

ABSTRACT

MEADWELL, ERIN SUZANNE. An Exploration of Fancy Yarn Creation. (Under the direction of William Oxenham)

The purpose of this research was to compile a lexicon of fancy yarns, along with explore non-traditional methods of creating fancy yarns for use in the mechanized, or commercial textile industry. There are many different types of fancy yarns throughout the textile industry. Their uses range from upholstery to apparel and from transportation to home furnishings. Fancy yarns are regarded as any yarn which has deliberate inconsistencies applied during processing. This could include variation through the diameter of the yarn, character, or even in the color. Given the large number of fancy yarns, along with the possibility for a large number of variations, there is also a large number of manufacturing processes that are used in the creation of fancy yarns.

A few of the processes used to create fancy yarns include hollow-spindle machinery, fancy twistors, ring-spinning, and chenille machines. These methods have been researched and documented thoroughly.

After exploring the traditional methods for fancy yarn creation, untraditional methods were explored, mainly the Gilbos Air Twist System. This system consolidates input feedstock and inserts areas of s- and z-twist throughout the length of the yarn. These areas are separated by areas of entanglement, known as tack points. This research explores the possibilities of

yarn creation on the Gilbos Air Twist System. Both yarn samples and fabric samples are included.

AN EXPLORATION OF FANCY YARN CREATION

by
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DEDICATION

This research is dedicated to my parents, Jack and Sandra Meadwell, who have supported me throughout my educational journey of the past eighteen years. Without their love, patience, and support, none of this would be possible.

BIOGRAPHY

ERIN SUZANNE MEADWELL was born on November 17, 1980 in Winston-Salem, NC where she lived for seventeen years and attended North Forsyth High School. In August 1998, she began her undergraduate degree at North Carolina State University. In May 2002, she received her Bachelor's of Science degree in Textile Technology with a concentration in Design. The following August, she began her master's degree in Textile Product Design.

After graduation, Erin plans to begin her career in the Textile Design industry.

ACKNOWLEDGEMENTS

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I would like to thank those at Gilbos of America who showed me such charity and guidance in completing numerous trials. Great gratitude goes out to Jack Gaches, who drove several hours from Georgia every time I needed some additional data. Also, to the others at Gilbos who humored this graduate student and all of her curious whims.

There are so many others that have exhibited their support throughout this process; including my roommates who have endured the countless months of staring at my loads of papers and computer strewn about. Also, to Lesley, who without her empathy, this process would have taken much more of a toll on my sanity than it did.

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1. Introduction

1.1 Objectives

The objective of this thesis is two-fold. First is to look into the different types of fancy yarns currently and previously manufactured. Second is to create new yarns with previously unexplored machines and technology.

The term 'fancy yarns' refers to a very broad category of yarns including any yarn that is not deliberately uniform. This non-uniformity can be in diameter, constitution, color, or texture. Given this vague definition, it is obvious that this category is not so easily subdivided. Therefore, the first objective of this thesis is to determine classifications that can be universally applied to all yarns that fall into the 'fancy yarn' category.

Given that fancy yarns are vaguely classified by being any yarn that is not uniform, the opportunity for creation is sizeable and, the challenge to find new machines for fancy yarn creation was addressed. To add to this challenge, consideration was also given to the fact that fancy yarns have historically been made from staple fibers. The second section of this thesis focuses on using an unlikely machine, along with synthetic filament fibers, to create fancy yarns. The machine chosen, the Gilbos Air Twist system, is a recently introduced machine which to date has been used to create "pseudo twisted yarns" for the carpet industry. In the present study, the potential of utilizing this new technology to create fancy yarns for areas other than carpets was investigated and representative examples of yarns and fabrics which were created are included.

1.2 Look at traditional technology

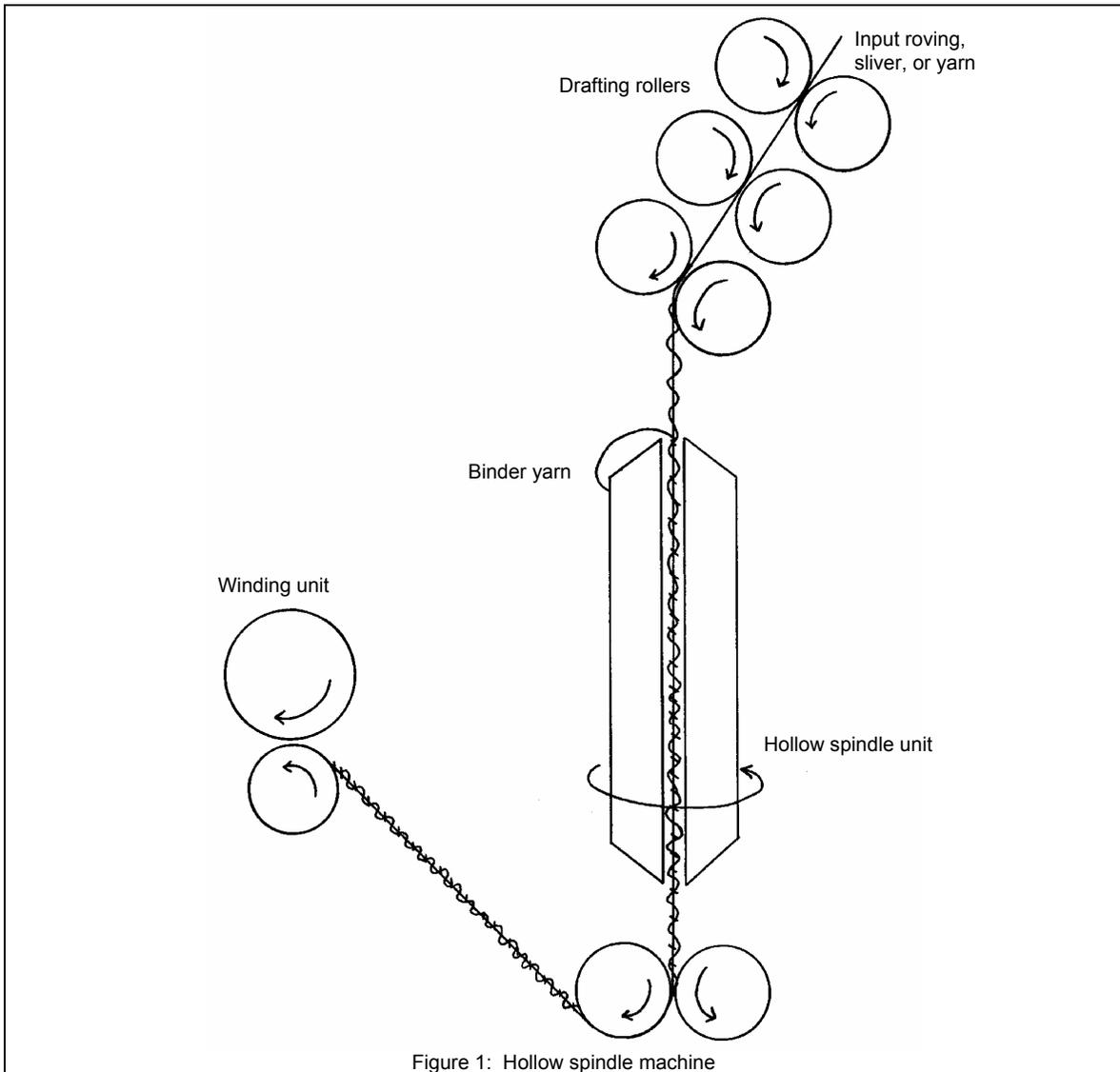
There are numerous technologies that can be used to create fancy yarns. Some of these technologies include machinery such as hollow-spindle machinery, chenille machines, ring-spinning and rotor-spinning frames, folding/cabling machinery, and specialized machines. These machines will be discussed further throughout this chapter.

1.2.1 Hollow spindle machinery

Hollow spindle machinery is a technology that has been improved over the years. In years past, it was a rarely used technology due to limitations such as low production speed, limitations on input feedstock, and the fact that it requires an additional binding operation. The yarns produced were not stable enough to continue to the next processing stage without losing their structure. Due to this, an additional binding operation was necessary to stabilize the structure of the yarn. Newer technologies have addressed some of these concerns.

Sliver or roving yarn is fed into a drafting system composed of several sets of rollers. Some of the variations of hollow spindle machines have several sets of drafting rollers at the onset of the process. Upon exit from the drafting rollers, the drafted sliver, roving, or yarn is introduced to the hollow spindle unit. This unit is a round spindle with a hollow core, which holds the bobbin of the binding yarn. The material leaving the drafting system, and entering the hollow spindle, can be made of various components. If required, for example in bouclé yarns, different lengths of each component may also be introduced at this stage. As the drafted sliver, roving, or yarn is fed into the hollow spindle unit, the binder yarn is

pulled from the package and passes into the core along with the sliver to be consolidated. The rotation of the hollow spindle unit wraps the binder yarn around the sliver. Upon exit from the hollow spindle unit, the fancy yarn which has been created goes through a set of rollers which lead the yarn to the winding unit.

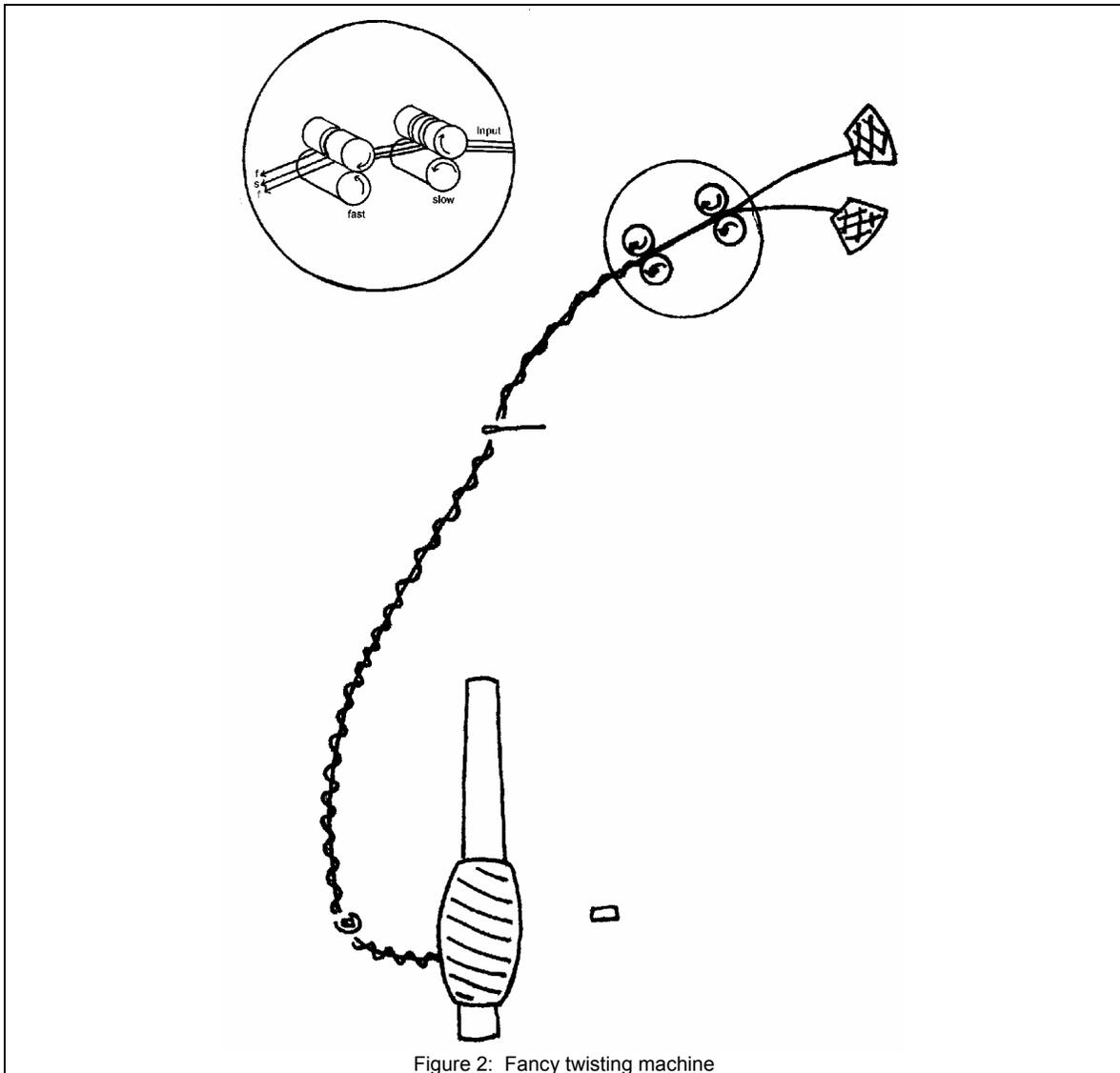


1.2.2 Fancy Twisting Machinery

Fancy twisting machines are similar to folding/cabbling machines, the difference being the set-up of the feed rollers. The input yarns are fed into two sets of rollers. The first set of rollers is rotating at a slower or faster rate than the second. The top roller of each set contains grooves or notches that follow the diameter of the rollers. As shown in Figure 2, the first set's top roller has two grooves. The input yarns are fed between the two rollers, two of the yarns following the paths of the grooves, and the third yarn in between the grooves so that it has contact from both the top and bottom roller. The top roller of the second set of rollers contains one groove in the center of the roller. The middle yarn which was previously receiving contact from both rollers in the first set is now fed through the groove in the second set of rollers. The other two yarns are fed between the two rollers on either side of the middle yarn. Since the second set of rollers is turning at a faster rate, the two yarns on the outside are fed at a higher rate than the yarn in the middle which is fed through the groove. This so called "overfeed" will ultimately create curls, loops, or snarls in the final yarn. The rollers' order can also be reversed to create additional effects to the yarn.

As the yarns exit the drafting zone, they are fed through several guides and then through a ring and traveler to twist the components together. The ring and traveler then wind the resultant yarn onto a cone. Due to the fact that these yarns are merely twisted together, it is necessary to follow up this process with an additional binding process to stabilize the structure of the yarn that was

previously created. Indeed, in most cases the features of the 'fancy yarn' are only realized after this additional twisting or binding process.

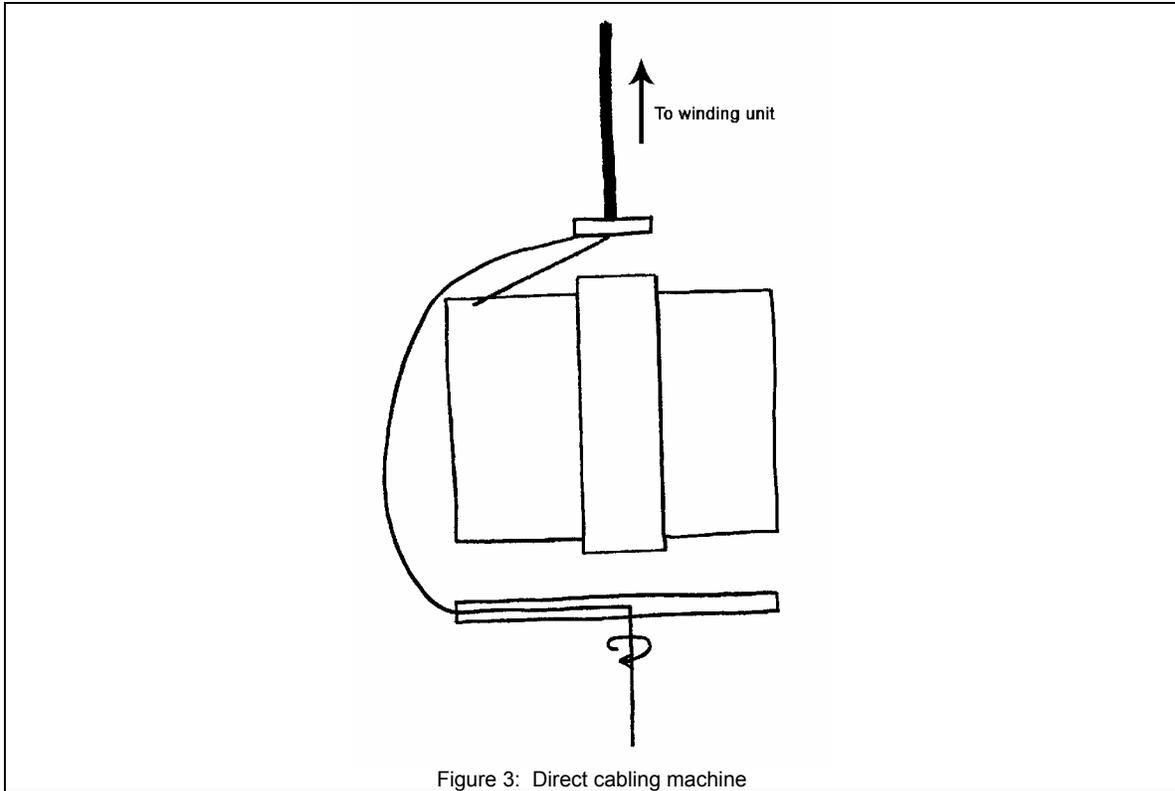


Fancy twisting machines can be used to create several different types of yarns dependent of the speeds and character of the rollers. The rollers can be set to run at the same speed; thereby producing colored twisted yarns, spirals, and diamonds. They can also be set to run at different speeds. If set to a continuous overfeed, as demonstrated by Figure 2, a wavy effect is imposed on

the yarn. This set-up is helpful in creating yarns like bouclés. With the same set-up applied to the rollers, if a twist-lively yarn is used as the effect yarn, instead of the effect producing waves, the twist-lively yarn twists upon itself to create a snarl yarn, like that in Figure 34. If all of the input yarns are created using stiff fibers, such as mohair, the resultant yarn created will be a loop yarn, as shown in Figure 29. By creating a variable overfeed through the rollers; variations of the previously discussed effects can be created. Additionally, by allowing the rollers to run intermittently, further effects such as knops and extended knops can be created, as shown in Figures 26 and 27, respectively.

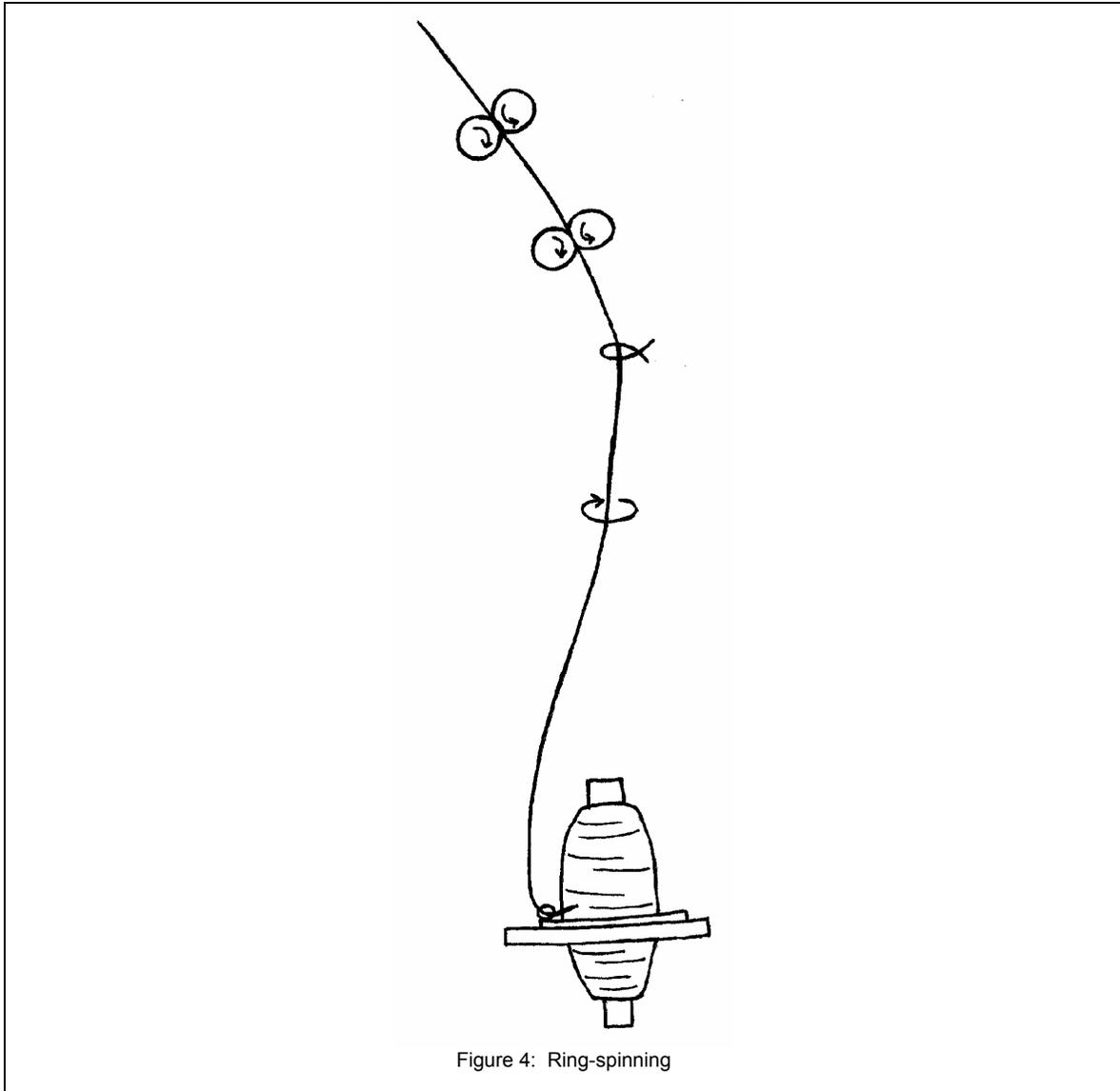
1.2.3 Folding/cabbling machinery

Traditional folding/cabbling machinery is not used exclusively to create fancy yarns. It is also used to create tire cords, carpet yarns, and sewing threads. It can, however, be used to create yarns such as spiral, diamond, gimp, and mock-chenille yarns. Specialized folding/cabbling machinery can also be used to create cloud, knop, loop, snarl, spiral, eccentric, and slub yarns.



1.2.4 Ring-Spinning frames

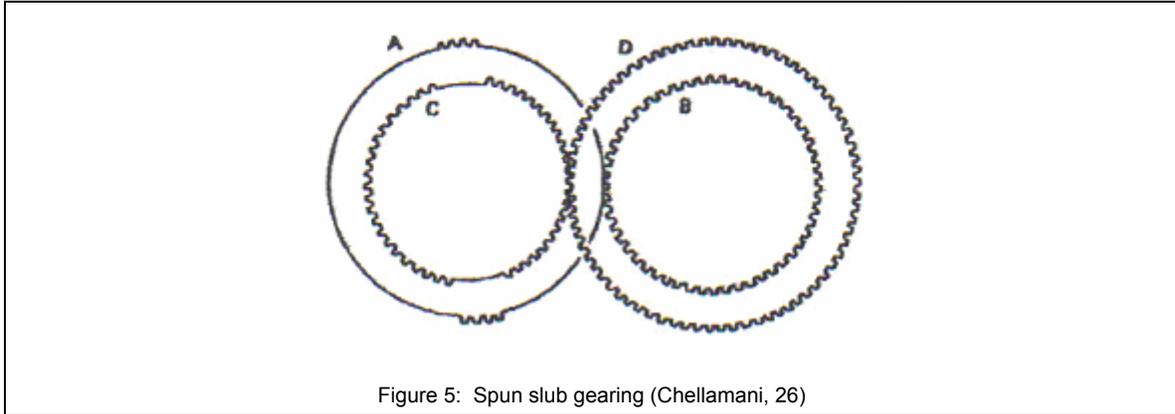
Ring-spinning frames have a number of parameters that can be varied to create different effects throughout a yarn. While roller speeds is an important variable in producing fancy yarns on ring-spinning frames, the shape of the roller is also a parameter that can be varied to create additional effects.



Spinning frames can be used to create yarns such as crimp, corkscrew, marl, and chenille yarns. They can also be modified create spun slub yarns, as discussed further in section 2.4.5.

Spun slub yarns can be created through two different processes. They can be created by using varying roller speeds in the drafting zones, or by using varying speeds at the roving stage and then drafting with a constant draft.

Modified drafting gears can also be utilized to create spun slub yarns. As the gears turn, the input slows down as it reaches a point in the gears where there are no teeth. This creates thick and thin places throughout the length of the yarn.



Chenille yarns can be created on modified ring-spinning frames. The effect yarn is fed through the top of the chenille apparatus. As it moves down the apparatus, it is wrapped around the neck of a gauge, as seen in Figure 6. As the effect yarn moves down the gauge neck, the tension of the yarn causes pressure which cuts the effect yarn into short lengths by pressing the effect yarn into a blade. The core yarns are then pressed into the center of the short lengths of effect yarn. As the core yarns are applied to the effect yarn, they are twisted using a ring-spinning system to secure the cut effect yarns.

