length is uniform with shorter fibres removed.
- Tweed: Two main types of tweed are Donegal, which is known for its texture, and Harris, which is known for its blended colour. For the purpose of this study, tweed is a colour that has been created by blending 23 colours and is not a texture tweed. It is a sister to heather, however, tweed is more homogenous than heather.
- Tweed yarn: A yarn spun from three or more colours of fibre optically blended to a homogeneous new colour.
- Wool combs: A tool with one to nine rows of tines set into two wooden handles. One comb is fixed to a surface and the other comb is active to align or blend fibres, or to blend colours.
- Woollen: A yarn spun from a rolag or roving using a woollen draw.
References:


Sample Chart #1
Ashford coloured merino top (22 micron)
Sample Chart # 2
A First Set

Hackles:
Waste- 79.9g
Loads- 5 Passes- 5 Set-1

Drum carder:
Drum Carder: Waste- N/R
Loads- 21 Passes- 1 Set-1
Sample Chart # 2 A
Continued

Mini combs
Sample Chart # 2

B Second Set

Hackles: Waste - 31.2g
Loads-5 Passes- 5 Set-2

Drum Carder: Waste-0.05g
Loads-12 Passes- 2 Set-2

Wood Combs:
Load-15 Load

Hand Carded:
Load-99 Passes
Sample Chart # 2 B
Continued

Mini combs
Sample Chart # 2
C Third Set

Hackles: Waste-21g
Loads-5 Passes-5 Set-3

Drum Carder: Waste-1.13g
Loads-19 Passes-2 Set-3
Sample Chart # 2

E Fifth Set

Hackles

Hackles: Waste- 22.7g
Loads-5 Passes-4 Set-5
Sample Chart #3

Waste

**Hackles:** Set-1
Waste- 79.9g

**Drum Carder:**
Neps- 0.05g

**Wool Combs:** Set-1
Waste- 112.155g

**Wool Combs:** Set-2
Waste- 38.2g

**Hand Carders:**
Neps- N/R Pass-1

**Mini Combs:** Set-1
Waste- 83.013g

**Hackles:** Set-2
Waste- 31.2g

**Drum Carder:** Neps- 0.05g

**Hand Carders:**
Neps- 1.13g
Waste- 21g

**Wool Combs:** Set-3
Waste- 26.87g

**Carders:**
Waste- 11g Pass-3
Chart # 3: Continued

Hackles

D Forth Set

Drum carder

E Fifth Set

Hackles: Set-4
Waste- 19.4g

Drum Carder: Neps-0.995g
Set-4

Drum Carder: Lint- 0.825g

Hackles: Set-5
Waste- 22.7g
Kristi Lacey
ID Comparison of Tools for Blending Tweed
Ashford's coloured merino top
Wool combs
Sliver
Short forward draw
Semi worsted
zzS
10y
Tpi- 4.4
Wpi- 8
Angle- 21°
Wt.- 6.3g
Count- 3's
Kristi Lacey

ID Comparison of Tools for Blending Tweed

Ashford's coloured merino top

Mini combs
Short forward draw
Semiworsted

Silver

23S
Tip 45
Wf 10y
Wpi 8
Angle 21*
Wt 5.9g
Count 3's
Kristi Lacey

ID Comparison of Tools for Blending Tweed

Ashford's coloured merino top
Wool combs
Rolags
Supported long draw
Woollen
zzS
10y
Tpi- 4
Wpi- 8
Angle- 21*
Wt- 6g
Count- 5's
Kristi Lacey

ID Comparison of Tools for Blending Tweed

Ashford's coloured merino top
Mini combs
Rolags
Supported long draw
Woollen

S
10y
Tpi-5-6
Wpi-8
Angle-21°
Wt.-6g
Count-5's
Fabric Sample Chart #1
Semi Worsted

A Hackles
Fabric Sample Chart #1 Continued
Semi Worsted

B Drum carder
Fabric Sample Chart #1 Continued

Semi Worsted

C Wool combs
Fabric Sample Chart #1 Continued

Semi Worsted

D Hand carders
Fabric Sample Chart #1 Continued
Semi Worsted
E Mini combs
Fabric Sample Chart #2
Woollen
A Hackles
Fabric Sample Chart #2 Continued

Woollen

B Drum carder
Fabric Sample Chart #2 Continued

Woollen

C Wool combs
Fabric Sample Chart #2 Continued

Woollen

D Hand carders
Fabric Sample Chart #2 Continued
Woollen

E Mini combs