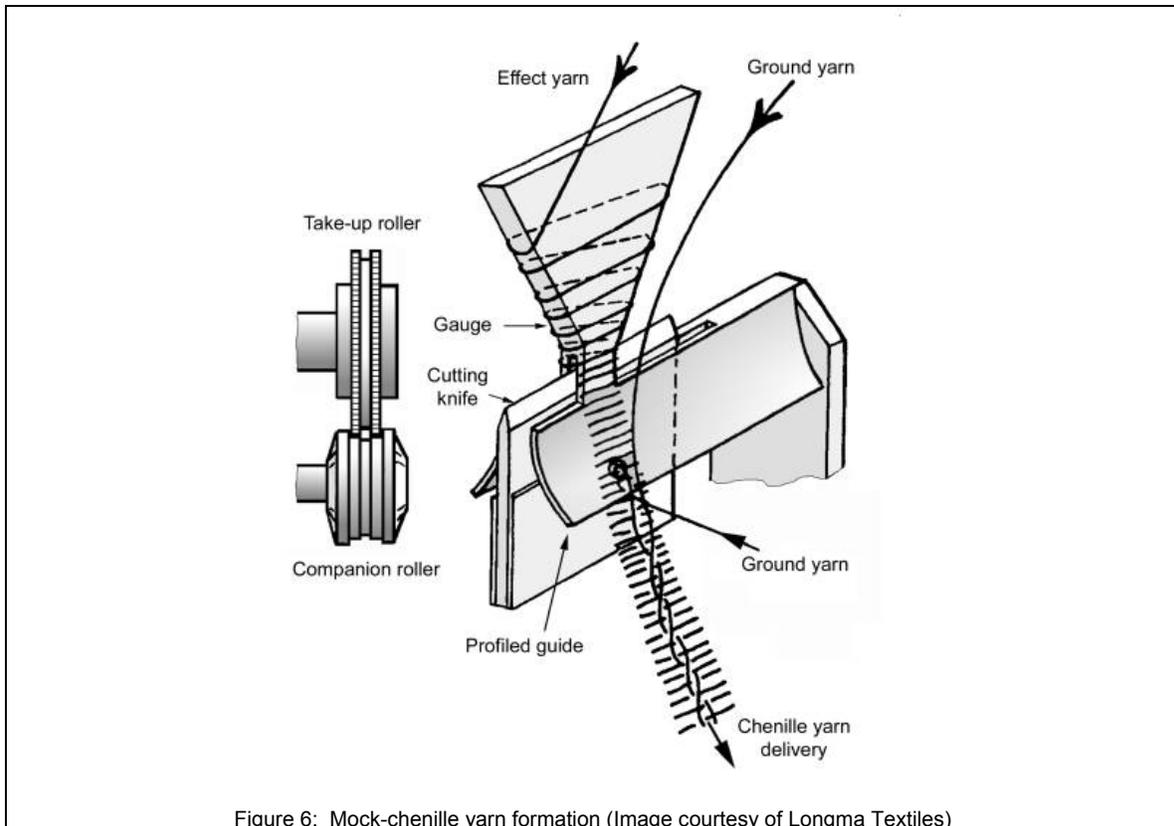
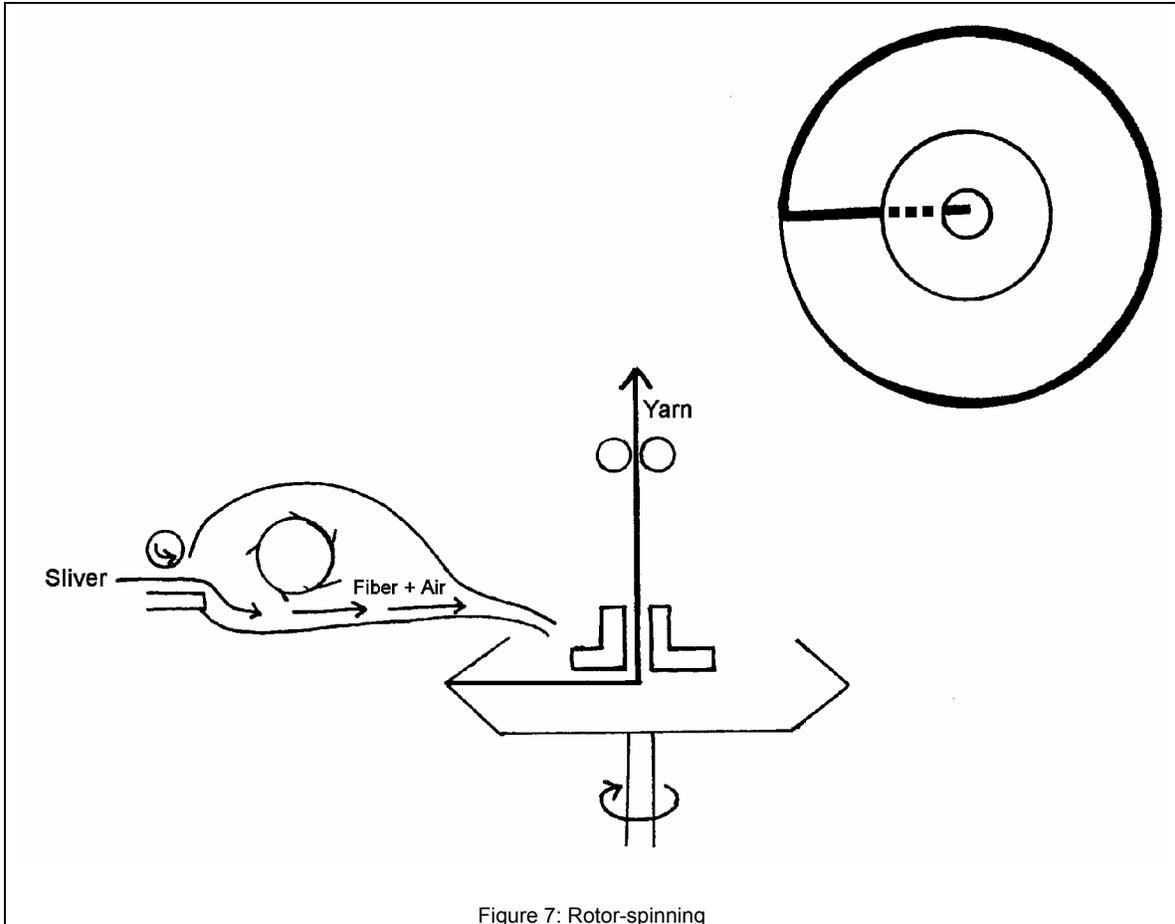


Figure 6: Mock-chenille yarn formation (Image courtesy of Longma Textiles)

1.2.5 Rotor-Spinning frames

Rotor spinning can also be used in fancy yarn creation. In rotor spinning, a sliver or roving is fed in through the side of the rotor while a twisted yarn is fed in through the open end. In the case of creating loop yarns, the core and effect yarns are combined inside of the rotor. The loops are created by varying the tensions on each yarn; the effect yarn having less tension applied than the core yarn. Upon exit of the rotor, the yarns are then combined with a binder yarn prior to winding.

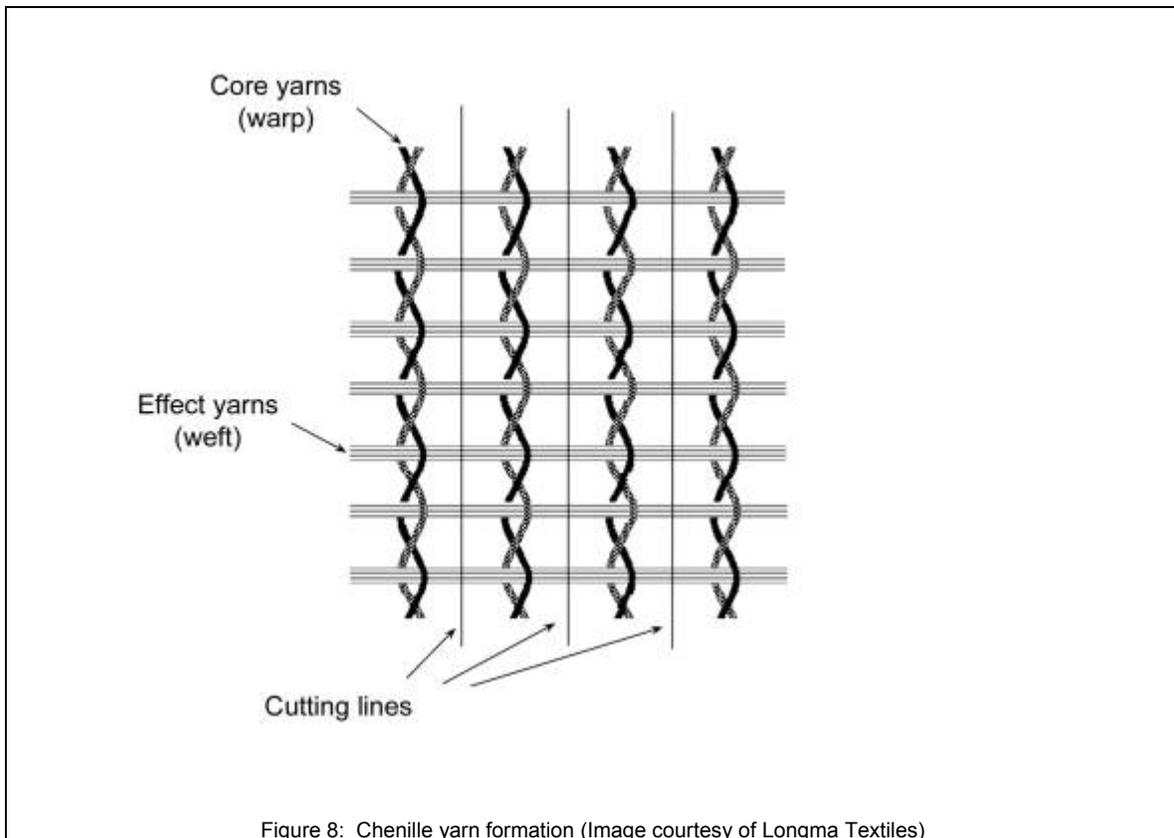


Additional variations to this process include introducing pulsed pressurized air to the input sliver inside of the rotor. This air causes the effects of the fancy yarns created through rotor spinning to become even more variable. The duration and frequency of the pulses of yarn can also be varied to create further variations in the yarn.

1.2.6 Chenille machines

True chenille yarns are produced on weaving looms; the warp forming the length of the yarn, and the weft forming the effect portion of the yarn. Several warp yarns were grouped together with areas containing no warp yarns in

between as shown in Figure 8. After the fabric was woven, it is cut into strips along the lengths of the areas containing no warp yarns.



1.2.7 Additional machinery

1.2.7.1 Texturing machines

Yarn texturing machines can be used to create fancy yarns, as well. However, the variety of yarns created on these machines is highly dependent on fiber types. Many of the yarns created on texturing machines are considered fancy due to their dyeability factors or thermal qualities. The variety of dye characteristics, depending on the fact that different fiber types will dye differently, is the main variable for textured fancy yarns. While yarn texturing machines are a possible resource for the production of fancy yarns, it is not one of the most

commonly used. An excellent resource for more information on yarn texturing is Hearle, Hollick, and Wilson's *Yarn texturing technology*.

1.2.7.2 Air Jet Spinning

Similar to yarn texturing systems, the creation of fancy yarns through air jet spinning is highly dependent of the multiple colors of feedstock.

1.3 Problem Statement

There are many reasons behind writing this thesis. One of these reasons is to compile a concise lexicon of fancy yarns. Another reason is to compile a resource for manufacturing techniques of fancy yarns. A third reason is to explore creating a definitive fancy yarn by means not previously explored.

Fancy yarns have existed for many years and in many different places throughout the world. However, a communication breach occurs when it comes to being able to find a concise definition of any fancy yarn. There is no previous resource that agrees with all other resources researched. This is why it is necessary to survey as many resources as possible to create a combined definition by which a multitude of fancy yarns can be classified, therefore creating a 'universal standard' of which fancy yarn classification is applied.

Also posing a problem is the fact that most research done on fancy yarns was done in the 1950's and 1960's. Since then, many more yarns have been developed, but not necessarily written about.

Because of the previously stated problem, there is also no previous primary resource with an abundance of information on the manufacture of fancy yarns. This reason supports the formulation of this thesis, including its resource for fancy yarn manufacture.

Given that fancy yarns are manufactured a number of different ways on a number of different machines, it is proposed that by the true definition of a fancy yarn, almost any yarn processing machine can be used to create a fancy yarn.

Using this assumption, the challenge was taken to create a fancy yarn on unlikely machinery that has never been previously been used to do so.

2. Literature Survey

2.1 Fancy Yarns

The term “fancy yarns” refers to a vague category in the textile industry. Over the years, many types of fancy yarns, also known as novelty yarns, have been created around the world. Given that global communication has not always been as strong as it is today, some yarns were created more than once in numerous countries and have been given numerous names. This “term, (fancy yarns,) can be applied to any ‘non-normal’ yarn (Oxenham 2002). Fancy yarns can be “manufactured by such techniques as ‘by blending together different colours or materials in the fiber state’ (Watson, 355) ; by printing or dyeing a pattern on the sliver or yarn; by introducing spots or neps of coloured fibres which are twisted in with the threads; by twisting together threads which are different in material, colour, softness, thickness, length, and amount and direction of twist; and by forming curls, snarls, lumps, knops, and thick and thin places at intervals in the yarn” (Oxenham, 2002). They are “those in which some deliberate decorative discontinuity or interruption is introduced, of either colour or form, or of both colour and form. This discontinuity is incorporated with the intention of producing an enhanced aesthetic effect.” (Gong & Wright, 2) In Katherine Hatch’s *Textile Science* textbook, they are defined as “those that ‘differ significantly from the normal appearance of single or plied yarn due to the presence of irregularities deliberately introduced during their formation’” (Hatch, 305).

In the 2002 edition of Textile Terms and Definitions, fancy yarns are defined as “a yarn that differs from the normal construction of single and folded yarns by way of deliberately produced irregularities in its construction. These irregularities relate to an increased input of one or more of its components, or to the inclusion of periodic effects, such as knops, loops, curls, slubs, or the likes” (Textile Terms and Definitions, 122).

Bellwood wrote a series of articles entitled “The Manufacture of Novelty Yarns” for publication in Wool Textile Industry. The majority of these articles, written between the years of 1968 and 1969 will be referenced in this review.

Bellwood’s July 1968 article briefly details a few uses for novelty/fancy yarns, namely in apparel applications. It was noticeable that mostly knops, slubs, and metallic yarns were used at this time. The only stipulations of fabric made with fancy yarn at this time was that it was wearable, drapable, and comfortable (Bellwood 3).

Fancy yarns can be produced during the various steps of yarn processing, especially carding, spinning, twisting, and weaving. Bellwood speaks to the process of carding in fancy yarn production. The three types of fancy yarns that can be produced during carding are nepp, slub, and flake, which are discussed in sections 2.3.2, 2.3.3, and 2.3.1, respectively (Bellwood 3-4).

Fancy yarns can be produced at the beginning of the carding process, or just prior to completion. They can also be created from the same material as the rest of the yarn, or can be introduced as a new type of material or fiber type.

2.2 Machinery

Fancy yarns can be produced by a number of different machines. As indicated earlier, these include “conventional machines, fancy twisting machines, hollow spindle machines, and yarn finishing machines” (Oxenham 2002). In conventional machinery, fancy yarns are created by purposely introducing defects into the yarns. They can be created prior to the spinning process, during the spinning process, or during twisting. As shown in Table 1, many fancy yarns can be created using a number of different machineries.

	Boucle	Button	Chenille	Gimp/ Ratiné	Loop	Chainette	Cloud	Cover	Diamond	Frisé	Frotté	Grandrelle/ Twist	Mock-chenille	Nub/slash	Flake	Slub	Snarl	Eccentric (slub gimp)	Flame/ Flammé	Fleck/Nepp/Knickerbocker/Knicker	Spiral/corkscrew	Stripe	Knop	Tape	Marl
Prior to spinning															X	X				X					
Hollow-spindle	X	X			X						X	X		X		X	X		X				X		
Fancy twister	X			X	X	X						X	X			X	X	X			X	X	X		
Folding/ cabling								X	X			X													
Spinning	X				X						X					X				X			X		X
Chenille machine			X																						
Weft knitting machine						X																		X	

Table 1: Yarn Production Technologies

2.2.1 Fancy twisting machinery

Traditional fancy twisting machines are used to create fancy yarns, but have an assortment of problems that accompany their use: “must start with yarns, slow process, because of twisting yarn tend to be ‘hard’, and yarns can only be produced on small packages” (Oxenham, 2002).

2.2.2 Hollow spindle machinery

Hollow spindle machines are used to create several different fancy yarns. In this machine, the appearance of the yarn is created by overfeeding the input and then inserting a binder via the hollow spindle. Yarn is not the only possible input for this machine; roving and sliver is also a possibility. These machines can also be combined with ring twisting systems to produce even more effects to the yarn. There are different zones, or rollers in hollow spindle machines that can be adjusted to act in a constant or variable fashion. Changing the sequence of these rollers can result in the production of different fancy yarns.

Modern hollow twisting machines are very sophisticated with computer control of various production parameters including the speeds of rollers, hollow spindle and take up unit. A typical example of such a machine with two inputs, and therefore greater 'patterning' capability is shown in Figure 9. It is indeed possible to have three independent feed systems for even more creative possibilities.

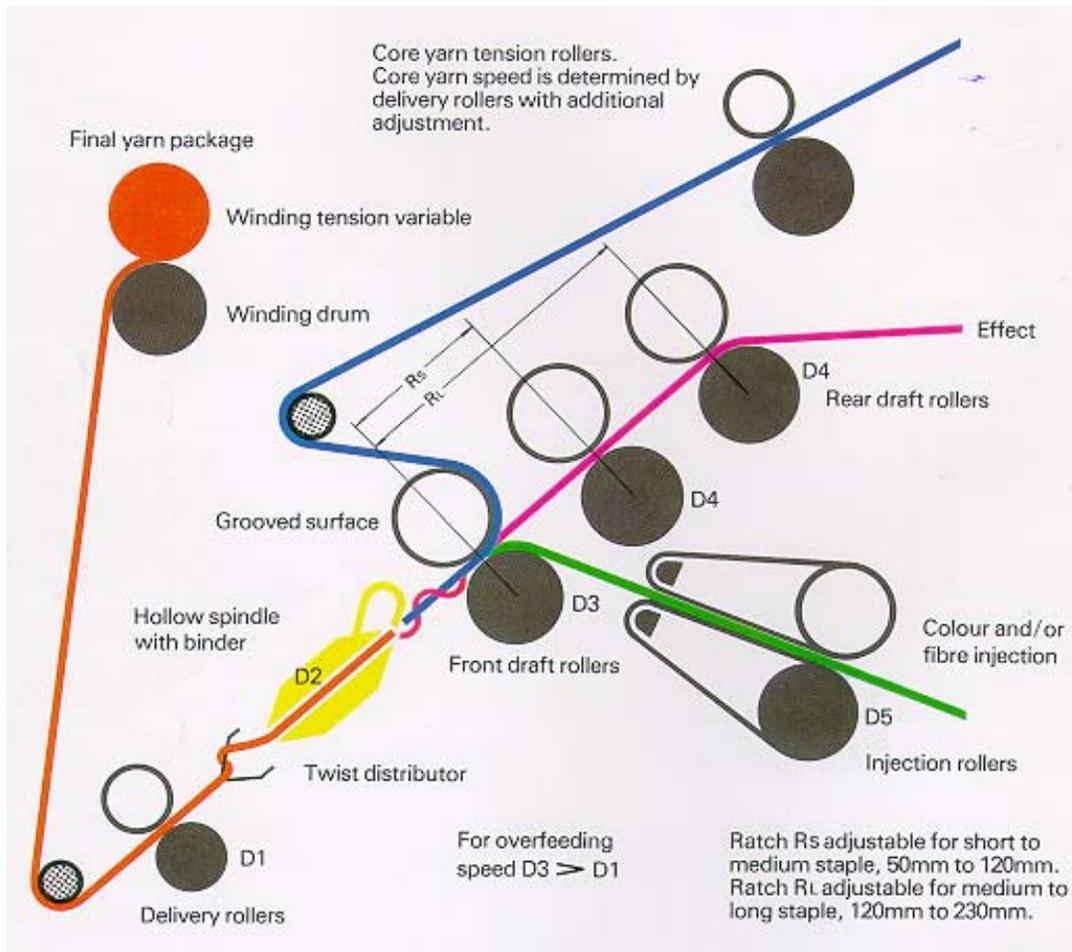


Figure 9: Hollow spindle machine (Gemmill & Dunsmore publicity material)

2.2.3 Yarn finishing machinery

Yarn finishing machines can either create fancy yarns or help to embellish the effects of previously produced fancy yarns. This can be achieved by steaming the yarns, brushing the yarns, heating the yarns, or chemically treating the yarn, including dyeing. Steaming allows for the yarns to be softened, so they have a less abrasive hand; it also allows the yarns to 'fluff,' or become more bulky. Brushing, or napping the yarns allow for yarns to become more hairy. These processes are most commonly used for yarns made of cellulosic fibers. Applying heat to yarns made of different fiber types allow for the natural thermal

behaviors of the fibers to occur. Chemical treatments and dyes have similar effects due to the different reactions of different fiber types.



Figure 10: Yarn-napping machine (PaFa publicity material)

2.2.4 Additional machinery and processes

There are also ‘yarn specific machines’ such as chenille machines that are used to make fancy yarns. Another effort to create fancy yarns has been made through the use of dyed fibers. Examples of these yarns include grandelle, single marl, marl, half marl, and double marl yarns. These yarns are created by implementing a traditional twisting process with dyed fibers.

2.3 Yarns/ Effects produced prior to spinning

2.3.1 Flake yarn

Flake yarns are very similar to slub yarns, which are discussed in sections 2.3.3 and 2.4.5, in the respect that the doffer speed is varied to produce the effect. Each end of the thick portion is tapered back to the contour of the yarn to complete the effect. Different colors can also be used to distinguish the flake area from the body yarn.

Flake yarns are produced on carding machines, but the material used to create the effect is created in a separate carding machine and is introduced as condenser bobbins, as discussed in Bellwood's August 1968 article. A specially fitted attachment is also necessary for the condenser. The rubbing of the fibers in the flake portion of the yarn is also of importance as it is with nepp and slub yarns. Only enough rubbing should take place as required to remove the effect material from the condenser bobbins without breaking. "In the making of flake yarns much depends upon individual ideas and requirements, no rule can be laid down as to the ratio of the thickness of the flake portion in relation to the ground yarn, but it must be borne in mind that spinning, winding and weaving difficulties may be created where the flake portion is too thick for the ground yarn upon which it is intended to be applied." The condenser attachment is explained in detail. Roller speeds are also discussed. (Bellwood, 5)

2.3.2 Fleck yarn/Nepp/Knickerbocker/ Knicker yarn

Knickerbocker/ nepp/ knicker yarns are created by introducing small neps during the carding stage. Neps are tight bundles of fibers which are usually

regarded as a defect in carding. For fancy yarn applications, neps are deliberately created on an 'incorrectly set' card, and may be produced in a multitude of colors and sizes. These neps can be different in color so as to produce a more fancy effect throughout the yarn. This yarn has traditionally been produced on the woollen spinning system.



Figure 11: Knickerbocker yarn

Certain methods of calculating appropriate feed rates for nepp yarns are explained in Bellwood's July 1968 article, and is advised that when using more than one color nepp in a yarn, to mix them thoroughly prior to introduction to the yarn. This will allow for more even distribution of colors, and if done with a perforated rotary drum, can actually help to consolidate soft nepps and rid nepps of trash (Bellwood 3-4).

The material creating the nepp needs to be slightly opened to discourage the swift, worker, and doffer rollers from working the structure into one similar to the rest of the yarn. However, it is sometime preferable to tease out areas close to the actual nepp so as to give an elongated look to the nepp. This creates a yarn that is similar to a slub.

When the nepp is created in the sliver, and is made of a different material than the rest of the yarn, it is necessary that it be made of an cohesive fiber type so that it does not receive excess weight and rubbing from the aprons which can tease out the nepp. It is also necessary to extend these yarns as little as possible due to the fact that where the nepp is present there is little body yarn

which can create a weakness in the yarn's structure. If too much extension is applied, the yarn can easily break at the nepp.

When nepps are introduced near the end of carding, a different approach is taken. There is a feed sheet involved which temporarily houses the nepps until they are placed to the yarn. There are rollers involved that take the nepps from the feed sheet, place them in the process of joining the yarn, and brushes the nepps to the yarn.

- Nepp – “made on the woolen system. They show strongly contrasting spots on the surface of the yarn, which are made by dropping in small balls of wool at the latter part of the carding process. The nepps may also be incorporated at the blend, with the carding machine set to ensure that these small lumps are not blended out.” (Gong & Wright, 51)
- Fleck – “presents a mixed appearance, combining spotted and short streaky effects, due to the introduction of a minority of fibres of different colour and/or lustre; it looks similar to the nepp yarn, but some of the nubs will have been slightly opened out during carding, which creates the streaky effect.” (Gong & Wright, 51)

2.3.3 Slub yarns

Slub yarns are said to be similar to the effect of nepp yarns, but the effect is larger. They can be produced one of four ways according to Bellwood's August 1968 article: “1. where a slub is introduced into the blend of raw material. 2. where the slubs are dropped into the carder. 3. where the slub is created

mechanically upon the card 4. the effect is created in the process of twisting, this being the most expensive way.” (Bellwood, 4-5) Methods of consolidating and hardening cellulosic slubs are then discussed. Like in nepp yarn production, it is very important to use fibers with good cohesive qualities so as to keep the slub in the yarn.

These slubs are deposited by a means of slowing down and speeding up the doffer rolls during carding. Only when the doffer's speed is decreased, can the yarn have a chance to build up the deposits used to create slubs. Slub yarns made this way have a smoother look to them than those that are dropped in or created during blending. They also have the benefit of varying the length of the slub. The slub can be any length desired, given that the body yarn portions between the slubs are strong enough to keep the entire yarn functional. Using the doffer rolls to create the slub yarns does have a downfall, being that different colors can not be incorporated into the slub areas of the yarn; the slubs must be the same color as the body yarn.

- Note: Generally, slub yarns are divided into two classes: (i) spun slub yarn, and (ii) plucked (or inserted) slub yarns. (Textile Terms and Definitions, 124)

2.3.4 Spaced-dyed yarns

Space-dyed yarns are a type of fancy yarns that do not rely on structure. They can be produced by printing slivers, roving, or the actual yarn. The printing can be done by roller, spraying, or injecting the yarn package with different

colors. Creating knitted fabrics, printing the fabrics, and then unraveling the fabric is also a process that can also be used to create this effect.

2.3.5 Special fiber mixing

Some fancy yarn effects can be created through the use of different fiber blends. Yarns are created that contain fibers with different thermal properties and also dyeability characteristics. Additionally, the addition of a small amount of very coarse fibers into a blend can create 'hairy' yarns.

2.4 Yarns/ Effects produced during spinning

2.4.1 Button yarn

Button yarns are created as a result of intermittent stopping of rollers during the yarn formation process. As the yarns are being fed through the rollers, stopping the rollers allows for the feedstock to be overfed in places, therefore creating the buttons in the yarn. Button yarns are similar to knop yarns which are created by traditional fancy twisters as discussed in section 2.5.10.

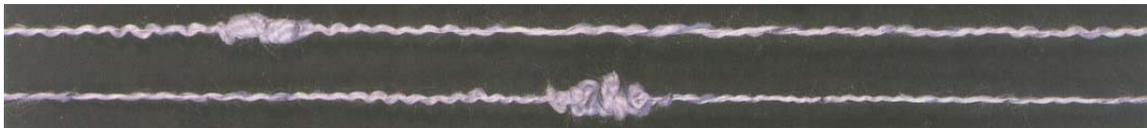


Figure 12: Button yarn (image courtesy of Gemmill & Dunsmore)

- “The button is an intermittent effect, created by a sudden pause in the progress of core yarns that allows a build-up of the effect material, usually in this case a sliver or roving, since most button yarns are created by fibre feedstocks.” (Gong & Wright, 51)

2.4.2 Flammé/ Flame yarn

These yarns are produced on traditional twisting or hollow spindle machinery. While appearing like a combination of slub yarns and boucle, they also employ the effect of multi-coloured fibers.

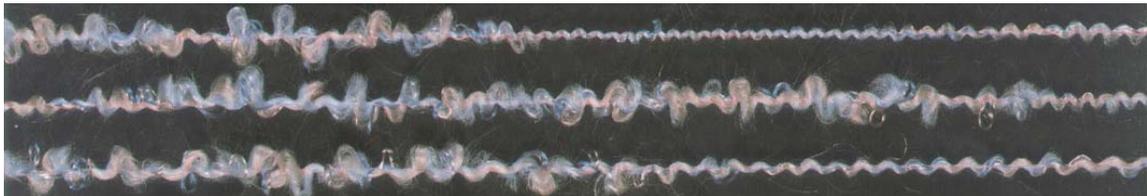


Figure 13: Flammé yarn (image courtesy of Gemmill & Dunsmore)

- “A yarn incorporating injected slubs which can be multi-coloured. The yarns are characterized by the gradual thinning of the linear density of the slubs at both ends as they emerge from and then merge back into the support or ground yarn.” (Textile Terms and Definitions, 123)
- “A yarn coloured over short sections by printing, intended for use in flammé fabrics.” (Textile Terms and Definitions, 124)

2.4.3 Frisé yarn

Frisé yarns can be created via either hollow-spindle or ring-spinning machines. These yarns are similar to boucle yarns, but do not require a large, fluffy effect yarn.



Figure 14: Frisé yarn (Saura Allma)

2.4.4 Marl yarn

Marl yarns are produced on the spinning frame. They are created by spinning together two different colored rovings to create a two-colored yarn.



Figure 15: Marl yarn

Marl yarns are fairly uniform in diameter, therefore being balanced. They consist of two similar rovings, in respect of count and twist, that are different colors that are folded together to create a subtle change in the aesthetic appearance of the yarn. Gong & Wright, however, discuss the option of creating marl yarns through use of consolidating yarns as the input. Considering the ease of production and subtlety of effect, marl yarns are known as the simplest of the fancy yarns.

- “one in which two yarns of the same count and twist, but of different colours, are folded together to form a balanced yarn....they result in a subtle, but noticeable, modification to the appearance of the finished fabric.” (Gong & Wright, 33)

2.4.5 Slub yarn

Slub yarns are produced during the spinning process. They are created by deliberately altering the draft during the spinning process. By reducing the draft, large slubs can be created throughout the length of the yarn.

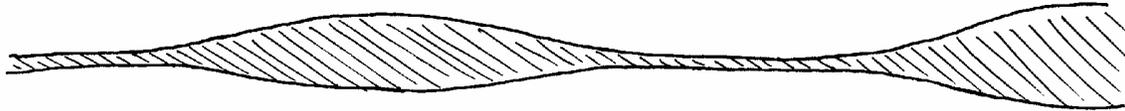


Figure 16: Slub yarn



Figure 17: Slub yarn (image courtesy of Gemmill & Dunsmore)

Slub yarns are those that are not uniform in diameter due to purposely manipulated processes that cause short thick places, or slubs, in the yarn. The slubs are created when certain rollers in the spinning process are accelerated or slowed intermittently.

Bellwood's February 1969 article discusses twisted slub effect yarns and their manufacture. Twisted slub effect yarns are used mainly because of the added luster that occurs in the slub portion of the yarn. Twisted slub yarns are generally comprised of two different yarns. The first yarn is a slub yarn with low twist, and the second is a finer yarn with a higher twist in the opposite direction. The resultant yarn is twisted in the same direction as that of the first yarn. The slub is carried out over approximately one inch. The yarn passes the rollers that vary their speeds in order to create the varying densities throughout the yarn. This twisted slub tends to give a more pronounced effect than a simple slub yarn (Bellwood, 17).

- “one in which slubs have been deliberately created to produce the desired discontinuity of effect....They can take the form of a very gradual change, with only a slight thickening of the yarn at its thickest

point. Alternatively, the slub may be three or four times the thickness of the base yarn” (Gong & Wright, 47).

- Note: Spun slubs may be produced by an intermittent acceleration of one pair of rollers during spinning or by the blending of fibres of different dimensions. Plucked slub yarns are composed of two foundation threads and periodic short lengths of straight-fibre materials that have been plucked from a twistless roving by roller action (Textile Terms and Definitions, 124).
- “a variation of spun yarns in which dramatic changes in width occur along the length of the yarn, creating slubs, or short thick places” (Hatch, 307).

2.5 Yarns/ Effects produced during twisting

2.5.1 Bouclé yarn

Bouclé yarns are comprised of three yarns. One is a twisted core yarn, one an effect yarn, the other is a binder yarn. When combined, the effect yarn presents wavy projections from the surface of the resultant yarn. These yarns can be created on hollow spindle machinery. Additional variations to the processing techniques can result in a variable bouclé yarn as shown.

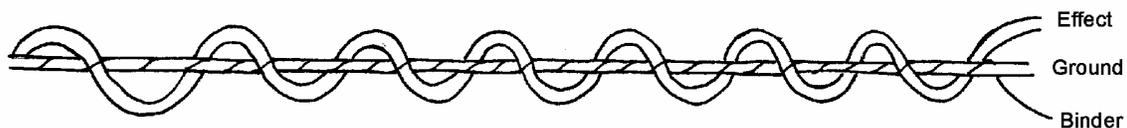


Figure 18: Bouclé yarn

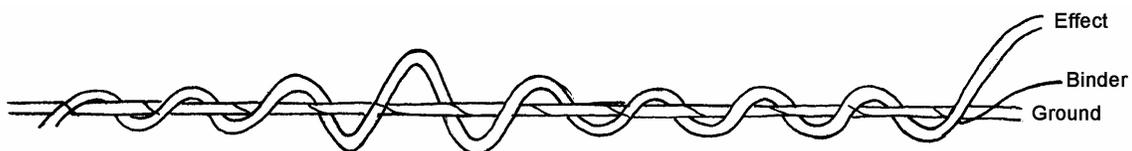


Figure 19: Variable bouclé yarn



Figure 20: Boucle yarn (Texture Yarn Co., Inc., Techniservice Division)

- “twisted core with an effect yarn wrapped around it so as to produce wavy projections on its surface” (Textile Terms and Definitions, 123)
- “compound yarn comprising a twisted core with an effect yarn (or roving) combined with it so as to produce wavy projections on its surface” (Gong & Wright, 38)
- “have a dramatic effect strand. The effect strand in boucle yarns is usually the softest and bulkiest of this group, and typically, does not lie near the core strand....the binder strand is necessary to hold the loops in place.” (Hatch, 306)



Figure 21: Bouclé stripe fabric from Craftex Mills (rotated 90 degrees at removal from loom)

2.5.2 Caterpillar yarn

Caterpillar yarns are similar to cloud yarns, discussed in section 2.5.3, in the manner that each of the component yarns takes part in covering the other

component yarns. The difference is the fact that there are more input yarns. Also, while cloud yarns alternate seeing one color or the other completely, caterpillar yarns display areas of twisting employing all of the component yarns.

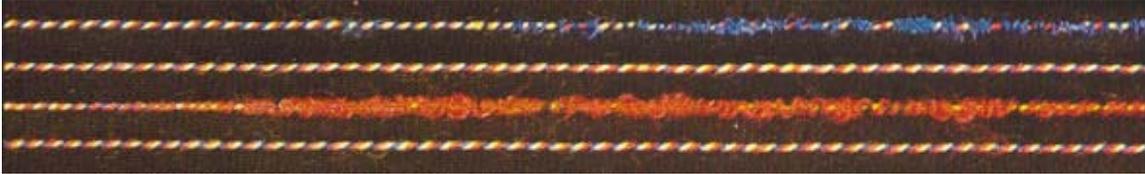


Figure 22: Caterpillar yarn (image courtesy of Saura Allma)

2.5.3 Cloud yarn

Cloud yarns are created using fancy twister machinery. They are a variation on the traditional cover yarn. While two yarns are still used to produce a cloud yarn, only one is visual at a time. Like a cover yarn, one yarn is wrapped completely around the other so that the core is not visible. By reversing the parameters at which each yarn is fed, fast and slow, the 'core' yarn wraps itself around the other yarn, therefore changing its status to become the effect yarn.

- made using the same apparatus used to create knop yarns. The two threads of different colours used to create the yarn are manipulated in such a manner that each thread alternately forms the base and cover to 'cloud' the opposing thread” (Gong & Wright, 47).
- “A type of yarn using two threads of different colours in such a manner that each thread alternately forms the base and cover to 'cloud' the opposing thread. It is made by alternate fast and slow deliveries from the two pairs of rollers” (Textile Terms and Definitions, 123).

2.5.4 Cover yarn

Cover yarns are created using traditional twisting technology. In Bellwood's February 1969 article, he discusses cover yarns which are different from other fancy yarns in the fact that only one main yarn color will be evident. Where two colors are to be used in a cover yarn, the rollers responsible for color A must be turning very slowly, while those responsible for color B must be very fast. These circumstances are reversed when color A is to be the dominant color of the yarn. At the time for the reversal of these roller speeds, the switch must be instantaneous so as to not have any portions of the yarns where the two yarns are striped. The yarn is then bound with a very fine yarn and a low amount of twist in the opposite direction than was initially introduced to the two yarns (Bellwood, 19).

- “one in which a yarn at the core is completely covered by the fibre or yarn wrapped around it” (Gong & Wright, 59).

2.5.5 Diamond yarn

Diamond yarns are created on folding/cabbling machinery. A large core yarn is wrapped by two smaller yarns in opposite directions. This creates a diamond pattern along the length of the yarn.

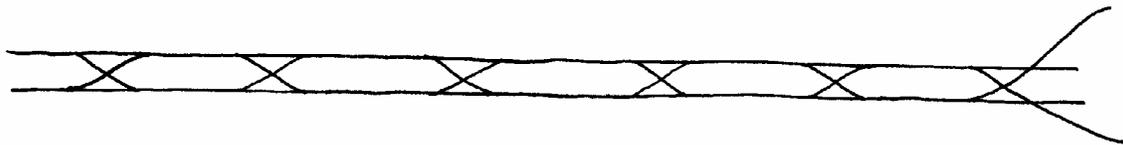


Figure 23: Diamond yarn

- “made by folding a thick single yarn or roving with a fine yarn or filament of contrasting colour using S-twist and cabling it with a similar fine yarn using Z-twist” (Gong & Wright, 36).

2.5.6 Eccentric yarn (“slub gimp”)

Eccentric yarns, also known as slub gimp or undulating gimp yarns are created by utilizing traditional twisting technology. These yarns are comprised of a binder yarn that has been twisted together with another fancy yarn, usually a stripe, slub, or spiral. The binder is added using the opposite direction of twist from the component fancy yarn.

- “an undulating gimp yarn, often produced by binding an irregular yarn, for example, a stripe, slub or knop yarn, in the direction opposite to the initial stage, creating graduated half-circular loops along the compound yarn” (Gong & Wright, 37).
- “An undulating gimp yarn” (Textile Terms and Definitions, 123).

2.5.7 Frisé yarn

Frisé yarns can be created via either hollow-spindle or ring-spinning machines. Please refer to Section 2.4.3 for more detail.

2.5.8 Gimp/ Ratiné yarn

Gimp/ Ratiné yarn are created by using two yarns, one thick and one thin. These are almost identical to spiral and corkscrew yarns. However, the two yarns used to create gimp and ratiné yarns are combined by use of a binder yarn which is twisted in the opposite direction as the initial twist. By use of the binder

yarn, the larger yarn creates wavy projects about the surface of the yarn. These yarns are most commonly created using traditional twisting machinery.

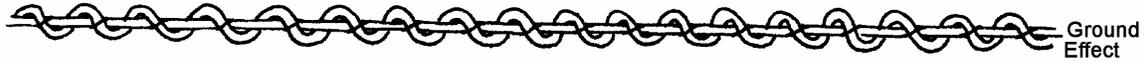


Figure 24: Gimp yarn

Bellwood's November/December 1968 article continues with the discussion of fancy yarns by focusing on gimp yarns. Gimp yarns are produced by using two yarns, one large and one thinner, twisted together. A binder yarn is then used in the opposite twist direction to bind the two with a lower tpi. This allows for the large yarn to create a wavy effect throughout the length of the yarn. It is preferable to twist the two yarns together in the opposite direction to what they were initially twisted, and then bound with the direction opposite to the consolidation twist.

The large yarn, which will form the corrugations, can be either one or two-fold, with two-fold being the most uncommon. When the larger yarn used is two-fold, a fiber with a softer hand may be used. Smaller yarns may also be used to create a more subtle decorative effect; the size of the larger yarn will dictate the relative size of the resultant yarn.

Although Bellwood categorizes the different types of gimp yarns by fiber type, his research is limited to man-made/synthetic yarns. The most prominent visual difference noted in this literature between the cellulosic yarns and synthetic ones is that the synthetic yarns look more hairy.

The article also suggests that in weaving, the yarns can be used as either decorative yarns, being used only in the weft, making up any percentage of the

weft, and they can also make up the entirety of the fabric. The latter of the two means would make for a much thicker fabric with variable texture (Bellwood, 6).

- “a yarn made of one or more strands twisted around a usually finer central ground yarn and overfed to form a clear spiral wrapping” (Textile Terms and Definitions, 124)
- “compound yarn consisting of a twisting core with an effect yarn wrapped around it so as to produce wavy projections on its surface” (Gong & Wright, 35)
- “have a slightly wavy appearance. In both yarns, the effect strand is twisted around the core strand. Ratiné yarns are usually larger and more wavy than gimp yarns due to a larger effect strand. Ratiné and gimp yarns have an effect strand that lies closer to the core strand than is typical in bouclé and loop yarns.” (Hatch, 306)

2.5.9 Grandelle/ Twist yarns

Grandelle/ twist yarns are similar to marl yarns in the fact that they rely on two separate colored feedstocks for their effect. In this instance, two separate colored yarns are twisted together to form one yarn. While similar to marl yarns, the effect of the grandelle/twist yarns is more dramatic due to the input feedstock and is produced during twisting.

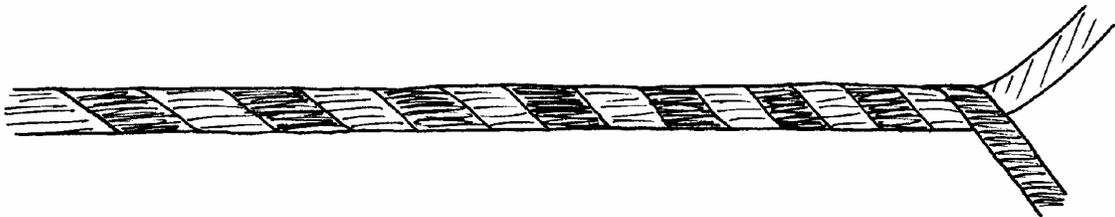


Figure 25: Twist yarn

2.5.10 Knop yarn

Knop yarns are created on fancy twisting machinery. They are created using intermittent rollers so that the ground yarn is stationary while the effect yarn continues to wrap itself around the ground yarn forming knops. The knop's character is determined by the knopping bar, which can either remain stationary or oscillate. If stationary, small knops will form, if oscillating, elongated knops, sometimes known as torpedoes, will occur.

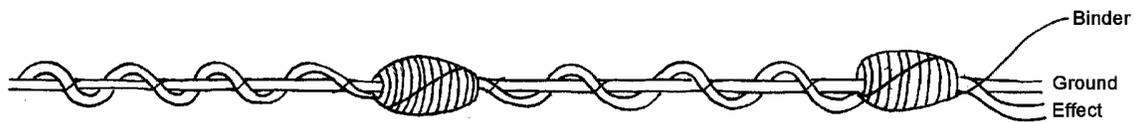


Figure 26: Knop yarn

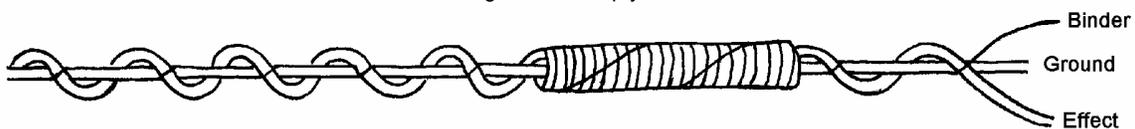


Figure 27: Elongated knop yarn

- “one that contains prominent bunches of one or more of its component threads, arranged at regular or irregular intervals along its length.”
(Gong & Wright, 45)
- Note 1: The yarn is usually made by using two pairs of rollers, capable of being operated independently, as follows:
 - (i.) foundation threads-intermittent delivery
 - (ii.) knopping threads-continuous delivery. The knopping thread(s) join(s) the foundation threads below the knopping bar and is (are) gathered into a bunch or knop by the insertion of twist.

Note 2: The knop yarn may be bound with a thread in the direction opposite to the initial stage to secure the knops and/or to produce

an additional spiral between the knops. (Textile Terms and Definitions, 124)

2.5.11 Knot yarn

Knot yarns are similar to caterpillar yarns in their structure. The main difference in the two is that the effect areas of knot yarns are much shorter than that of a caterpillar yarn.

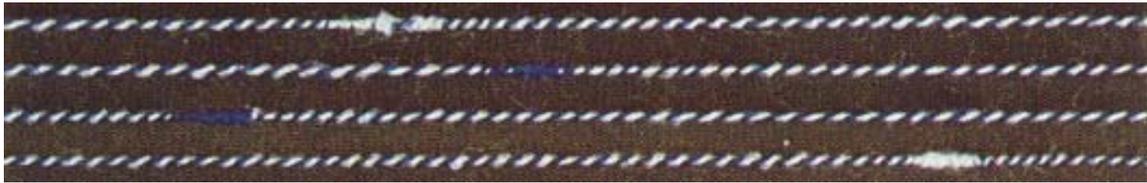


Figure 28: Knot yarn (Saura Allma)

2.5.12 Loop yarn

Loop yarns consist of three or four input yarns; one or two ground yarns, an effect yarn, and a binder yarn. They are created on either a hollow spindle machine, or may also be created on a fancy twister and then bound by reverse twisting with a finer yarn. The main difference between loop yarns and other yarns created on this machine is the rigidity of the fibers in loop yarns. In order to create a loop, and not have the effect yarn result in a boucle or snarl effect, the fibers used must have high rigidity so that they will loop, but not to the point of twisting upon themselves.

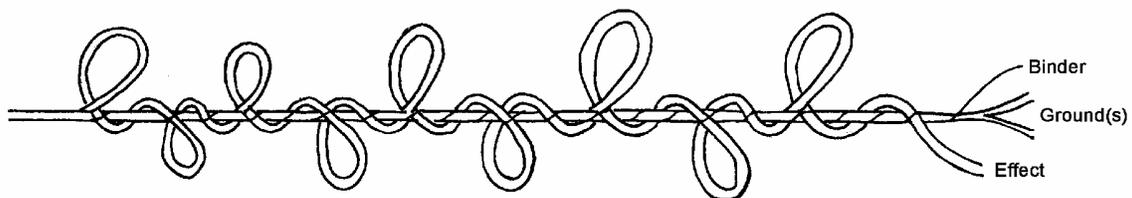


Figure 29: Loop yarn



Figure 30: Loop yarn

In Bellwood's March 1969 article, he focuses on loop yarn features, those being the type of fiber used, spinning twist, and the method of manufacture. The two most important features in manufacturing loop yarns are the fiber type and the amount of spinning twist applied to the looping yarn.

According to Bellwood, in terms of fiber type, coarse wool or mohair is most suited for the application, due to their rigidity in maintaining the shape of the loop. While mohair is a preferable, it is often substituted by wool due to its high cost. These fibers are preferred due to their ample staple length, and their luster in terms of aesthetic appeal. Considering the focus of these particular articles is wool, synthetics are rarely discussed (Bellwood, 5-6). However, a synthetic yarn that has been cut and carded so that it can be spun into yarn is a possible choice for creating loop yarns. Given the advancements in synthetic filament production, the possibilities for a yarn of this type with properties similar to the more costly mohair and wool varieties are great.

Loop yarns are formed by combining three separate yarns; a base yarn, binding yarn, and a looping yarn. While the base yarn is created with the appropriate amount of twist for its application, usually apparel, the looping yarn must have a much smaller number of turns per inch introduced to it so as not to create a snarl when looped. The first step of the operation usually incorporates "s-twist" while the next step of the operation incorporates "z-twist."

Upon consolidation of these three yarns, there is a very meticulous process that occurs as according to Bellwood. “The arrangement of the rollers and the threading of the yarns is shown at Fig. 6. The pair of rollers A, which

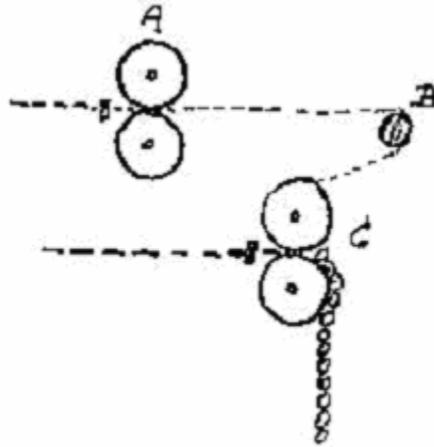


Figure 31: Loop yarn rollers (L. Bellwood, March 1969)

may have plain surfaces or may have fluted bottom roller and plain top roller, control the delivery of the base yarns and of course may be set to revolve at very many different speeds according to requirements. These two yarns are not allowed to wrap around each other but are kept apart by the guide eyes mounted as closely as possible to the point of entry of the yarns into the rollers. After the yarns emerge from the rollers they are taken round a guide bar B, the sole purpose of which is to direct them to the top of the pair of rollers C. These are the rollers which control the rate of delivery of the looping yarn. The looping yarn must be maintained in the centre of the pair of rollers, ensured by the positions of a guide eye close up to the nip of the rollers. ... By threading the base yarns into the grooves (of roller C) this is achieved and when the three yarns meet the base yarns are on each side of the looping yarn and bind the loop formation. Binding follows normal twisting practice, the first process yarn is bound in the opposite

twist direction to the first process with one or two yarns dependent upon strength required and also appearance” (Bellwood, 6).

- “compound yarn comprising a twisted core with an effect yarn wrapped around it so as to produce wavy projections on its surface” (Textile Terms and Definitions, 124)
- “consists of a core yarns with an effect yarn wrapped around it and overfed so as to produce almost circular projections on its surface” (Gong & Wright, 40)
- “have a dramatic effect strand. In loop yarns, the effect strand is usually made of long, rigid fibers that may also be lustrous, such as mohair or wool, or untwisted thick filament strand. The core strand in loop yarns is usually coarser and heavier than in bouclé yarns.” (Hatch, 306)

In Bellwood’s April/May 1969 article, he continues to discuss loop yarns, but in this instance, the focus is on their fiber contents. Considering that this series of articles by Bellwood focuses on natural fibers, it is interesting that he considers blending nylon with wool when making finer count loop yarns. However, he discounts the notion of allowing too much nylon to be used due to its different dyeing behavior from wool (Bellwood, 5).



Figure 32: plaid loop yarn fabric (manufacturer unknown, donated by Culp Industries)

2.5.13 Mock-chenille yarn

Mock-chenille yarns are the twisted versions of traditional chenille yarns. Instead of being an actual woven structure, mock-chenille yarns are twisted. They also require a modification to the traditional ring-spinning system to be produced as discussed in the Technology section of Chapter One.



Figure 33: Mock-chenille yarn (Longma Textiles)

- “does not at all resemble a true chenille yarn...It is in fact a doubled corkscrew or gimp yarn, and it is made by doubling together two or more unbalanced corkscrew or gimp yarns in the reverse direction with sufficient twist to form an unbalanced structure.” (Gong & Wright, 44)
- “A doubled corkscrew yarn.” (Textile Terms and Definitions, 124)

2.5.14 Nub/Slash yarn

Nub/ slash yarns are created using traditional twisting technology. They are similar to knop yarns due to the fact that they are characterized by having small round protrusions about the surface of the yarn.

- “have the effect strand twisted around the core strand a number of times in a small area to form an enlarged bump or ‘nub.’ A binder strand may or may not be used; a binder strand is not usually necessary to hold the nub in place. The nubs may be at regular or irregular intervals. The differences between the yarns lie in the size and shape of the bump. In a nub yarn, the bump is the largest in size and shortest in length, making it the roundest irregularity found in this type of fancy yarn. In a slash yarn, the enlarged area is longer and thinner than in a nub yarn. There are other yarns in this group, such as seed yarns, that have a similar appearance but differ in the size and spacing of the nubs.” (Hatch, 306)

2.5.15 Snarl yarn

Snarl yarns are made from three separate yarns on hollow spindle machinery or fancy twisting machinery. Twist-lively yarns are used as effect yarns during this process. When they are overfed, they twist upon themselves, thus creating the snarls as shown in Figure 34. The entire yarn is then bound in a subsequent process.

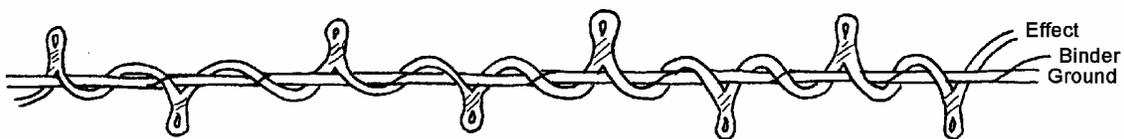


Figure 34: Snarl yarn

Bellwood also discusses snarl yarns in his February 1969 article. Snarl yarns are comprised of two yarns. The first yarn is a larger yarn while the second yarn is smaller, but has an increased amount of twist in the opposite direction of the first yarn. When the two yarns are combined, the smaller of the two yarns is overfed, allowing it to snarl on itself. The size of the snarl can be determined by the ratio of the smaller yarn to the larger yarn; the larger the amount of smaller yarn, the larger the snarl. The resultant yarn is then bound by an even smaller yarn in the opposite direction of which the two yarns were folded.

Additional effects to the snarl yarns can be achieved if the small binder yarn used in the last step of the process is used to create knops throughout the length of the yarn. A similar method would be used to overfeed the binder yarn using the same direction of twist as in snarl yarn production (Bellwood, 17,19).

- “based around a twisted core...displays ‘snarls’ or ‘twists’ projecting from the core” (Gong & Wright, 43)
- Note: It is made by the same procedure as a loop yarn, but, instead of a resilient thread, a lively highly twisted yarn is used. Thus, snarls are formed in place of loops when the tension is released at the front rollers. The snarls may be controlled to vary in size and frequency, either continuously or in groups at places along the yarn.” (Textile Terms and Definitions, 124)

- “have a dramatic effect strand. A snarl yarn uses a twist-lively strand to form the projecting snarls. The twist of the effect strand is usually in the same direction as the twist that holds the effect and core strands; the binder strand is usually twisted in the opposite direction.” (Hatch, 306)

2.5.16 Spiral/ Corkscrew yarn

Spiral/ corkscrew yarns are created using traditional twisting machinery. They are created from two yarns, one soft and thick, and the other fine and hard. The two input yarns are twisted together to create these yarns. The differing factor between the two is the twist directions of the two yarns used as input. To create spiral yarns, input yarns with different twist directions are plied together in the direction of the smaller yarn. To create corkscrew yarns, the twist directions are the same while the combining twist direction is opposite of the input yarns.

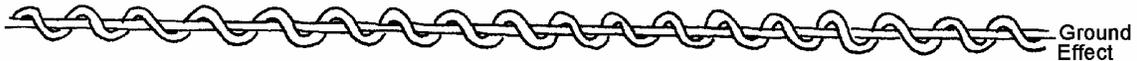


Figure 35: Spiral yarn

- “a plied yarn that displays a characteristic smooth spiraling of one component around the other.” (Gong & Wright, 34)
- Note: Spiral yarns include: (i) a plied yarn made up of two single ends or groups of ends of equal length containing S and Z twists, respectively; (ii) a plied yarn produced by delivering on or more of its components at a greater rate. The shorter length forms the base, while the greater length of its companion(s) creates a spiral round it;

(iii) a plied yarn made from two ends of equal length, one coarser than the other (Textile Terms and Definitions, 125).

- “both have one strand that spirals around the other strand. Usually one strand is a soft and bulky yarn, and the other strand is a fine yarn. In a spiral yarn, the thicker strand is usually wound around the finer strand. In the corkscrew yarn, the finer strand is wound around the thicker strand.” (Hatch, 306)

2.5.17 Stripe/ Elongated knop yarn

Stripe yarns are created using fancy twisting machines that are modified with the addition of a knopping bar. Similar to a knop yarn, variations in roller speeds allow for the base yarn to be completely covered by the effect yarn at times; this occurs when the roller speeds responsible for delivery of the effect yarn is at its highest speed. See section 2.5.10 for additional information.

- “contains alternating elongated knops.

Note: It can be made by two methods: (i) as a knop with a moving knopping bar to spread the surplus thread; (ii) by alternating fast and slow delivery of one or more of its component threads and a constant rate of delivery of the base threads. The threads join below a stationary bar to form the intermittent stripes” (Textile Terms and Definitions, 125).

2.6 Yarns created using non-traditional processing machinery

2.6.1 Braids

While truly a fabric, certain braids can also be considered to be fancy yarns or cords. An excellent coverage of styles and color combinations is given by Owen.

2.6.2 Chenille

Chenille yarns can be produced on chenille machines, weaving looms, and spinning frames. All produce a similar, but slightly different version of the chenille yarn, like the type discussed in section 2.5.13.



Figure 36: Chenille yarn

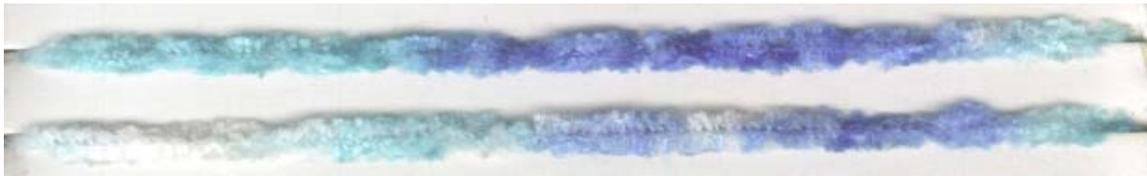


Figure 37: Chenille yarn

Bellwood's April/May 1969 article briefly discusses chenille yarns. The "original, traditional method was actually a weaving operation." Two small yarns, called lens yarns are used as the warp, while the weft yarns used are much larger. These yarns are used in a leno construction to create a cloth as shown in Figures 8 and 38.

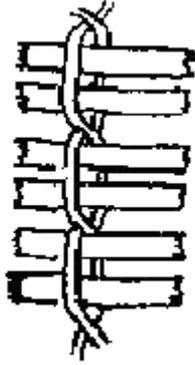


Figure 38: leno weave (Bellwood, 6)

When creating chenille yarns using leno weaving, the warp is sectioned on the loom so as to leave room to cut the fabric after it has been woven. The small sections of fabric that are split form the chenille yarns. This was previously shown in Figure 8.

Warp knitting chenille yarns are formed in a similar way. Extra yarns are laid in during knitting, forming the effect portion of the yarn. This effect yarn is cut to form the pile of the yarn.

- “consists of a cut pile which may be made of a variety of fibres helically disposed around the two axial threads that secure it.” (Gong & Wright, 55)
- “A tufted weft yarn made by weaving in a loom (known as a weft loom) in which the warp threads are arranged in small groups of 2 to 6 ends, which interlace in a gauze or cross-weaving manner, the groups being a definite distance apart to suit the length of pile. The weft is inserted in the normal way, each pick representing a potential tuft. The woven

piece is cut into warp-way strips, which are then used as weft yarn in the production of chenille fabrics” (Textile Terms and Definitions, 123).

- “The product of a chenille machine. Pile yarn is introduced between and at right angles to a pair of axial threads at the point at which these axial threads engage as they are twisted together. The pile yarn is then cut” (Textile Terms and Definitions, 123).
- “It has a soft, fuzzy, lofty surface, an effect achieved by a core of two yarns plied together and firmly holding short tufts of soft-twisted yarn between the twist along the core’s length. The result is a yarn with a velvetlike or pile surface” (Kalaoglu & Demir, 37).



Figure 39: undulating lines chenille fabric (Dicey Mills)

2.6.3 Chainette

Chainette yarns are produced on small circular weft knitting machines. The machines are composed of about 8 needles and produce a tubular fabric, known as a chainette yarn.



Figure 40: Chainette yarn

- “made by a miniature circular weft knitting process, often using a filament yarn and a ring of between 6 and 20 needles.” (Gong & Wright, 55)

2.6.4 Flocked yarn

Flocked yarns are similar in appearance to chenille yarns. They are produced through a process called flocking, however, which is very dissimilar to other ways of producing chenille and mock-chenille yarns. The process of flocking requires a core yarn that has been coated with adhesive and has also had an electrostatic charge applied to it. Shorter, loose fibers are charged with the opposite charge of the core yarn. The opposite charges attract the shorter fibers to the core yarn and the adhesive on the core yarn binds the effect fibers to the core (Longma Textiles).

2.6.5 Paper yarn

Paper yarn is exactly what it sounds, yarn made of paper. Sheets of paper are created through pulp processing, which is similar to fiber processing, but has some additional, material appropriate processes. The sheets are then cut into strips and are twisted using spinning wheels. The resultant twisted structure is then woven or knitted into a fabric.

2.6.6 Tape yarn

Tape yarns are created by any type of narrow fabric formation. They are made from untextured filaments and are comparable to ribbons. While actually a fabric, if created with a narrow enough width, these actually can be used, themselves, to construct fabric.

- “may be made by a variety of processes; braiding, warp knitting and weft knitting being among them....It is also possible to use narrow woven ribbons, or narrow tapes of non-woven material, or slit film, in the same way.” (Gong & Wright, 53)

3. Approach Followed

Gilbos' Air Jet System is a yarn processing system that in the past has only been used to create carpet yarns and high-tenacity yarns for technical fabrics; not fancy yarns. While the following experiments show the effects of yarns made with numerous colors of input, this machine has traditionally been used to create pseudo two-fold yarns, not different colored yarns. This system is a modification to their Dyna Jet Air Twist machine that is comprised mainly of a detorque jet and a pulsing air jet. Several different other components are also included. These components include a supply creel, a twisting mechanism, a second false twisting mechanism, a winding unit, and an autodoing mechanism. All of these components are controlled by a control box, which is programmed by a desktop computer.

The main function of this machine is three-fold; to input S-twist, create an entanglement point, also known as a tack point, and then insert Z-twist into the yarn. The length and frequency of these occurrences can be varied via the attached computer program.

The supply creel holds the input yarns for the Air Twist system. This creel can input between one and twelve separate yarn packages. The input yarns used can also vary in color and yarn type (monofilament, BCF, textured yarns, etc.).

The input yarn or BCF is drawn from a creel and then goes to several rollers which place tension on the yarns.



Figure 41: Gilbos Air Twist system



Figure 42: Detorque and air entanglement jets

The yarns then pass through a group of tubes which place additional tension on the yarns while preventing them from becoming tangled with one another. The yarns go into the first twisting mechanism where a detorque jet inputs sections of alternating s- and z-twist into the yarns. The yarn then goes into the second unit, known as the entanglement zone. This mechanism inserts “tack points” into the yarns by means of air entanglement. These tack points act as areas that hold the twist in the yarn throughout the length of the yarn. All of these parameters, the length of tack points and twisted areas, along with the amount of twist and pressure

to achieve the tack points, can be varied and their values are input through the control box. Upon exit from the second unit, the resultant yarns pass through a number of rollers and then to the winding unit. It then traverses onto the yarn tubes and creates the package. The autodoffing unit then automatically removes the completed package from the winding unit and replaces it with a fresh, empty package.



Figure 43: Entire Air Twist system



Figure 44: Guide rollers and jet box

Enclosed jet box which houses the detorque jet and pulsing air entanglement jet.



Figure 45: Guides and rollers

Guides and rollers which separate the yarns pre-texturing and twisting at top of machine.



Figure 46: Guides and rollers

Guides and rollers which separate the yarns prior to texturing and twisting near bottom of machine.



Figure 47: Air compressor

Air compressor which controls the rate of the pulsing entanglement jet.



Figure 48: Deterorque and entanglement jets

1 - Pulsing air entanglement jet which creates tack points

2 – Deterorque jet that inserts pseudo-twist into the yarns

The output yarns created are mounted on both white and black backgrounds as shown in the Experimental and Discussion sections of the thesis. This was done to display their suitability for dark or light warps.

The yarns were then woven into samples using an AVL 24” Industrial Compu-Dobby® loom. They were woven at 18 ends per inch into a plain weave. The picks per inch for each fabric sample varies due to the diameter of each yarn created. The warp for the first two sets of samples consists entirely of a bluish-grey cotton yarn, while the weft is exclusively the yarns created as dictated throughout the experiments. The warp used for the remaining two sets of samples is a split warp containing half space-dyed air tacked yarn and half rose colored air tacked yarn. Both of the yarns used for this warp are made of synthetic filaments. The fabrics are displayed in the Discussion section of the thesis.

After the fabrics were woven, they were evaluated visually and the results were also recorded in the Discussion section. Some of the samples exhibited moiré patterning ranging from subtle to extreme. The discussion of the fabric

appearance is purely subjective, given that there is no standard or controlled sample that all samples are compared to.

The dominance of the patterning is relative to the width of the fabric along with the lengths of the twisted and air-entangled areas. The amount of pressure used to apply the twist and tack points has no obvious effect on the appearance of the resultant fabric.

After reviewing the preliminary yarns created, and the fabrics they were woven into, several decisions were made. These decisions were regarding the different parameters that can be varied to produce different looking yarns and fabrics. It was evident that varying the amount of pressure applied to produce the twisted and tacked areas was unnecessary.

4. Experimental

To begin this exploration, a trip to Gilbos USA was necessary to observe the Air Twist System. Here, preliminary trials were carried out to determine the suitability of this novel machine to carry out the proposed research.

The following experiments were carried out to determine which parameters would be most influential on the resultant yarn when varied.

4.1 Experiment One

The input feedstock for this first sample batch was red, yellow, and blue BCF yarns. The yarns that were produced ran at 500 yards/minute.

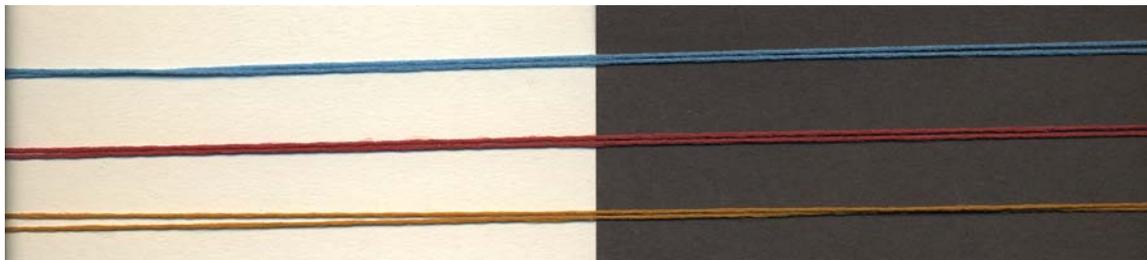


Figure 49: Feedstock yarns for Experiment 1

	Color	Yarn Count
Yarn A	Red	151 tex
Yarn B	Yellow	145 tex
Yarn C	Blue	147 tex

Table 2: Feedstock yarns for Experiment 1

The first sample that was created was produced with 90 psi for the twisting element. The S-twist sections were set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long.

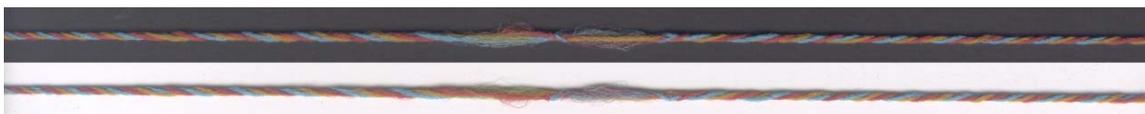


Figure 50: Yarn 1 Samples

The second sample was produced at 30 psi for the twist. The S-twist sections were set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long.



Figure 51: Yarn 2 Samples

The third sample was produced at 50 psi for the twist for the red and yellow yarns. The blue yarn had 0 psi of input twist. The S-twist sections were set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long.

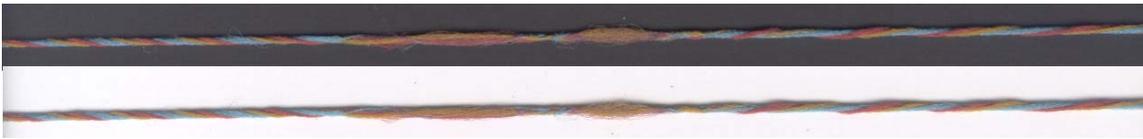


Figure 52: Yarn 3 Samples

The fourth sample was produced at 50 psi for the twist for the red and blue yarns. The yellow yarn had 0 psi of input twist. The S-twist sections were set to be 1000 mm long, the tack points, 60 mm long, and the Z-twist sections, 1000 mm long.

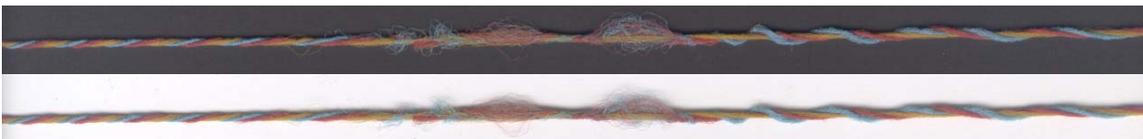


Figure 53: Yarn 4 Samples

The fifth sample was produced at 50 psi for the twist for the red and yellow yarns. A thicker blue yarn replaced the original blue yarn and had 0 psi applied

to it. The S-twist sections were set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.

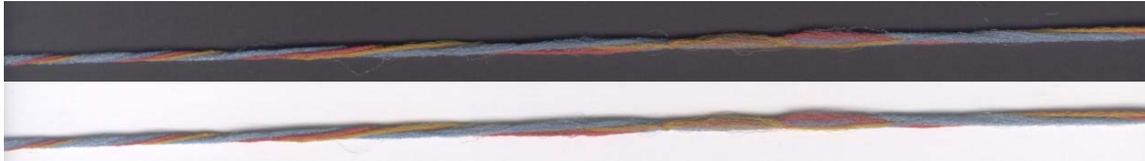


Figure 54: Yarn 5 Samples

The sixth sample was produced at 90 psi for the twist. The S-twist sections were set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long. In this sample, the red and yellow BCF yarns were run through the same tube and then introduced to the blue yarn.

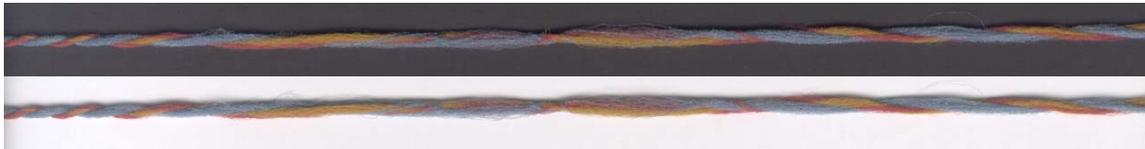


Figure 55: Yarn 6 Samples

The seventh sample produced is a variety of different experiments. The last experiment performed was at 90 psi for all of the yarns. The S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long. This created a yarn with long tack points; however, most of the twisted sections of the yarn are not twisted cohesively enough to stay together, therefore making it an improbable choice for knitting or weaving.

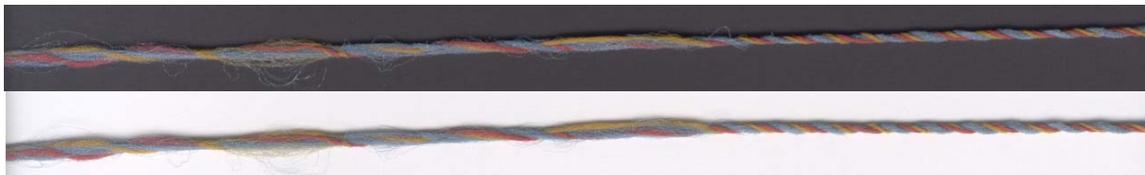


Figure 56: Yarn 7 Samples

It was evident from the samples created that this machine could be used to create a variety of fancy yarns given that so many of the variables, such as the twisted section lengths, the tack point area lengths, and the psi applied to the individual yarns, are easily changed to produce different effects.

Sample No.	Twist psi applied			Length of S-twist section	Length of Z-twist section	Length of Tack Point
	Red yarn	Yellow yarn	Blue yarn			
1	90 psi	90 psi	90 psi	1000 mm	1000 mm	50 mm
2	30 psi	30 psi	30 psi	1000 mm	1000 mm	50 mm
3	50 psi	50 psi	0 psi	1000 mm	1000 mm	50 mm
4	50 psi	0 psi	50 psi	1000 mm	1000 mm	60 mm
5	50 psi	50 psi	90 psi	1000 mm	1000 mm	100 mm
6	90 psi	90 psi	90 psi	1000 mm	1000 mm	100 mm
7	90 psi	90 psi	90 psi	1000 mm	1000 mm	1000 mm

Table 3: Experiment 1 sample yarn data

Upon the first visit to monitor the Air Twist system, several key factors were noted. One factor was the actual production steps that were included in this system. Another factor was the amount of different parameters that factor into the character of these yarns.

Some parameters were predetermined, such as the speed at which the machine ran which was 500 yards per minute. The parameters that are variable are the lengths of the twisted areas, the lengths of the tack points, along with the number and characteristics of the input yarns and the amount of air pressure used to apply the tack points and twist, as seen in Table 3. It is also necessary

that the lengths of the sections with Z-twist and those with S-twist be the same. This creates balance in the yarn.

In planning the remainder of this experiment, it was decided to use the variations in the possible parameters in order to create a large array of samples.

However, as indicated above, after preliminary trials, it was decided that the air pressure will be set at 50 psi. This was decided to be the most appropriate because it is the mean value of the possible values. While a lower value would not allow enough cohesiveness to keep the yarn stable, a higher value is simply not necessary. While it has very little influence on the appearance of the resultant fabric, it is likely that higher air pressure would create more compact and hence harsher handling fabrics. Additionally, the use of higher air pressures also has a significant negative influence on the economics of the process.

Three additional experiments were carried out after the preliminary experiment which followed the parameters discussed above.

4.2 Experiment Two

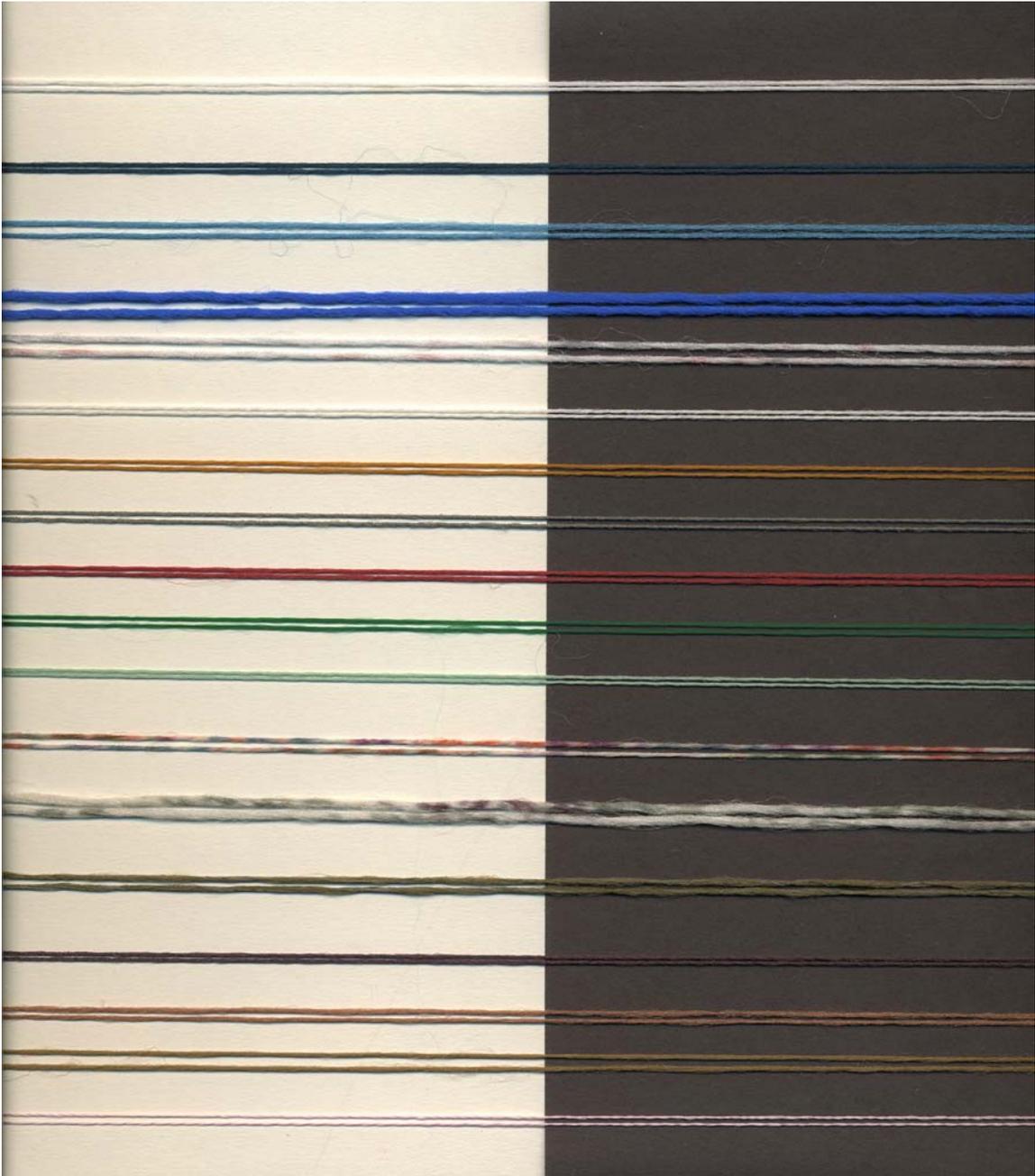


Figure 57: Feedstock yarns for Experiment 2

Feedstock	Color	Yarn Count
Yarn1	Mint green	151 tex
Yarn2	Green	147 tex
Yarn 3	Space-dyed 1	316 tex
Yarn 4	Space-dyed 2	152 tex
Yarn 5	Grey	151 tex
Yarn 6	Navy blue	150 tex
Yarn 7	Robin's egg blue	152 tex
Yarn 8	Royal blue	549 tex
Yarn 9	Pre-tacked white	163 tex
Yarn 10	Mushroom brown	300 tex
Yarn 11	Red	147 tex
Yarn 12	White	167 tex
Yarn 13	Space dyed 3	447 tex
Yarn 14	Pink	67 tex
Yarn 15	Purple	142 tex
Yarn 16	Camel	153 tex
Yarn 17	Peach	146 tex
Yarn 18	Gold	144 tex

Table 4: Feedstock yarns for Experiment 2

Sample No.	Length of S-twist section	Length of Z-twist section	Length of Tack Point
1	800 mm	800 mm	100 mm
2	900 mm	900 mm	70 mm
3	900 mm	900 mm	100 mm
4	900 mm	900 mm	80 mm
5	900 mm	900 mm	60 mm
6	1000 mm	1000 mm	50 mm
7	900 mm	900 mm	60 mm
8	1000 mm	1000 mm	50 mm
9	900 mm	900 mm	50 mm
10	900 mm	900 mm	50 mm
11	1000 mm	1000 mm	50 mm
12	900 mm	900 mm	100 mm
13	900 mm	900 mm	70 mm
14	900 mm	900 mm	50 mm
15	900 mm	900 mm	50 mm
16	900 mm	900 mm	100 mm

Table 5: Experiment 2 sample yarn data

For the second set of samples created, some parameters were held constant. For example, all of the twist and air entanglement points were created using 50 psi of air pressure. Also, all of the samples were created at 500 yd/min.

Sample one is created by using the royal blue, grey, mint green and navy feedstocks. The blue and grey yarns were placed in the same tube prior to the detorque zone, as were the mint green and navy blue yarns. For this reason, the blue and grey yarns were twisted together and the mint and navy yarns were twisted together before twisting together to form the resultant yarn. For sample one, the S-twist sections were set to be 800 mm long, the tack points, 100 mm long, and the Z-twist sections, 800 mm long.

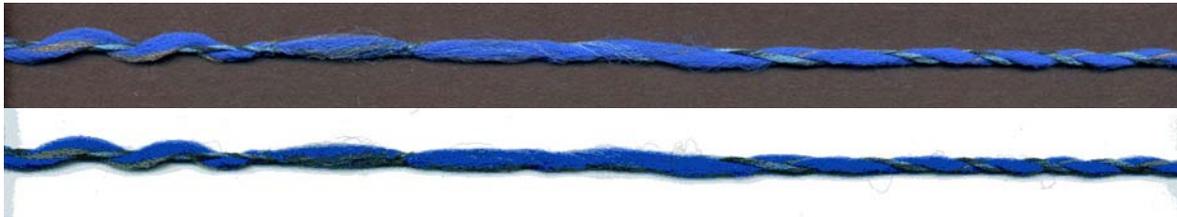


Figure 58: Yarn 1 Samples

The second sample was produced using S-twist sections which were set to be 900 mm long, the tack points, 70 mm long, and the Z-twist sections, 900 mm long. Similar to yarn 1, the white and grey yarns were placed in the same tube, as were the blue and navy yarns.

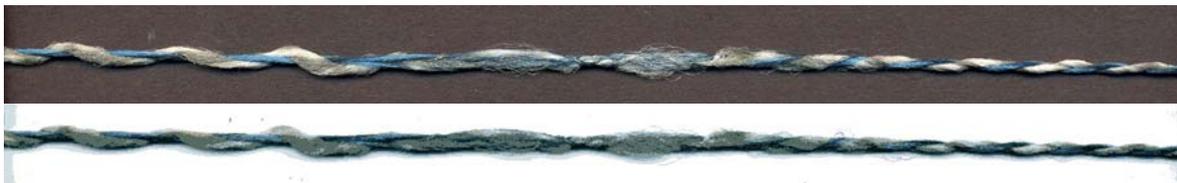


Figure 59: Yarn 2 Samples

Yarn 3 is made of blue and white yarns that were twisted together and mushroom brown and white yarns twisted together. These are all consolidated in the detorque and entanglement zones. The third sample had similar parameters to yarn 2. The S-twist sections were set to be 900 mm long, the tack points, 100 mm long, and the Z-twist sections, 900 mm long.

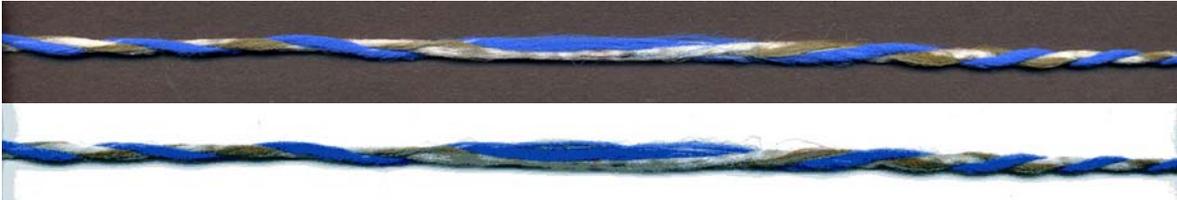


Figure 60: Yarn 3 Samples

Sample four contains S-twist sections that were set to be 900 mm long, the tack points, 80 mm long, and the Z-twist sections, 900 mm long. It is comprised of the royal blue, space-dyed 3, red, brown, and grey yarns. The space-dyed and brown yarns were placed into the same tube prior to entering the detorque and entanglement zones, therefore resulting in these two being twisted together and then being twisted with the remaining yarns.

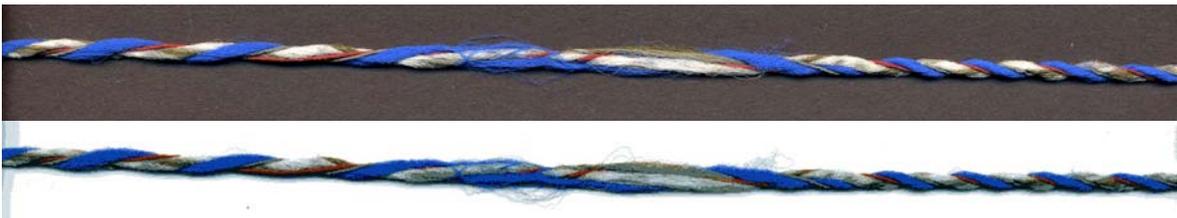


Figure 61: Yarn 4 Samples

Sample five contains S-twist sections set to be 900 mm long, the tack points, 60 mm long, and the Z-twist sections, 900 mm long. The input yarns are white, grey, and purple.

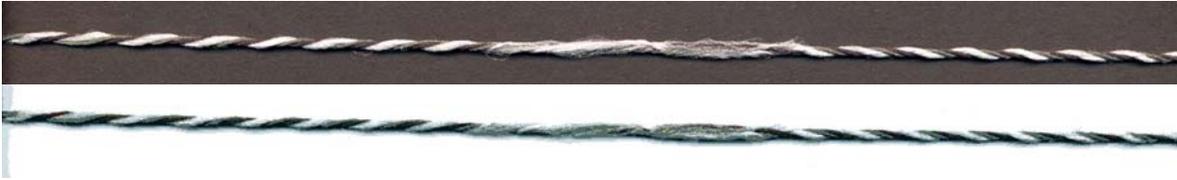


Figure 62: Yarn 5 Samples

The sixth sample has S-twist sections set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long. The input feedstock for this yarn is the grey and space-dyed 2.

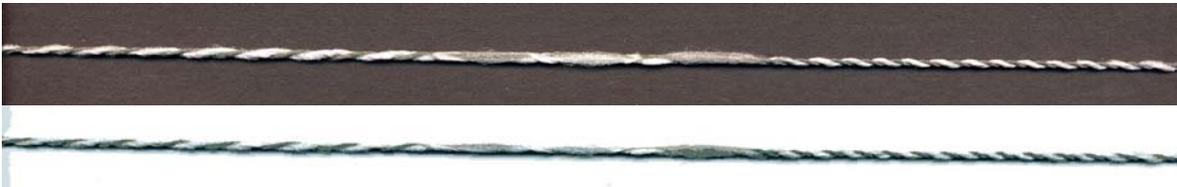


Figure 63: Yarn 6 Samples

When producing sample seven, The S-twist sections were set to be 900 mm long, the tack points, 60 mm long, and the Z-twist sections, 900 mm long. The input yarns are space dye 1, grey, and mushroom brown.



Figure 64: Yarn 7 Samples

When producing sample eight, the S-twist sections were set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long. The input yarns are space dye 1, pink, red, and mushroom.

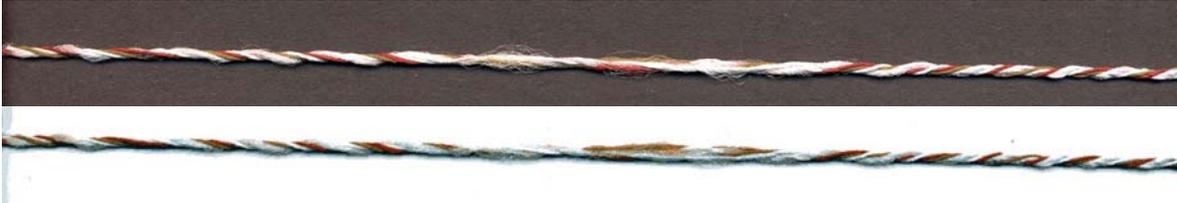


Figure 65: Yarn 8 Samples

During the production of sample nine, the S-twist sections were set to be 900 mm long, the tack points, 50 mm long, and the Z-twist sections, 900 mm long. The input yarns are pink, green, and mushroom.



Figure 66: Yarn 9 Samples

Sample ten contains S-twist sections which were set to be 900 mm long, the tack points, 50 mm long, and the Z-twist sections, 900 mm long. The input yarns are white, pink, mushroom, and mint green.



Figure 67: Yarn 10 Samples

The eleventh sample produced was done so with similar tack point lengths. The S-twist sections were set to be 1000 mm long, the tack points, 50 mm long, and the Z-twist sections, 1000 mm long. The input yarns are green, space dye 2, and pink.

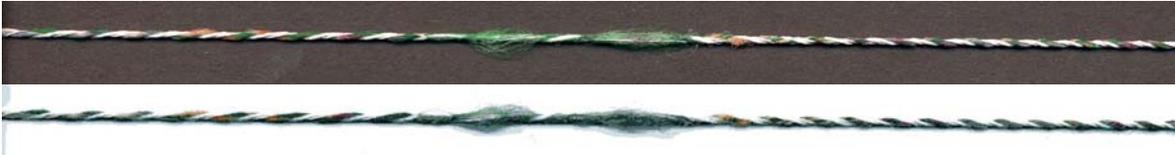


Figure 68: Yarn 11 Samples

Yarn 12 was produced with S-twist sections which were set to be 900 mm long, the tack points, 100 mm long, and the Z-twist sections, 900 mm long. It is comprised of the pink and green yarns.

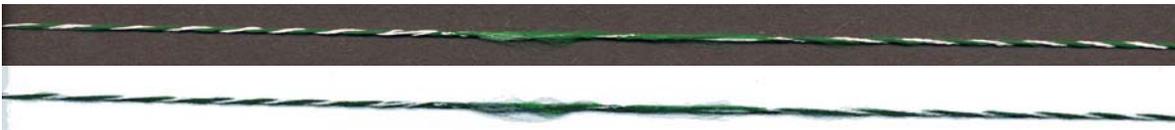


Figure 69: Yarn 12 Samples

Yarn 13 samples were produced with S-twist sections set to be 900 mm long, the tack points, 70 mm long, and the Z-twist sections, 900 mm long. This sample is similar to yarn 12, but the green and white yarns have been fed into the same tube prior to entering the detorque and entanglement zones.

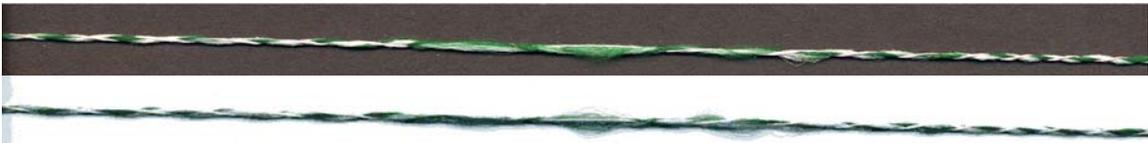


Figure 70: Yarn 13 Samples

Yarn 14 samples were produced with S-twist sections set to be 900 mm long, the tack points, 50 mm long, and the Z-twist sections, 900 mm long. This yarn is comprised of the space dye 2, royal blue, white and green yarns. The white and green yarns were fed into the same tube prior to being entangled and twisted.

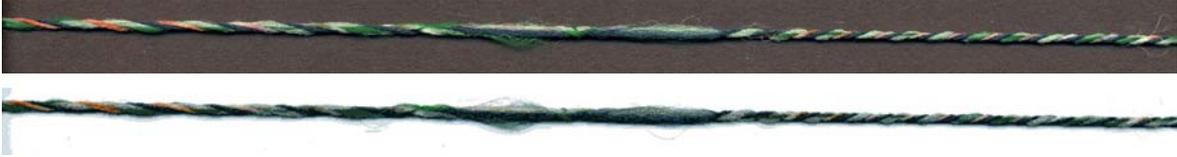


Figure 71: Yarn 14 Samples

Sample fifteen parameters were set so that the S-twist sections were to be 900 mm long, the tack points, 50 mm long, and the Z-twist sections, 900 mm long. The input yarns used were space dye 2, navy, and mint green.



Figure 72: Yarn 15 Samples

Yarn 16 samples were created with the S-twist sections set to be 900 mm long, the tack points, 100 mm long, and the Z-twist sections, 900 mm long. The input yarns were red, camel, gold, and peach. The first two and latter two yarns were fed into tubes together to create the twisting prior to final consolidation of the yarns.

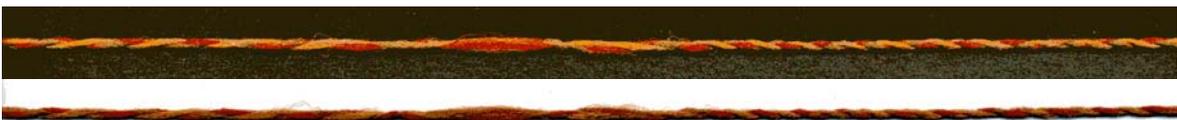


Figure 73: Yarn 16 Samples

4.3 Experiment Three

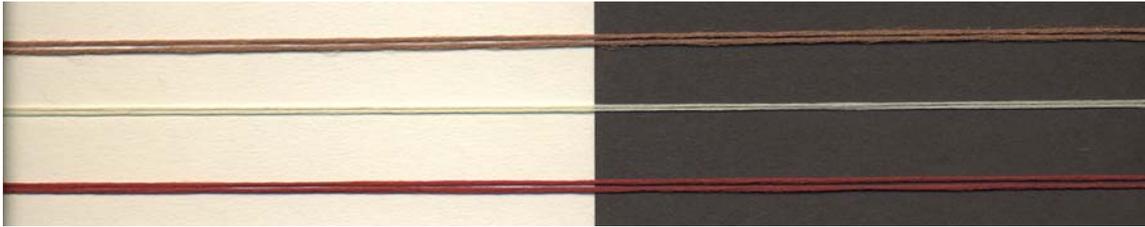


Figure 74: Feedstock yarn for Experiment 3

Feedstock	Color	Yarn Count
Yarn1	Red	144 tex
Yarn2	White	73 tex
Yarn 3	Camel	145 tex

Table 6: Feedstock yarns for Experiment 3

Yarns	Z-twist length	S-twist length	Tack point length
A	500	500	40
B	600	600	40
C	750	750	40
D	900	900	40
E	1000	1000	40
F	600	600	400
G	400	400	600
K	1000	1000	100
L	1000	1000	200
M	1000	1000	400
N	1000	1000	800
O	1000	1000	1000
Minimum	400 mm	400 mm	40 mm
Maximum	1000 mm	1000 mm	1000 mm

Table 7: Experiment 3 sample yarn data

When producing the third sample set, all of the twist and air entanglement points were created using 50 psi of air pressure. Also, all of the samples were created at 500 yd/min. All of the samples produced during the third experiment were created by all of the input yarns running through separate tubes so that they did not twist with each other before being twisted to create the resultant yarn. All of the experiments used the three input yarns stated earlier.

For sample A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long.

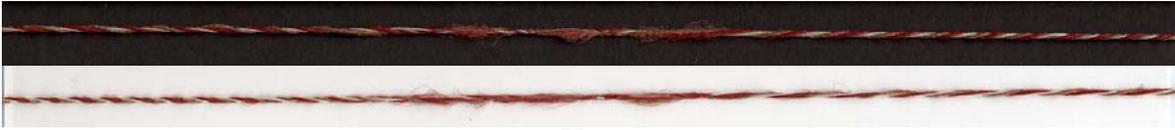


Figure 75: Yarn A Samples

Sample B was produced using S-twist sections which were set to be 600 mm long, the tack points, 40 mm long, and the Z-twist sections, 600 mm long.



Figure 76: Yarn B Samples

Yarn C was produced having the S-twist sections set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.



Figure 77: Yarn C Samples

Sample D contains S-twist sections that were set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.

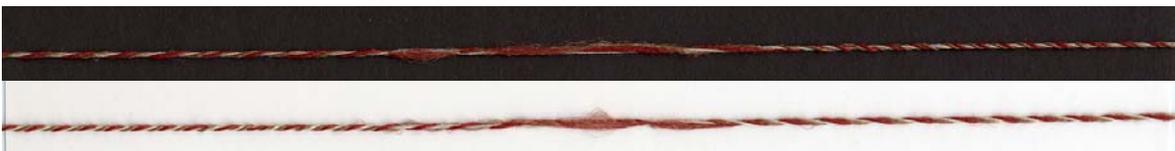


Figure 78: Yarn D Samples

Sample E contains S-twist sections set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.



Figure 79: Yarn E Samples

Sample F has S-twist sections set to be 600 mm long, the tack points, 400 mm long, and the Z-twist sections, 600 mm long.



Figure 80: Yarn F Samples

When producing sample G, the S-twist sections were set to be 400 mm long, the tack points, 600 mm long, and the Z-twist sections, 400 mm long.



Figure 81: Yarn G Samples

When producing sample K, the S-twist sections were set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 82: Yarn K Samples

During the production of sample L, the S-twist sections were set to be 1000 mm long, the tack points, 200 mm long, and the Z-twist sections, 1000 mm long.



Figure 83: Yarn L Samples

Sample M contains S-twist sections which were set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.



Figure 84: Yarn M Samples

Sample N has S-twist sections set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.



Figure 85: Yarn N Samples

Yarn O was produced with S-twist sections which were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.



Figure 86: Yarn O Samples

4.4 Experiment Four

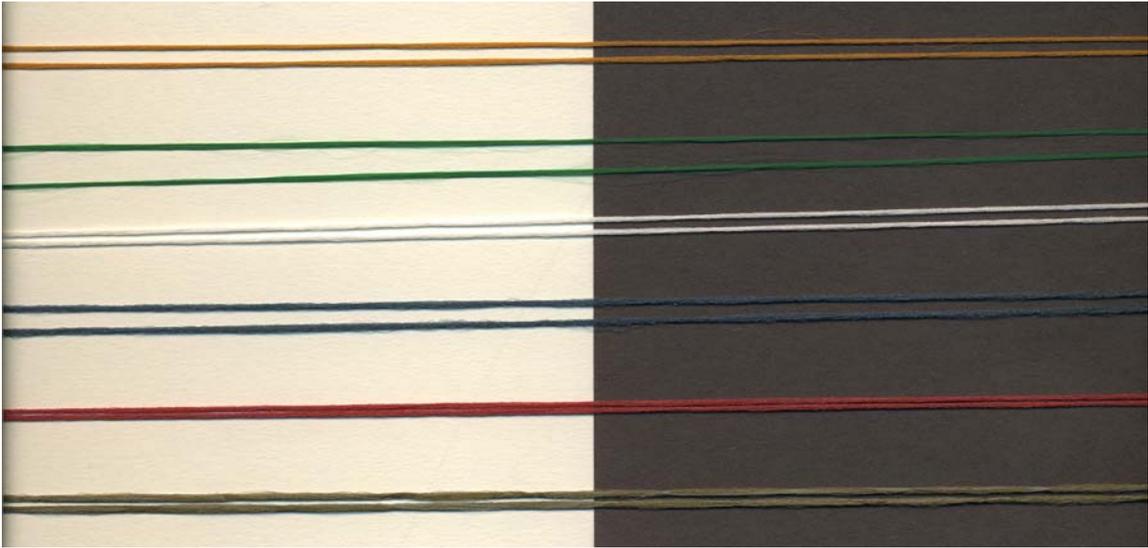


Figure 87: Feedstock yarn for Experiment 4

Feedstock	Color	Yarn Count
Yarn1	Red	159 tex
Yarn2	Brown	296 tex
Yarn 3	Blue	148 tex
Yarn 4	White	175 tex
Yarn 5	Green	145 tex
Yarn 6	Gold	147 tex

Table 8: Feedstock yarns for Experiment 4

Yarns	Z-twist length	S-twist length	Tack point length
2-A	500	500	40
2-B	750	750	40
2-C	900	900	40
2-D	1000	1000	40
2-E	1000	1000	100
2-F	1000	1000	400
2-G	1000	1000	800
2-H	1000	1000	1000
3-A	500	500	40
3-B	750	750	40
3-C	900	900	40
3-D	1000	1000	40
3-E	1000	1000	100
3-F	1000	1000	400
3-G	1000	1000	800
3-H	1000	1000	1000
4-A	500	500	40
4-B	750	750	40
4-C	900	900	40
4-D	1000	1000	40
4-E	1000	1000	100
4-F	1000	1000	400
4-G	1000	1000	800
4-H	1000	1000	1000
5-A	500	500	40
5-B	750	750	40
5-C	900	900	40
5-D	1000	1000	40
5-E	1000	1000	100
5-F	1000	1000	400
5-G	1000	1000	800
5-H	1000	1000	1000
6-A	500	500	40
6-B	750	750	40
6-C	900	900	40
6-D	1000	1000	40
6-E	1000	1000	100
6-F	1000	1000	400
6-G	1000	1000	800
6-H	1000	1000	1000
Minimum	400 mm	400 mm	40 mm
Maximum	1000 mm	1000 mm	1000 mm

Table 9: Experiment 4 sample yarn data

Experiment 4 brings yet another variation of samples into this research. While Experiment 3 used three input yarns in the feedstock throughout the duration of the experiment, Experiment 4 uses six. They are white, blue, red, gold, green, and brown in color and have similar diameters. The experiment begins with the red and brown yarns. After eight samples have been created (A-H), a new yarn is added to the feedstock. This is continued until all of the feedstock yarns are in use (samples 6A-H). The same parameters in terms of twisted area lengths and tack point lengths are used throughout each set of samples in experiment 4. Like the previous sample sets, some parameters were held constant. For example, all of the twist and air entanglement points were created using 50 psi of air pressure. Also, all of the samples were created at 500 yd/min. When producing the remaining samples, all of the input yarns were fed through individual tubes. For this reason, none of the yarns are twisted around each other before being twisted as part of the resultant yarns as seen in some previous samples.

For sample 2-A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long. The input yarns for this sample and the next seven samples were the brown and red yarns.



Figure 88: Yarn 2-A Samples

Sample 2-B was produced using S-twist sections which were set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.



Figure 89: Yarn 2-B Samples

Yarn 2-C was produced having the S-twist sections set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.



Figure 90: Yarn 2-C Samples

Sample 2-D contains S-twist sections that were set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.

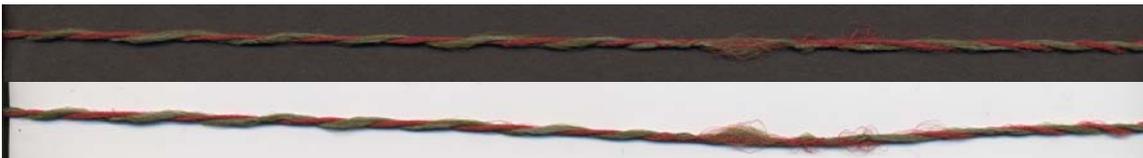


Figure 91: Yarn 2-D Samples

Sample 2-E contains S-twist sections set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 92: Yarn 2-E Samples

Sample 2-F has S-twist sections set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.

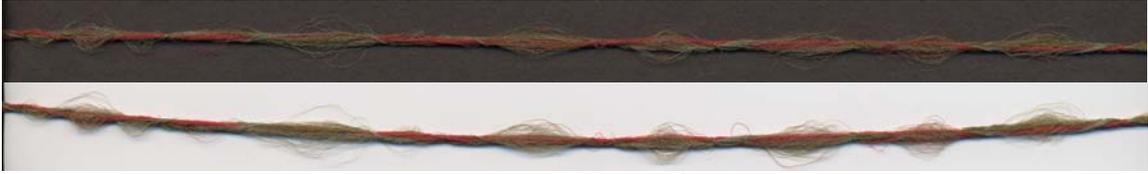


Figure 93: Yarn 2-F Samples

When producing sample 2-G, the S-twist sections were set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.



Figure 94: Yarn 2-G Samples

When producing sample 2-H, the S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.

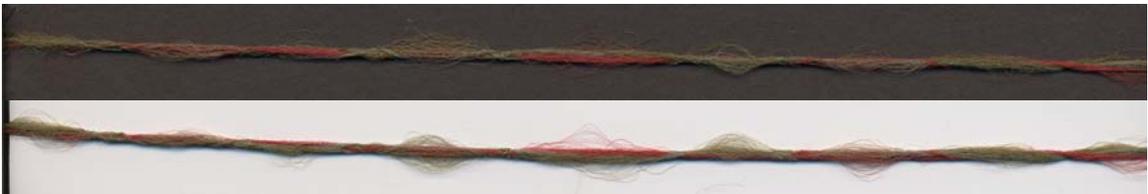


Figure 95: Yarn 2-H Samples

For sample 3-A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long. The input yarns for this sample and the following seven samples are the brown, red, and blue yarns.



Figure 96: Yarn 3-A Samples

Sample 3-B was produced using S-twist sections which were set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.



Figure 97: Yarn 3-B Samples

Yarn 3-C was produced having the S-twist sections set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.



Figure 98: Yarn 3-C Samples

Sample 3-D contains S-twist sections that were set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.

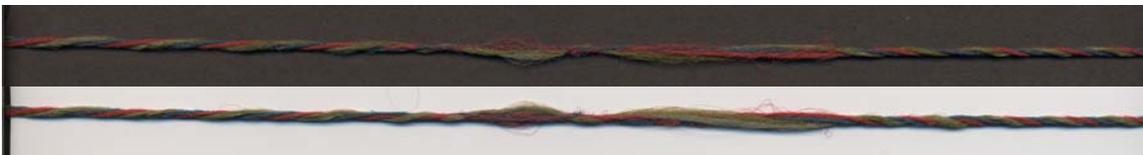


Figure 99: Yarn 3-D Samples

Sample 3-E contains S-twist sections set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 100: Yarn 3-E Samples

Sample 3-F has S-twist sections set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.



Figure 101: Yarn 3-F Samples

When producing sample 3-G, the S-twist sections were set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.



Figure 102: Yarn 3-G Samples

When producing sample 3-H, the S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.

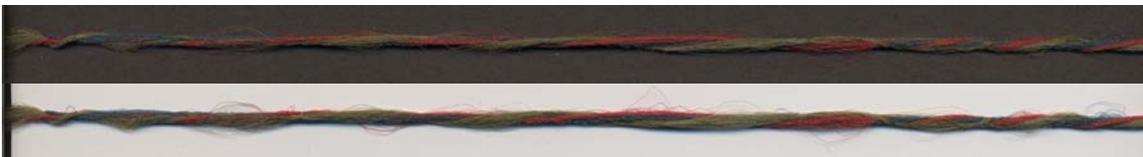


Figure 103: Yarn 3-H Samples

For sample 4-A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long. For this sample and the following seven samples, white is added to the input feedstock.



Figure 104: Yarn 4-A Samples

Sample 4-B was produced using S-twist sections which were set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.



Figure 105: Yarn 4-B Samples

Yarn 4-C was produced having the S-twist sections set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.



Figure 106: Yarn 4-C Samples

Sample 4-D contains S-twist sections that were set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.



Figure 107: Yarn 4-D Samples

Sample 4-E contains S-twist sections set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 108: Yarn 4-E Samples

Sample 4-F has S-twist sections set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.



Figure 109: Yarn 4-F Samples

When producing sample 4-G, the S-twist sections were set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.

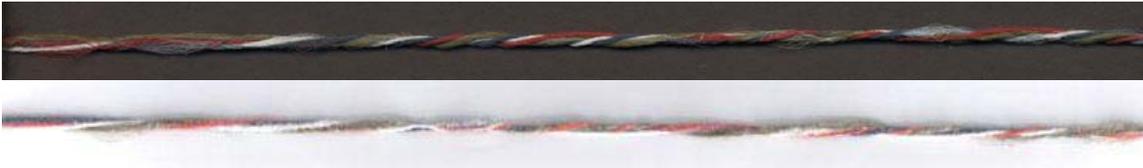


Figure 110: Yarn 4-G Samples

When producing sample 4-H, the S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.

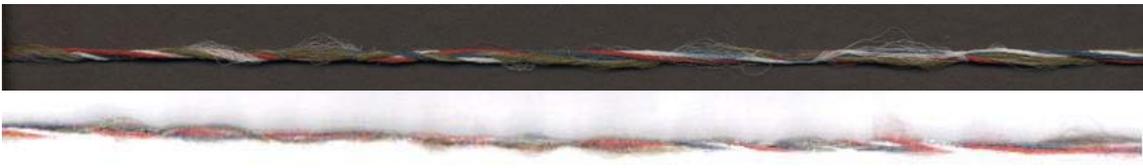


Figure 111: Yarn 4-H Samples

For sample 5-A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long. In addition to the input feedstock used in the previous samples in Experiment 4, green is added.

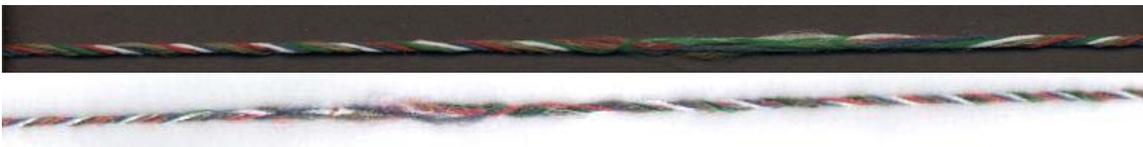


Figure 112: Yarn 5-A Samples

Sample 5-B was produced using S-twist sections which were set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.

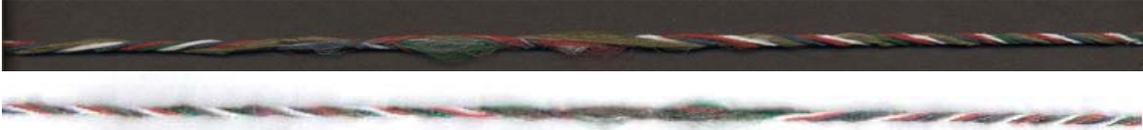


Figure 113: Yarn 5-B Samples

Yarn 5-C was produced having the S-twist sections set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.



Figure 114: Yarn 5-C Samples

Sample 5-D contains S-twist sections that were set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.

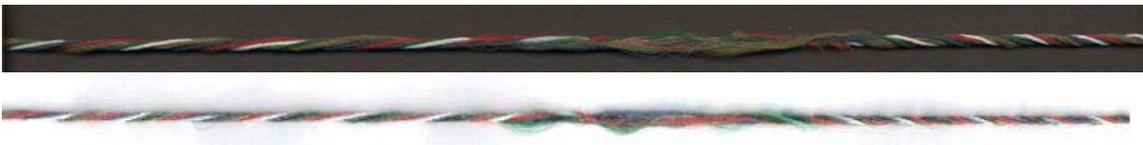


Figure 115: Yarn 5-D Samples

Sample 5-E contains S-twist sections set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 116: Yarn 5-E Samples

Sample 5-F has S-twist sections set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.

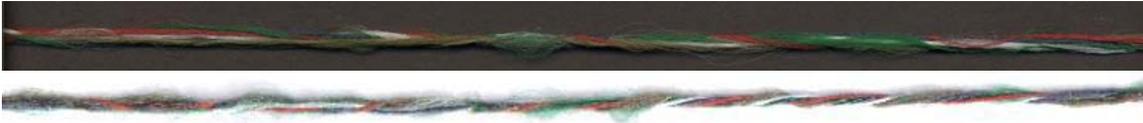


Figure 117: Yarn 5-F Samples

When producing sample 5-G, the S-twist sections were set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.

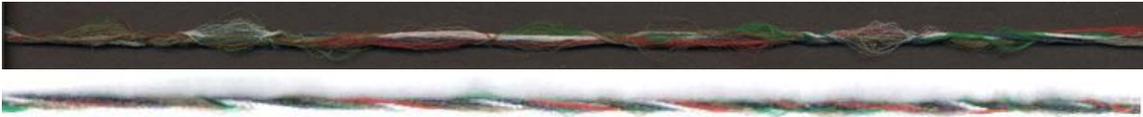


Figure 118: Yarn 5-G Samples

When producing sample 5-H, the S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.



Figure 119: Yarn 5-H Samples

For sample 6-A, the S-twist sections were set to be 500 mm long, the tack points, 40 mm long, and the Z-twist sections, 500 mm long. For sample set 6, gold is added to the input feedstock.



Figure 120: Yarn 6-A Samples

Sample 6-B was produced using S-twist sections which were set to be 750 mm long, the tack points, 40 mm long, and the Z-twist sections, 750 mm long.



Figure 121: Yarn 6-B Samples

Yarn 6-C was produced having the S-twist sections set to be 900 mm long, the tack points, 40 mm long, and the Z-twist sections, 900 mm long.



Figure 122: Yarn 6-C Samples

Sample 6-D contains S-twist sections that were set to be 1000 mm long, the tack points, 40 mm long, and the Z-twist sections, 1000 mm long.



Figure 123: Yarn 6-D Samples

Sample 6-E contains S-twist sections set to be 1000 mm long, the tack points, 100 mm long, and the Z-twist sections, 1000 mm long.



Figure 124: Yarn 6-E Samples

Sample 6-F has S-twist sections set to be 1000 mm long, the tack points, 400 mm long, and the Z-twist sections, 1000 mm long.

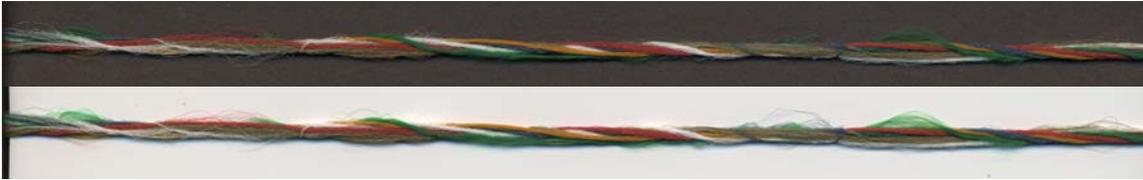


Figure 125: Yarn 6-F Samples

When producing sample 6-G, the S-twist sections were set to be 1000 mm long, the tack points, 800 mm long, and the Z-twist sections, 1000 mm long.



Figure 126: Yarn 6-G Samples

When producing sample 6-H, the S-twist sections were set to be 1000 mm long, the tack points, 1000 mm long, and the Z-twist sections, 1000 mm long.



Figure 127: Yarn 6-H Samples

5. Results and Discussion

5.1 Preliminary Experiments

The yarns made on the Gilbos Air Twist system have deliberate inconsistencies applied during production to make them more interesting visually. They include areas of tacking, where the entanglement jet has pulsed through the yarn allowing the fibers to maintain their cohesion. They also include areas of twist in both the S and Z direction. The yarns created for this research using this system were made using a number of varying parameters. These parameters were length of tack points, the length of twisted areas, and number of input feedstocks.

5.1.1 Experiment One

The first batch of preliminary experiments used using three feedstocks: red, yellow, and blue BCF, to create seven extremely different yarns.

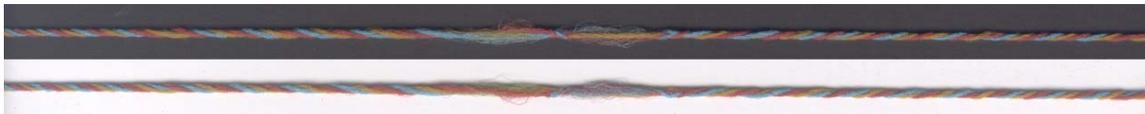


Figure 128: Yarn 1

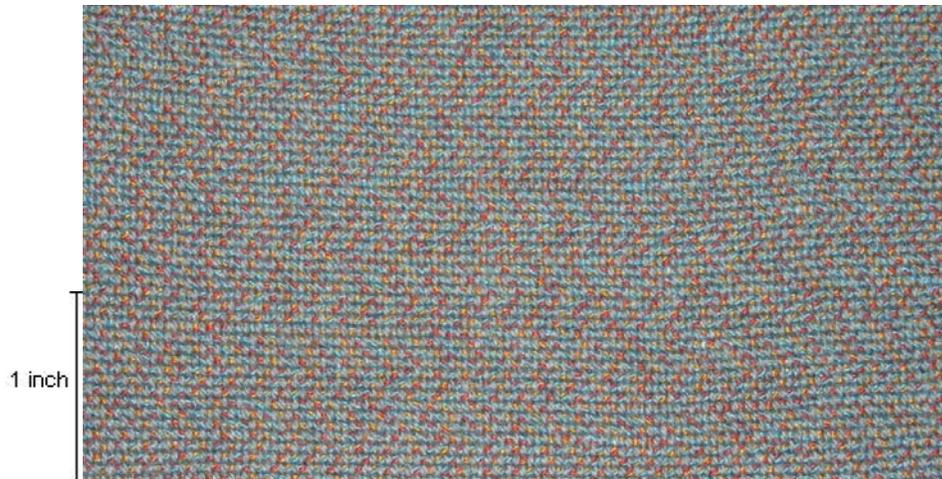


Figure 129: Fabric created using Yarn 1



Figure 130: Detail of fabric created using Yarn 1

Yarn 1 is an example of a yarn which is created using small tack points (the area in the center of Figure 128) and short twisted regions. Because the areas are small, the tack point seems more condensed, and the twisted area seems 'tighter', giving it a high number of turns per inch.

The fabric created by yarn 1 does exhibit a visual pattern throughout the cloth. The detailed image above shows the pattern to be an inconsistent zigzag/chevron pattern. The pattern in the fabric is directly related to the lengths of

twisted areas in the yarn, along with the length of the tack point. Given that the pattern in the fabric is subtle and inconsistent, the aforementioned lengths are set at acceptable values. This fabric was woven at 12 picks per inch.

Yarn 1, along with all of the samples that follow were woven using plain weave construction. The warp yarns are bluish-grey cotton yarns and the weft is wholly made up of the samples created for this research. Each sample is woven at 18 ends per inch, but the picks per inch for each sample vary due each yarn's diameter.



Figure 131: Yarn 2

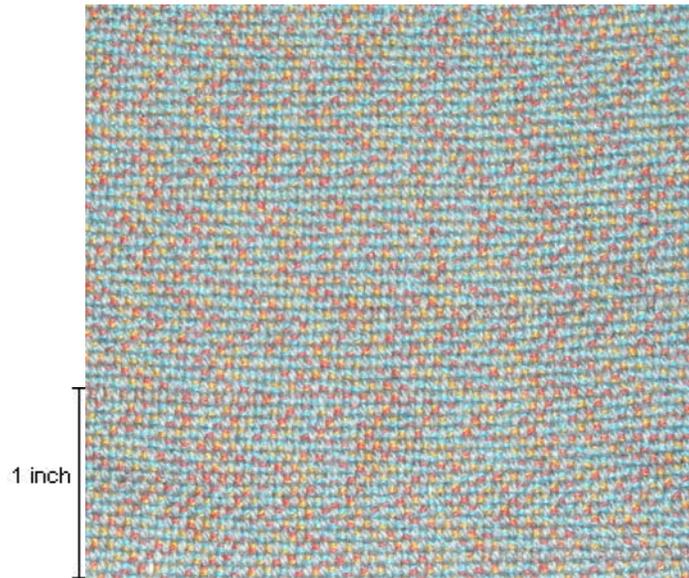


Figure 132: Fabric created using Yarn 2

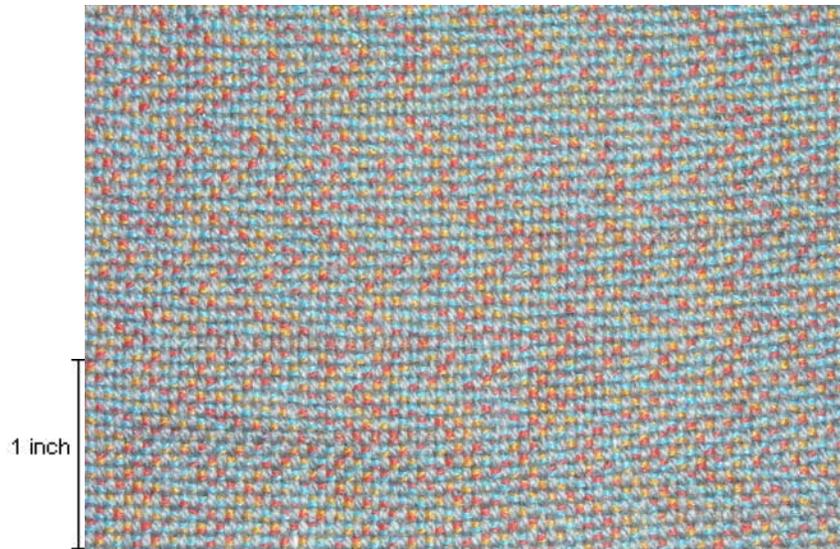


Figure 133: Detail of fabric created using Yarn 2

In Yarn 2, both the tack points and the twisted areas of the yarn seem to have been increased. However, the lengths of the areas actually remained the same. The tack point looks less condensed because the pressure creating this tack point has been lessened. It is important to note that the twisted areas of the yarn allow themselves to untwist and relax into the portion of the yarn that is the tack point because the tack point pressure has been decreased. The air pressure applied to the torque jets for all three yarns has also been decreased.

The fabric created using yarn 2 seems to have more obvious zigzag, or moiré, patterning than that created using yarn 1. Because of this, it could be suggested that the pressure used to insert the twist and tack points into the yarn should be increased. As noted in the Experimental section of this paper, for Experiments 2, 3, and 4, the air pressure applied to create the twist and tack points throughout the yarn was set to be 50 psi. The pressure used to create yarn 2 is much less than the decided amount of air pressure. This fabric was woven using 12 picks per inch.

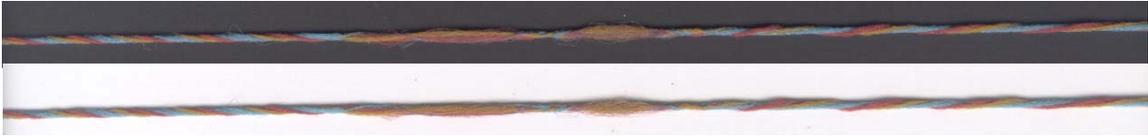


Figure 134: Yarn 3

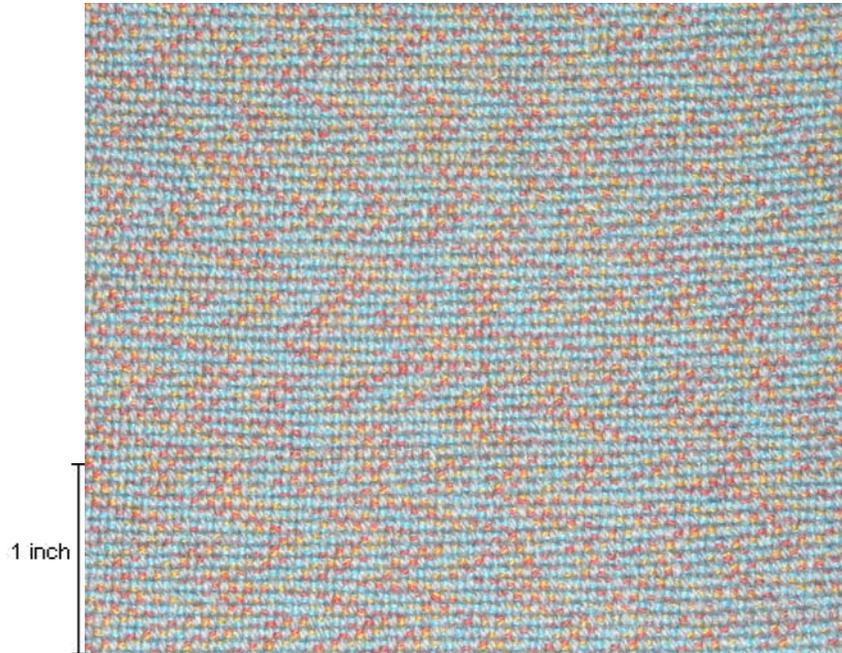


Figure 135: Fabric created using Yarn 3

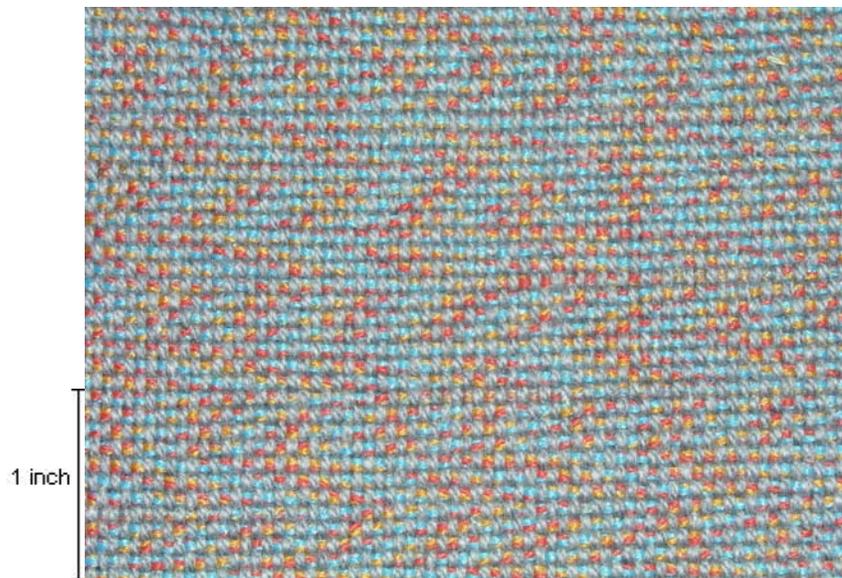


Figure 136: Detail of fabric created using Yarn 3

During production of Yarn 3, the air pressure applied to the torque jets for the red and yellow yarns were increased, but the pressure on the blue yarn was

set at zero. This allowed for the red and yellow yarns to actually wrap themselves around the blue yarn as is shown above.

The resultant fabric does exhibit patterning, but because of the parameters discussed above, the patterning is acceptable. The patterning is similar to that shown in the fabric created using yarn 1. The patterning is inconsistent and appears to be predominantly created by the red and yellow yarns on a blue background. The fabric created using yarn 3 was woven using 12 picks per inch.

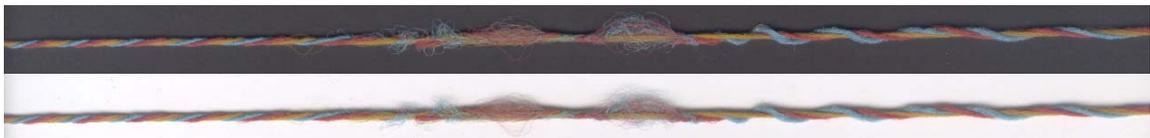


Figure 137: Yarn 4

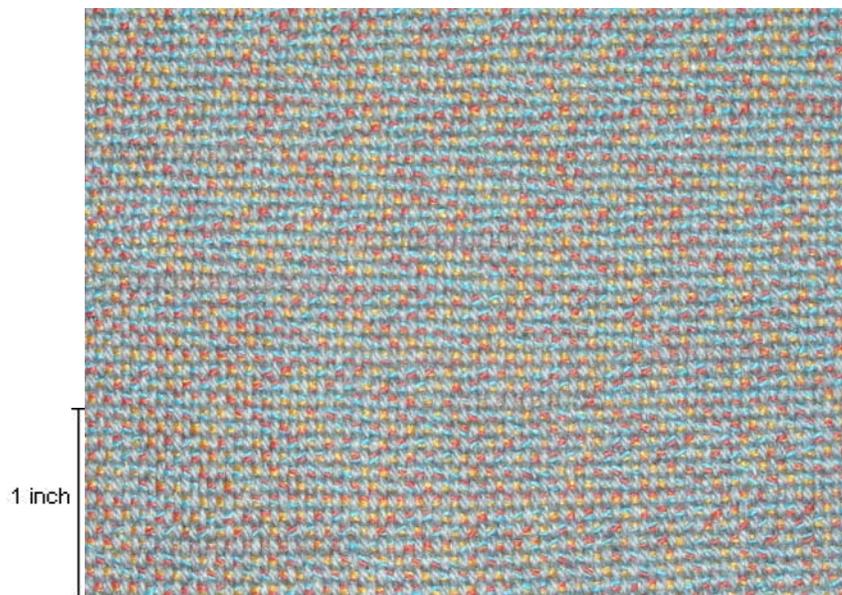


Figure 138: Fabric created using Yarn 4

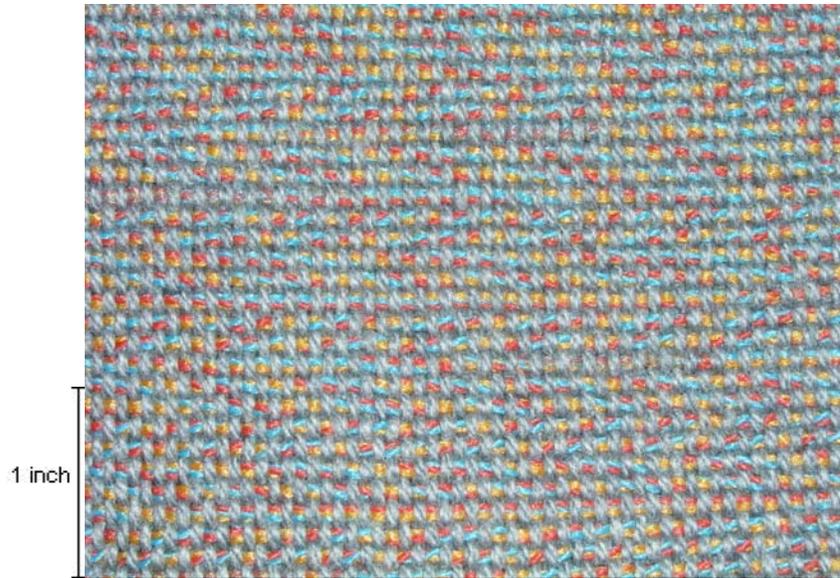


Figure 139: Detail of fabric created using Yarn 4

Yarn 4 was created in a similar fashion as Yarn 3, the pressure applied to the red and blue yarns were consistent, but that on the yellow yarn was decreased to zero. The tack point for this yarn is also increased.

The fabric created using yarn 4 was woven at 12 picks per inch. This fabric is more visually balanced, having equal amounts of each colored yarn in the fabric. Thus, the patterning in the fabric is subtle and not visually distracting. The tack point length and the pressure applied to the yellow yarn seem to have no negative effect on the appearance of the fabric.

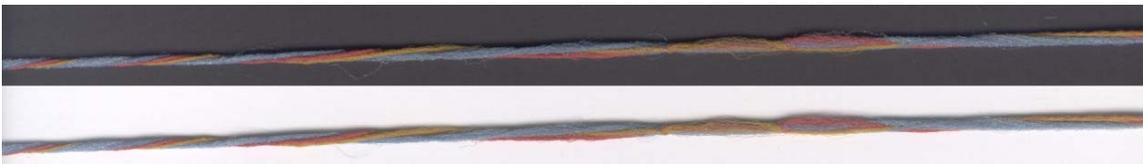


Figure 140: Yarn 5



Figure 141: Fabric created using Yarn 5



Figure 142: Detail of fabric created using Yarn 5

When manipulating the parameters in Yarn 5, the torque jet air pressure applied to the red and yellow yarns were the same, but the pressure on the blue yarn was increased to almost double that of the other two yarns. This caused the blue yarn to be more dominant throughout the length of the yarn, and the red and yellow yarns to wrap themselves around the blue. The tack point in this yarn is

also longer than previous yarns.

This fabric, similar to the fabric created by yarn 3, has a predominantly blue background. It was woven at 12 picks per inch. The red and yellow patterning exhibited in this fabric, however, is more visually distracting with extreme chevron patterning. To remedy this problem, it is suggested that the tack point length throughout the yarn be decreased to be similar to the lengths of the twisted areas.

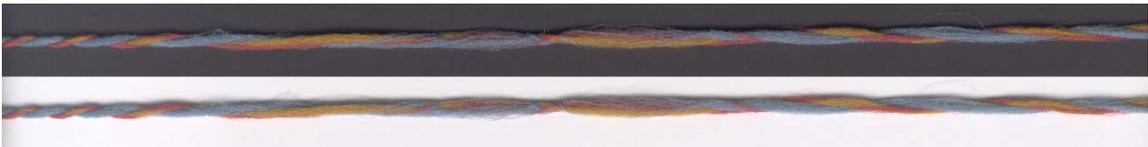


Figure 143: Yarn 6

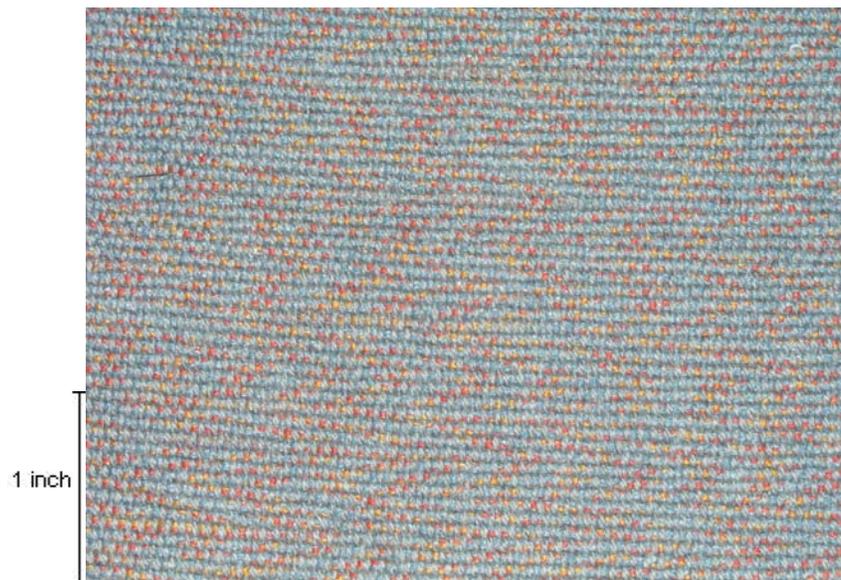


Figure 144: Fabric created using Yarn 6



Figure 145: Detail of fabric created using Yarn 6

Yarn 6 was produced with all of the yarns having the same pressure. One difference between this yarn and the previous five, however, is that during production, the red and yellow yarns were fed through the same tube while the blue yarn had its own tube. This allowed the red and yellow yarns to be twisted together before they were combined with the blue yarn.

The fabric created with yarn 6 does seem to have some obvious patterning; this is because of the dominance of the blue yarn in the fabric. While previous fabrics had patterning that appeared to float on a blue background, the length of the twisted areas and the intervals of the tack points create a zigzag patterning that is more obvious. This fabric was woven at 12 picks per inch.

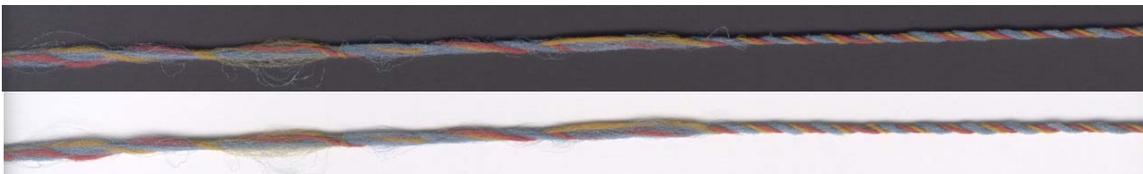


Figure 146: Yarn 7

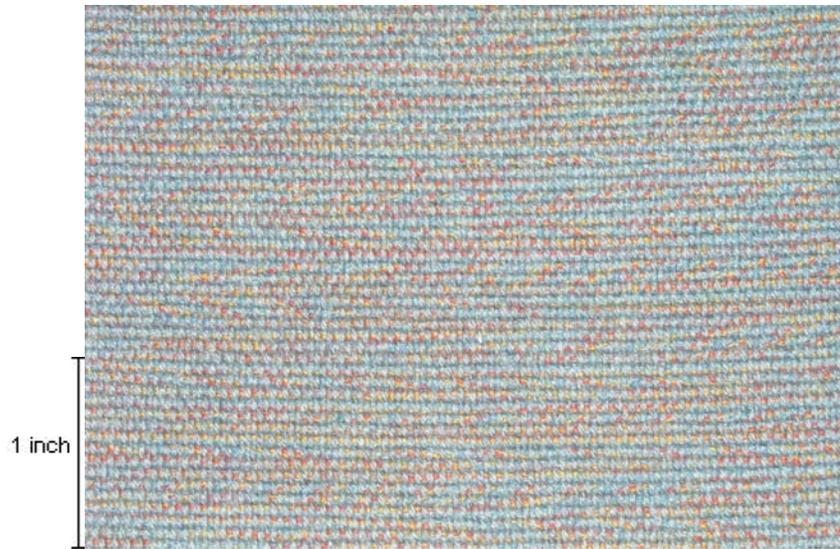


Figure 147: Fabric created using Yarn 7



Figure 148: Detail of fabric created using Yarn 7

During the production of Yarn 7, the parameters were adjusted so that the length of the tack points and the twisted regions were equal. This allowed for a very interesting yarn with equal amount of hairy and cord-like areas.

This fabric appears visually balanced with regards to the yarn colors. Because of this, the patterning throughout the fabric is not visually distracting. The fabric was woven at 12 picks per inch.

All of the following experiments were also done on Gilbos' Air Twist System following the same steps discussed previously in this chapter. Several parameters were changed throughout the following three experiments for varying results.

5.1.2 Experiment Two

The input feedstocks for this experiment included sixteen different yarns.

They include the following colors:

Mint green	Robin's egg blue	Grey	Space-dyed pink
Green	Space-dyed purple and orange	Royal blue	Navy blue
Pre-tacked white	Mushroom brown	Red	White
Space dyed	Pink	Purple	Camel
	Peach	Gold	

Table 10: Experiment 2 feedstock yarns

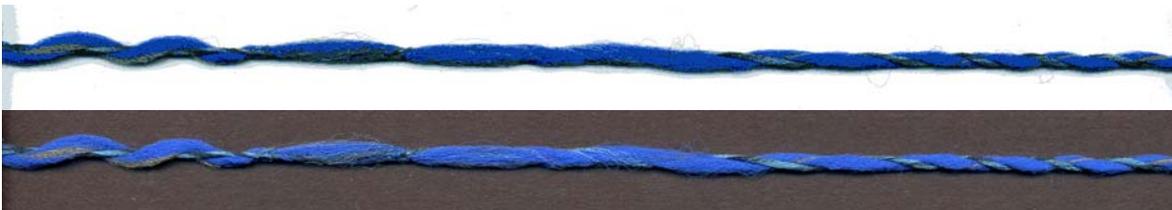


Figure 149: Yarn 1

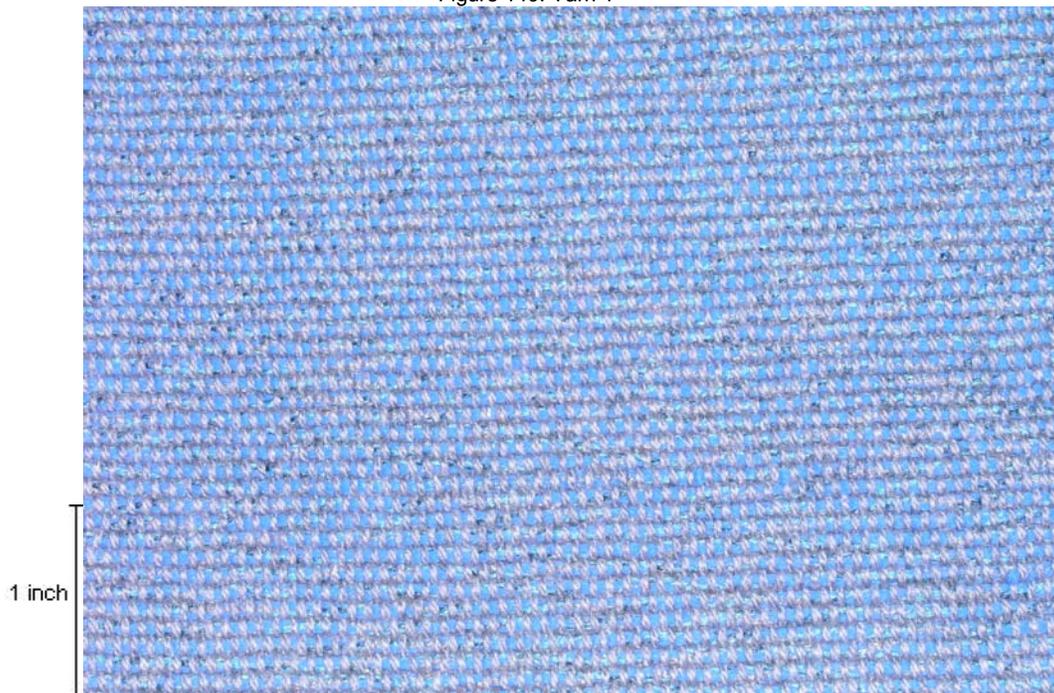


Figure 150: Fabric created using Yarn 1

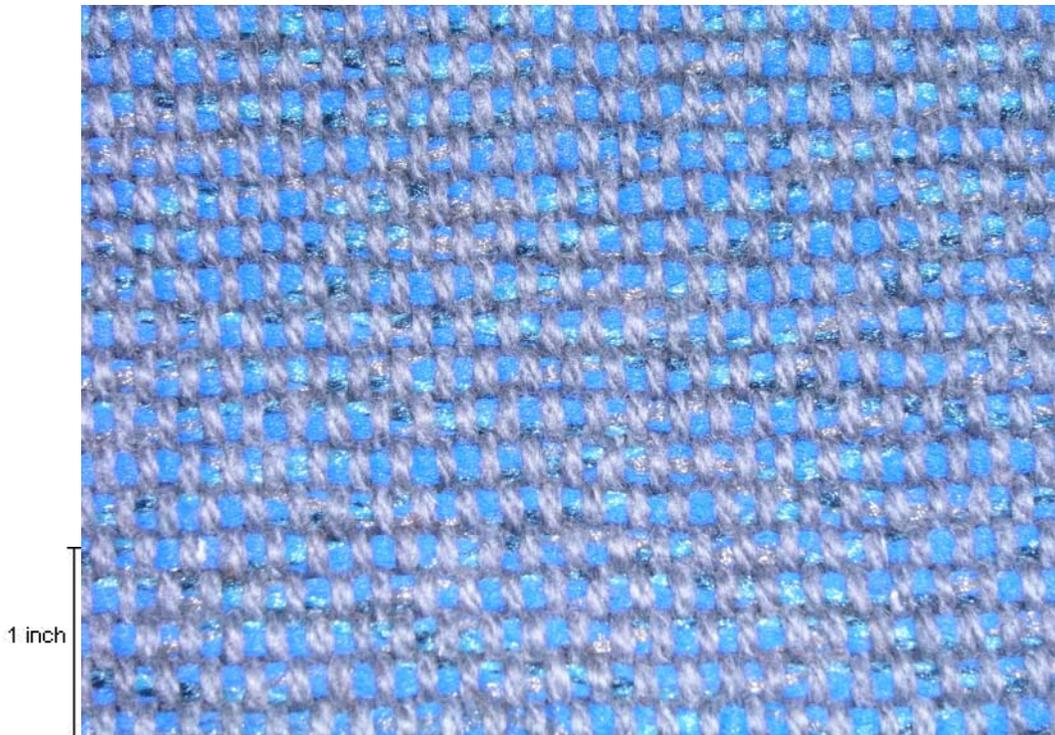


Figure 151: Detail of fabric created using Yarn 1

Yarn 1 includes large sections of twisted yarn in comparison to the length of the tack point. It is comprised of four different input yarns. The royal blue yarn has a very large diameter where the other three input yarns are much smaller.

The fabric created using yarn 1 does not have any obvious patterning displayed. This is most likely due to the fact that the large blue yarn, while present in the same amount of the other feedstock yarns, is predominantly the focus in this fabric. Had the diameters of the other yarns been more similar to the blue yarn, they would be more visible. This fabric was created using 8 picks per inch.

Yarn 1, along with all of the samples that follow were woven using plain weave construction. The warp yarns are bluish-grey cotton yarns and the weft is wholly made up of the samples created for this research. Each sample is woven at 18 ends per inch, but the picks per inch for each sample vary due each yarn's

diameter.

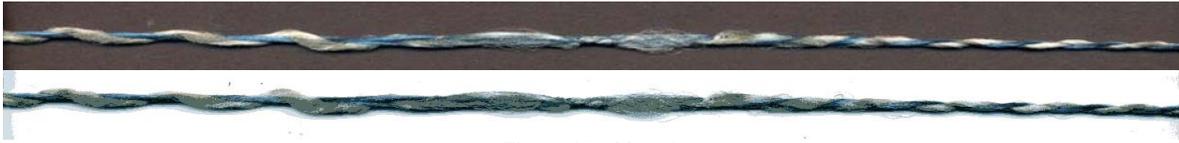


Figure 152: Yarn 2



Figure 153: Fabric created using Yarn 2



Figure 154: Detail of fabric created using Yarn 2

Yarn 2 is made up of four different colored yarns, blue, white, dark blue, and grey. All of these yarns have similar diameters. The lengths of twisted areas have been increased, but the lengths of the tack points have been decreased.

The fabric created with yarn 2 has obvious chevron patterning throughout. This is attributed to the color choice of the yarns. Had the choices not been so contrasting, the patterning would not be so obvious. Also, had the lengths of the twisted sections and the lengths of the tack points been more similar, the patterning would not be so dominant. The fabric was woven at 9 picks per inch.



Figure 155: Yarn 3

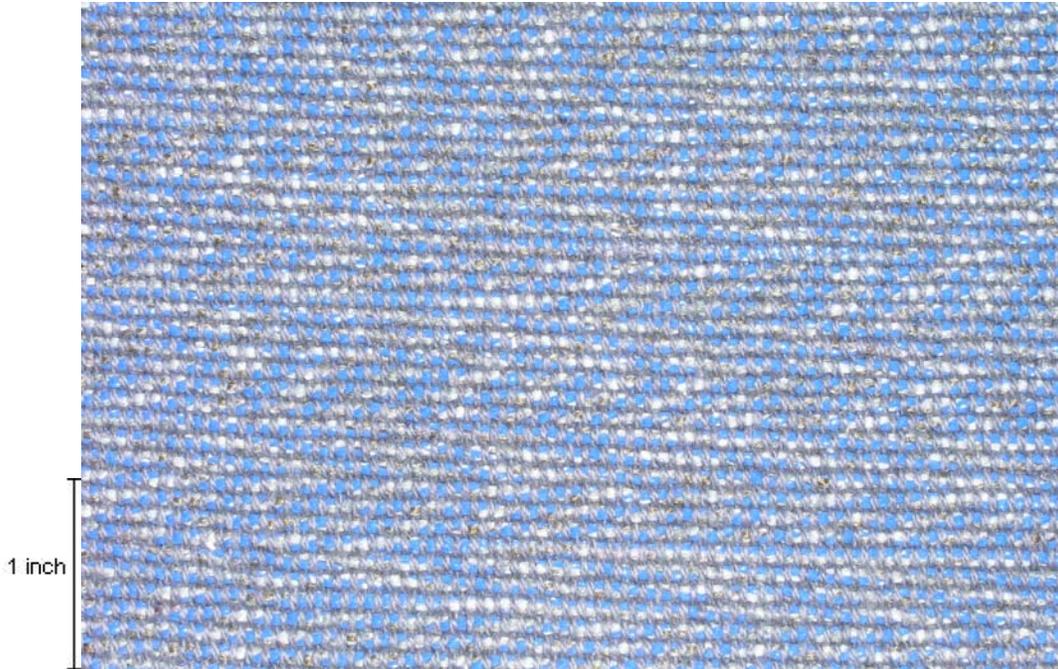


Figure 156: Fabric created using Yarn 3



Figure 157: Detail of fabric created using Yarn 3

Yarn 3 is comprised of three input yarns, royal blue, grey, and mushroom. This yarn is similar to yarn 1 due to the fact that the diameter of the royal blue yarn

is much larger than that of the other two input yarns. The lengths of the twisted areas have remained the same, but the lengths of the tack point areas have increased.

The fabric created using yarn 3 is similar to that created using yarn 1 here too; the large blue yarn is the most visible in this fabric. However, the diameters of the other input yarns used to create yarn 3 are more similar to that of the large blue yarn. Because of this, the other input yarns are more visible and create an obvious visual patterning effect. This fabric was woven at 9 picks per inch.

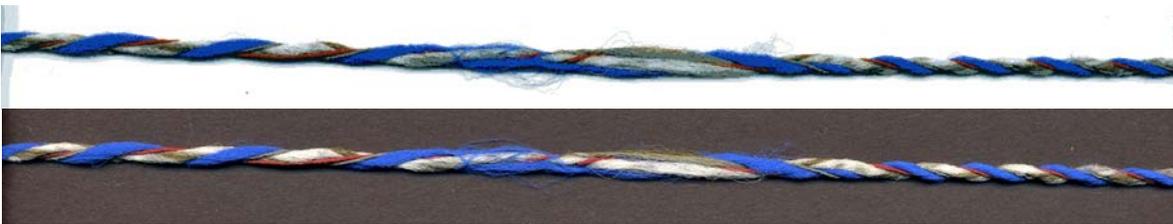


Figure 158: Yarn 4

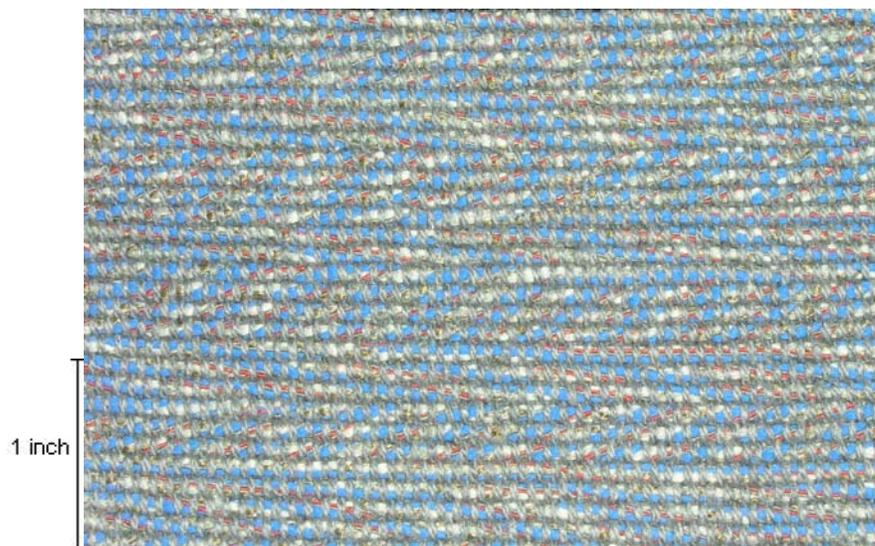


Figure 159: Fabric created using Yarn 4



Figure 160: Detail of fabric created using Yarn 4

Yarn 4 is comprised of four different input yarns, royal blue, white, mushroom, and red. Like previous yarns shown in Experiment 2, the royal blue yarn has a much larger diameter than the other input yarns. The lengths of twisted areas throughout the yarn remained the same, but the lengths of tack points were decreased slightly.

The fabric created using yarn 4 has a very obvious patterning effect. This is mostly due, as in previous fabrics, to the color choices in the yarn. The lengths of tack points and twisted areas, while different from previous samples, are not different enough to contribute to the patterning. The fabric was woven at 7 picks per inch.

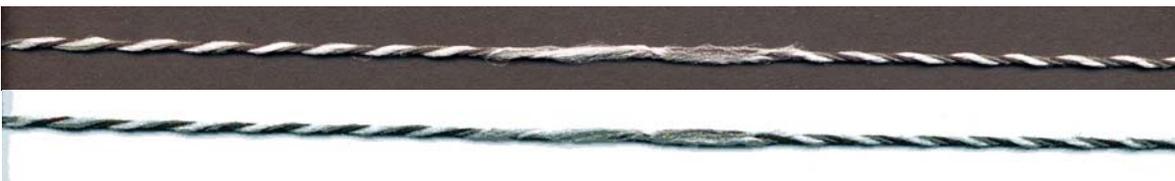


Figure 161: Yarn 5

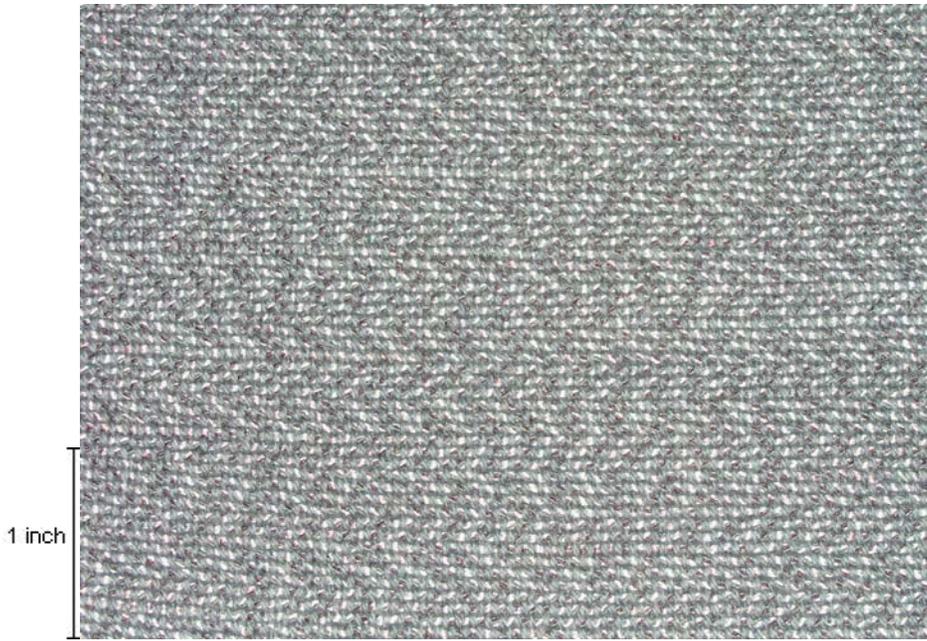


Figure 162: Fabric created using Yarn 5



Figure 163: Detail of fabric created using Yarn 5

Yarn 5 is comprised of four input yarns, white, purple, grey, and a space-dyed yarn with variations of colors throughout. The lengths of the twisted areas are the same as those in yarn 4, while the length of the air entangled areas have

decreased slightly.

The fabric created using yarn 5 also has an obvious pattern throughout the cloth. While the pattern is not as large as in the fabric created using yarn 4, due to the diameters of the resultant yarns, it is still obvious as a smaller chevron pattern. The fabric was woven at 11 picks per inch.

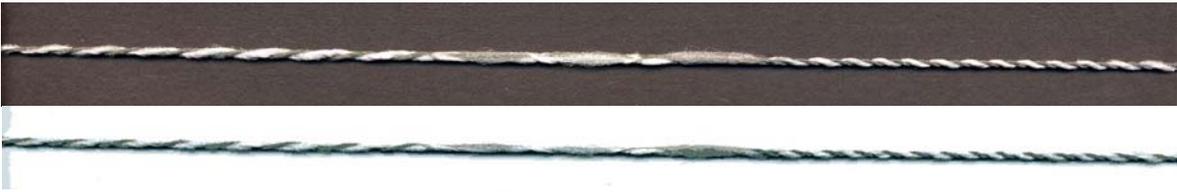


Figure 164: Yarn 6



Figure 165: Fabric created using Yarn 6

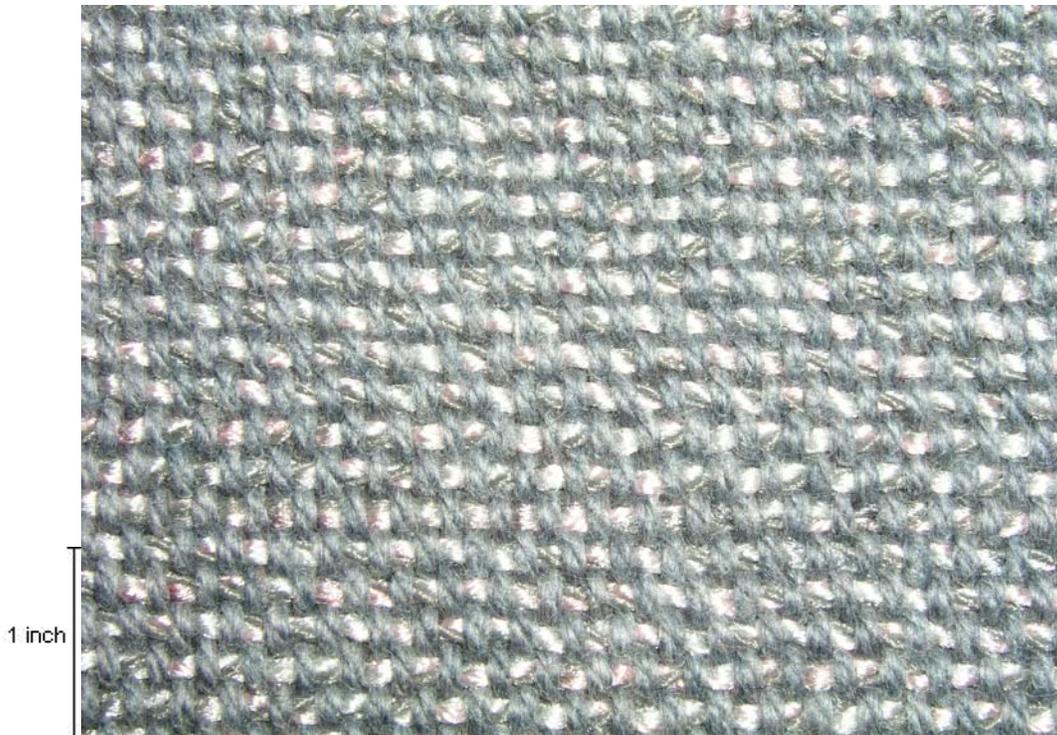


Figure 166: Detail of fabric created using Yarn 6

Three of the yarns used in yarn 5 are used to create yarn 6; white, grey, and a space-dyed pink yarn. The lengths of the twisted sections have been increased, while the lengths of the tack points have been decreased slightly.

The patterning in this fabric is still visible, but is not as obvious as that in the fabric created with yarn 5. This is due to the color choices of the yarns. The input yarns for yarn 5 are more contrasting than those used to create yarn 6 since the dark purple yarn was omitted to create yarn 6. The fabric was woven at 11 picks per inch.



Figure 167: Yarn 7

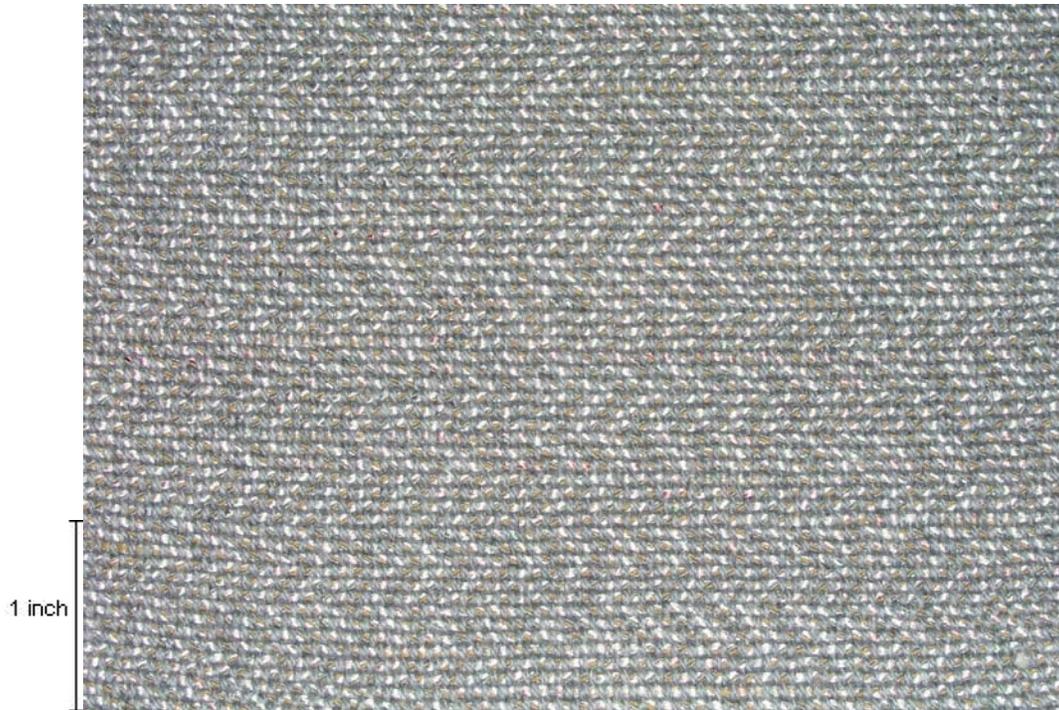


Figure 168: Fabric created using Yarn 7



Figure 169: Detail of fabric created using Yarn 7

Yarn 7 is comprised of four input yarns, mushroom, grey, white, and pink space-dyed yarn. The lengths of the twisted areas have been decreased slightly

while the lengths of the tack points have been increased slightly.

The fabric created using yarn 7 is similar to that using yarn 5. The patterning is more obvious than that in the fabric created using yarn 6 due to the contrasting colors of feedstock used for yarn 7. The mushroom colored yarn creates the contrast that the purple yarn did in yarn 5. The lengths of the tack points and twisted areas throughout the yarns have no obvious effect on the patterning. The fabric created using yarn 7 was woven at 10 picks per inch.

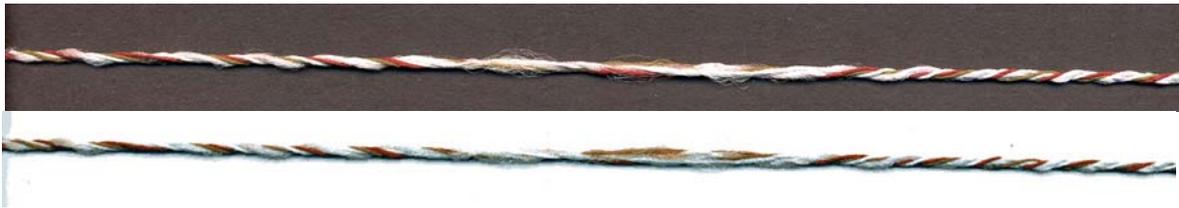


Figure 170: Yarn 8

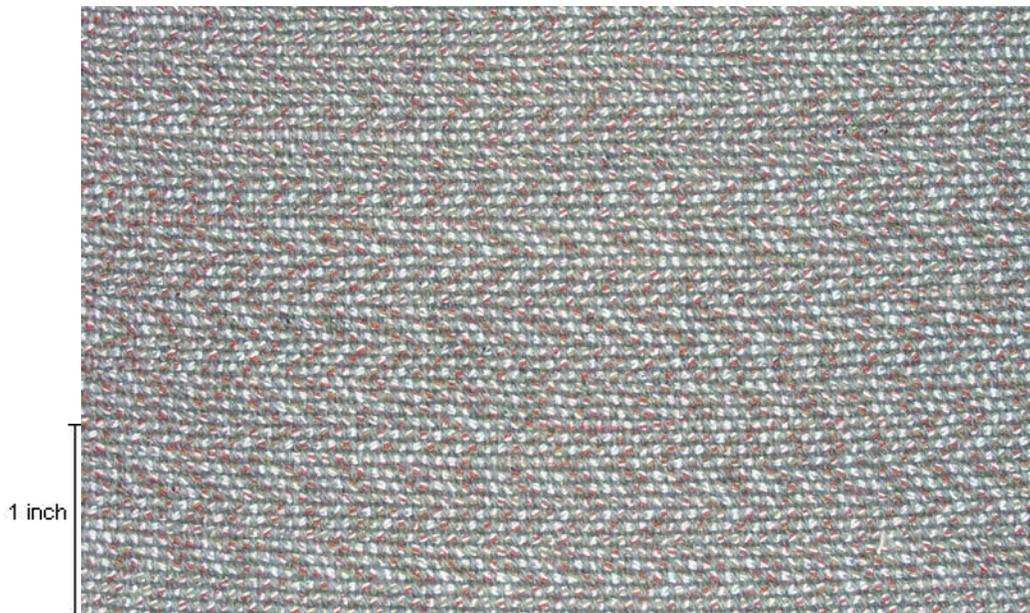


Figure 171: Fabric created using Yarn 8



Figure 172: Detail of fabric created using Yarn 8

There are four yarns that are consolidated to create yarn 8, red, white, pink, and mushroom. The tack point lengths have been slightly lowered, while the lengths of the twisted areas were slightly increased.

The fabric created using yarn 8 is similar to that created with yarn 7. The input yarns used to create the yarns are similarly contrasting visually. This aids in creating a visually distracting patterning. This fabric was woven at 10 picks per inch.



Figure 173: Yarn 9

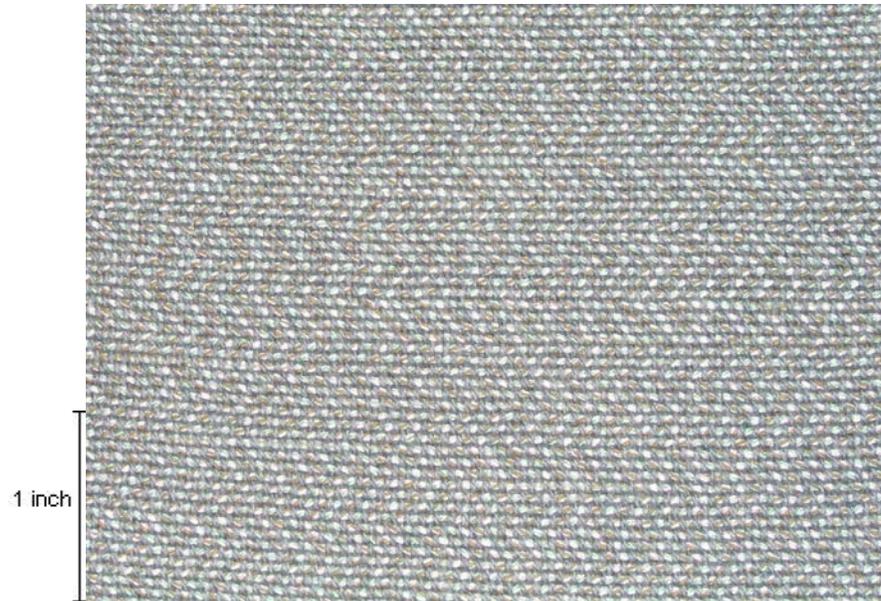


Figure 174: Fabric created using Yarn 9



Figure 175: Detail of fabric created using Yarn 9

Pink, white, mushroom, and mint green yarns are used to create yarn 9. While the length of the tack points remains the same, the length of the twisted areas throughout the yarn are reduced slightly.

While the fabric created using yarn 9 does exhibit some patterning throughout, it is not as obvious as that created by yarn 8. There are contrasting colors throughout the yarn, which allow for some distracting patterning. This fabric was woven at 11 picks per inch.



Figure 176: Yarn 10

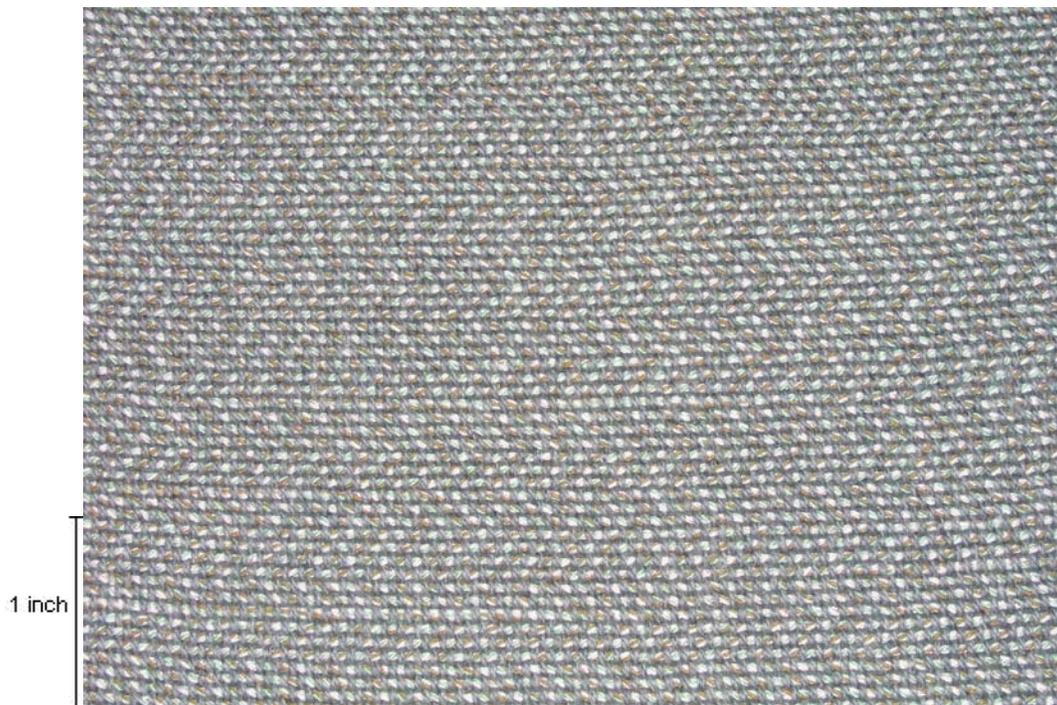


Figure 177: Fabric created using Yarn 10



Figure 178: Detail of fabric created using Yarn 10

Pink, white, mushroom, and mint green yarns are used to create yarn 10. The lengths of the tack points and twisted areas remain the same.

The fabric created using yarn 10 does exhibit some patterning throughout. While it is not as obvious as that in the fabric created by yarn 8, there are contrasting colors throughout the yarn which allow for some distracting patterning. This fabric was woven at 11 picks per inch.

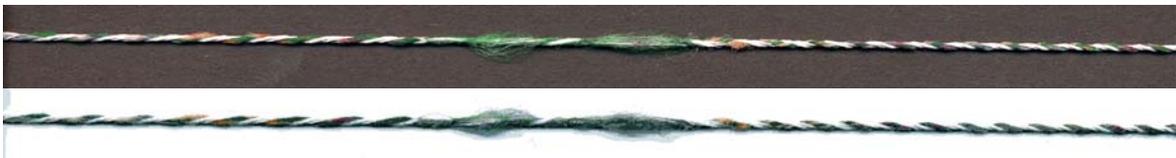


Figure 179: Yarn 11



Figure 180: Fabric created using Yarn 11

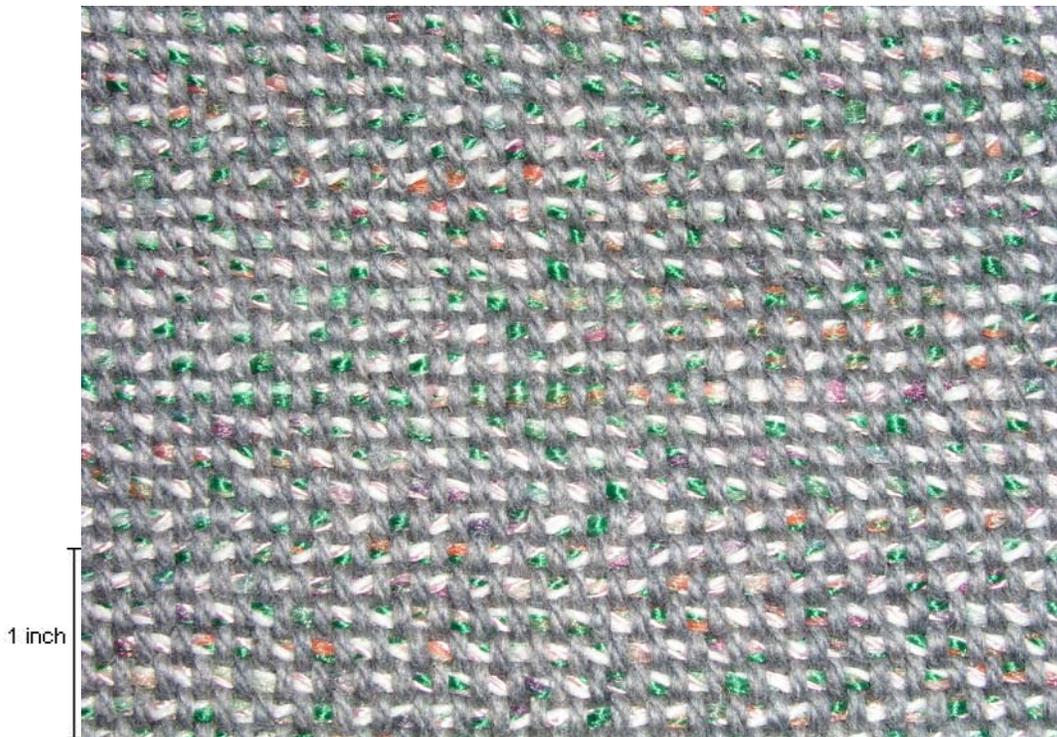


Figure 181: Detail of fabric created using Yarn 11

Yarn 11 is created using green, white, and a space-dyed yarn. The length of the twisted areas has been increased, but the length of the tack points remain

the same.

The fabric created using yarn 11 has some patterning, but is not as visually distracting as it is inconsistent. This inconsistency is due to the space-dyed yarn used in the creation of yarn 11. The irregularly spaced colors throughout the space-dyed yarn result in randomness of the patterning throughout the fabric. The fabric created using yarn 11 was woven at 11 picks per inch.



Figure 182: Yarn 12

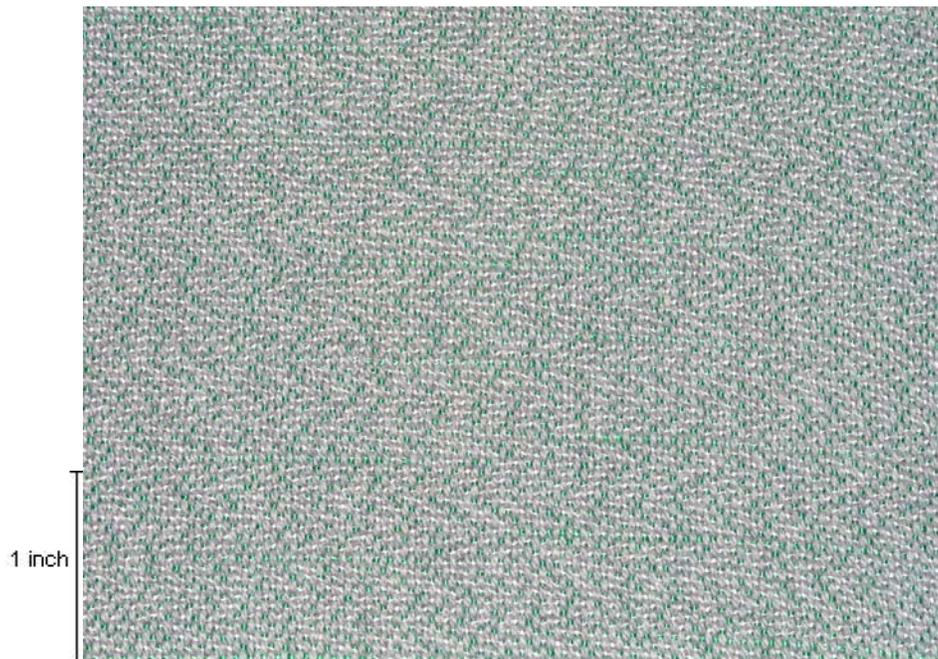


Figure 183: Fabric created using Yarn 12



Figure 184: Detail of fabric created using Yarn 12

Yarn 12 is created by using two yarns of similar diameters, pink and green. The lengths of the twisted regions are reduced slightly, while the lengths of the tack points are increased.

The fabric created using yarn 12 has highly visible patterning throughout. This is due to the contrast of the resultant yarn with the warp yarns. The two input yarns used to create yarn 12 are of contrasting colors. When these are combined with a neutral tone such as that of the warp yarn, the contrast is great. The lengths of the tack points and twisted regions have no effect on the patterning. This fabric was woven at 13 picks per inch.

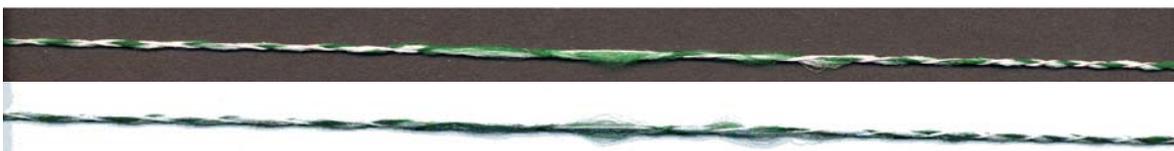


Figure 185: Yarn 13

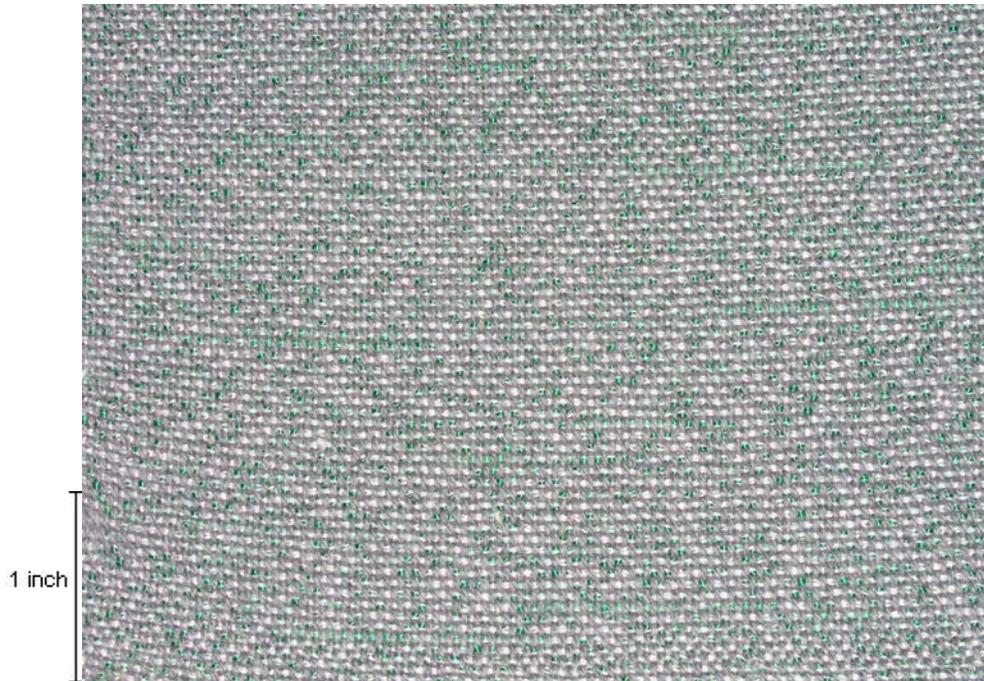


Figure 186: Fabric created using Yarn 13

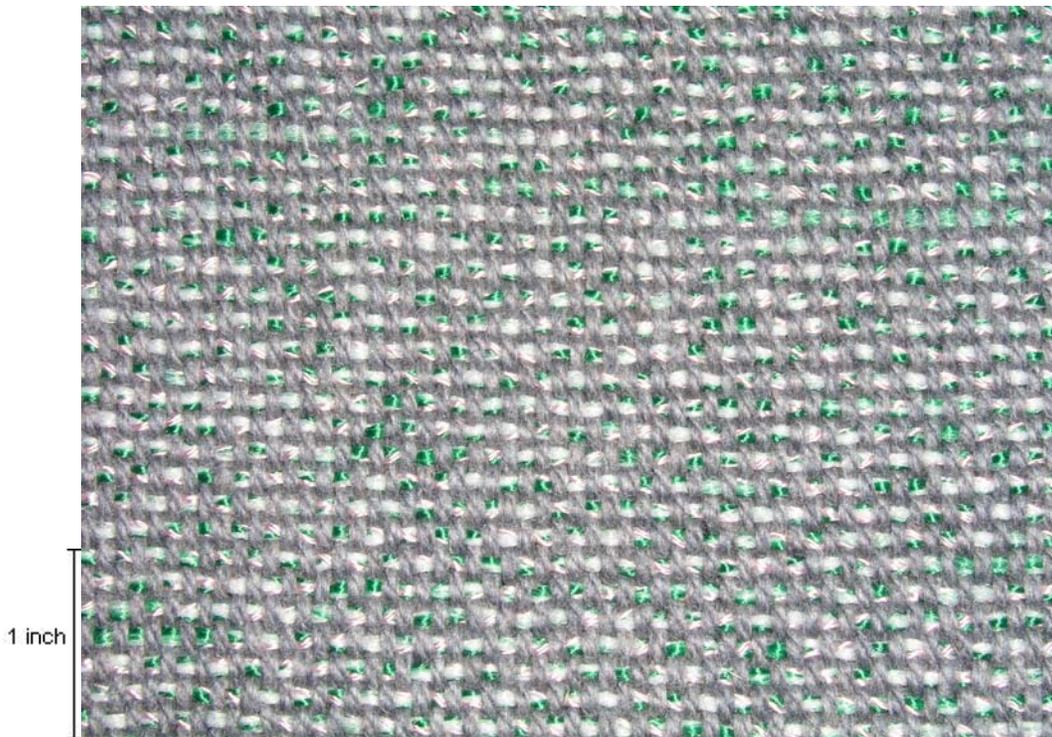


Figure 187: Detail of fabric created using Yarn 13

Yarn 13 is created by combining the green and pink yarns from yarn 12, along with the white yarn. The lengths of the twisted regions remain the same

while the lengths of the tack points are decreased.

The fabric created using yarn 13 has a small amount of patterning throughout. However, the addition of the white yarn into the input feedstock allows for a more random patterning throughout the fabric, making it less visually distracting. The fabric created using yarn 13 was woven at 11 picks per inch.

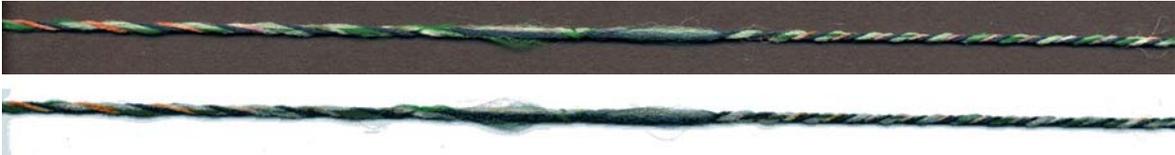


Figure 188: Yarn 14

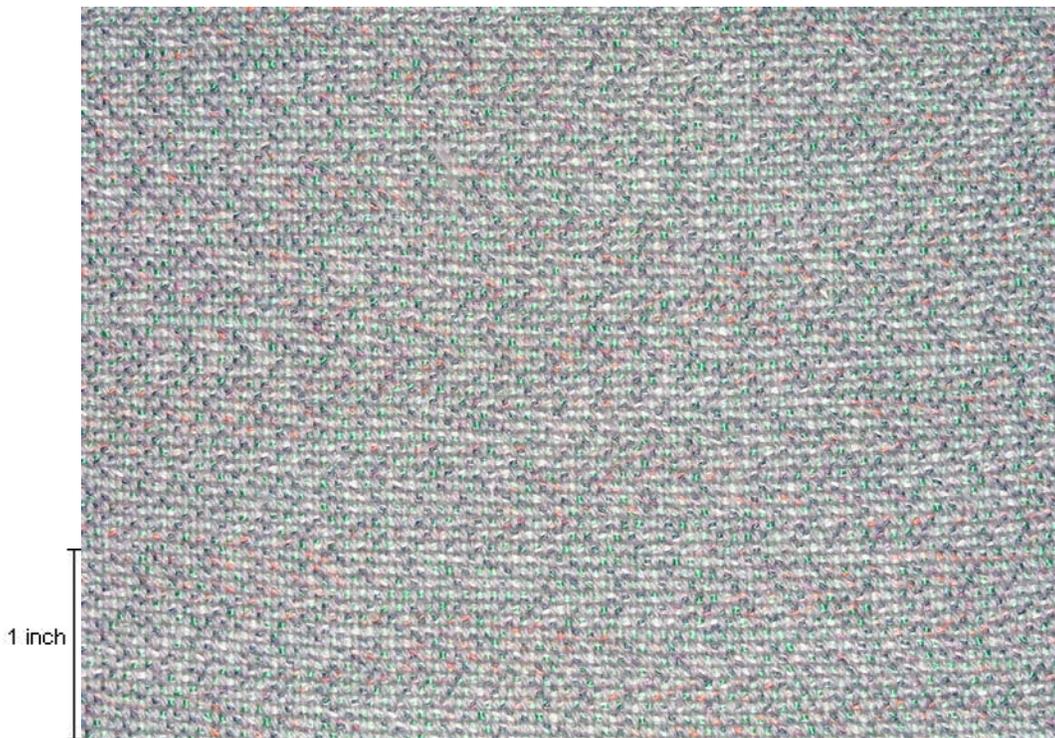


Figure 189: Fabric created using Yarn 14

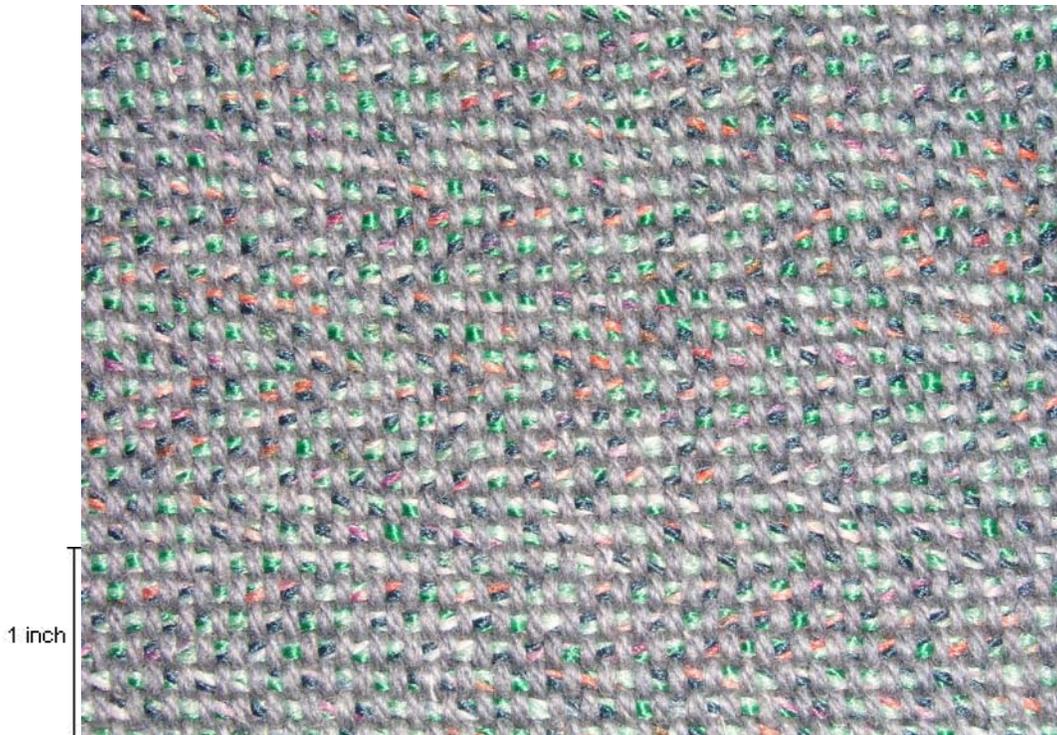


Figure 190: Detail of fabric created using Yarn 14

Yarn 14 is comprised of purple, navy, green, and space-dyed yarns. The twisted lengths in the yarn have remained at their previous length, while the lengths of the tack points have decreased slightly. All of the component yarns have similar diameters, creating a yarn where equal amounts of each color are visible.

The fabric created using yarn 14 has little visible patterning. This is mainly due to the space-dyed yarn used in the creation of yarn 14, similar to the fabric made with yarn 11. This fabric was woven at 11 picks per inch.



Figure 191: Yarn 15



Figure 192: Fabric created using Yarn 15



Figure 193: Detail of fabric created using Yarn 15

Yarn 15 was created using space-dyed, navy, and mint green yarns. The parameters were kept at the same values as yarn 14.

The fabric created using yarn 15 has no distracting patterning. This is due,

not only to the use of space-dyed yarn, but also to the use of colors similar in intensity to those in the space-dyed yarn. The fabric was woven at 11 picks per inch.

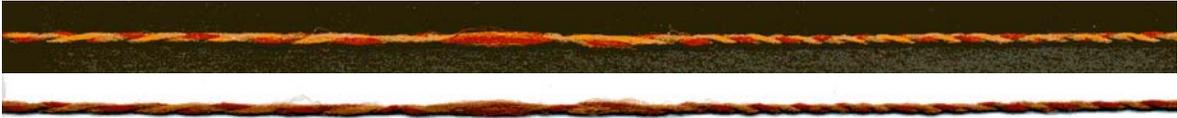


Figure 194: Yarn 16

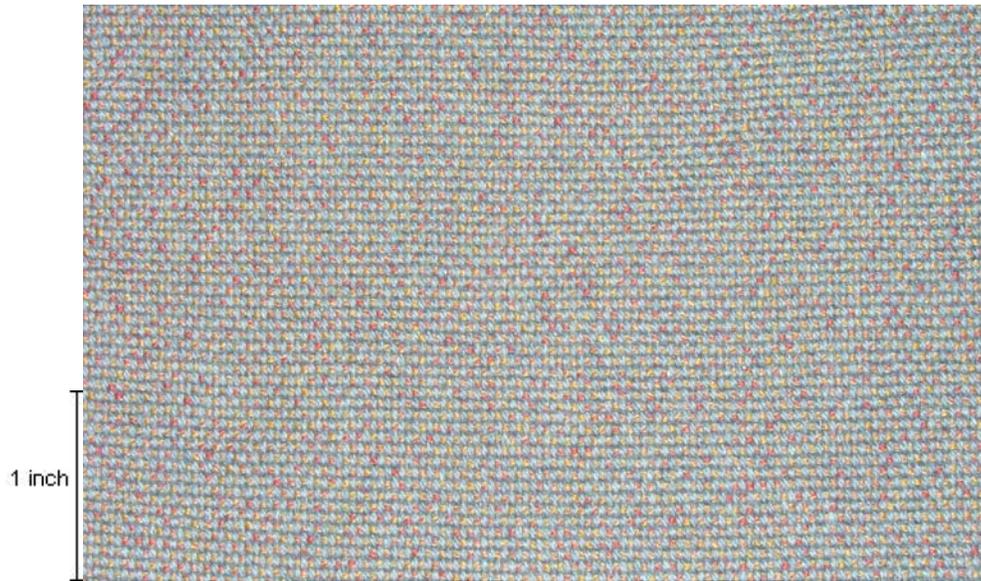


Figure 195: Fabric created using Yarn 16



Figure 196: Detail of fabric created using Yarn 16

Yarn 16 is created by combining red, camel, and mushroom yarns. The lengths of twist remain the same as yarn 15. The tack point length is increased. The diameters of the input yarns are similar, therefore showing equal amounts of each color throughout the yarn.

The fabric created using yarn 16 has no obvious patterning throughout. This is because yarn 16 is a visually balanced yarn, having equal amounts of each color displayed throughout it. Also, all of the colors chosen for the yarn are similar in value. The fabric was woven at 11 picks per inch.

5.1.3 Experiment Three

The input feedstocks for this experiment included three different yarns, one red, one white, and one camel colored. All of the fabrics created during experiment three were woven at 15 picks per inch and 16 ends per inch.



Figure 197: Yarn A



Figure 198: Fabric created using Yarn A

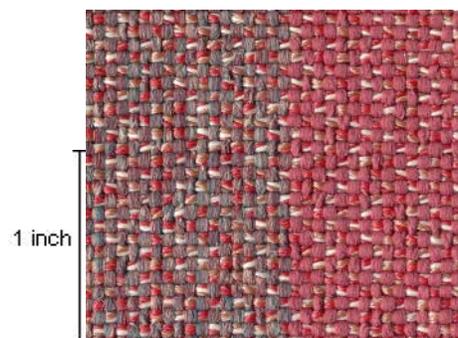


Figure 199: Detail of fabric created using Yarn A

Yarn A is an example of a yarn that has a long amount of twisted area with a small tack point. Because the tack point is so small, it appears very tight and secure.

Yarn A, along with all of the samples that follow were woven using plain weave construction. The warp used was a split warp that consisted of two colors of yarn, a spaced-dyed blue and rose colored yarn and a rose colored yarn. The warp yarns are synthetic air entangled yarns, and the weft is wholly made up of the samples created for this research. Each sample is woven at 16 ends per inch, but the picks per inch for each sample vary due each yarn's diameter.

The fabric created using yarn A, shown in Figure 198, does have an overall pattern, but it does not seem to have obvious motifs. The patterning is not as obvious on the left side of the fabric. This could be attributed to the fact that these warp yarns are space dyed, thereby adding more colors into the fabric than in the right side of the fabric. This addition of colors makes the patterning less obvious.



Figure 200: Yarn B

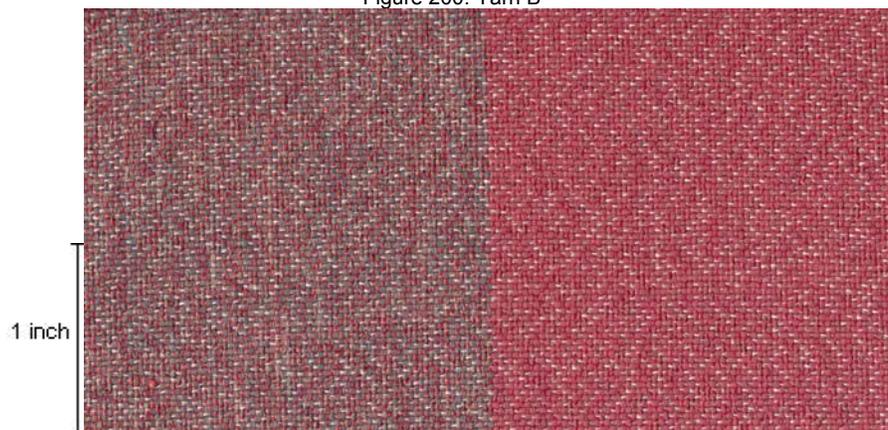


Figure 201: Fabric created using Yarn B

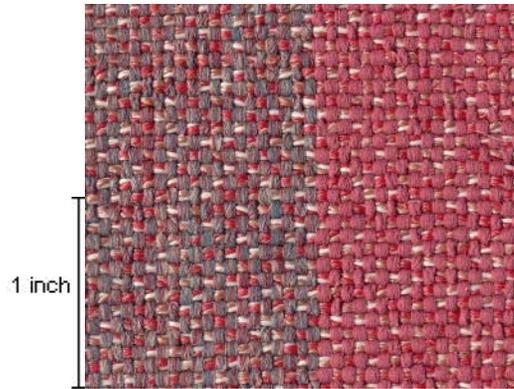


Figure 202: Detail of fabric created using Yarn B

Yarn B is similar to yarn A in that it has a much longer twisted area than tack point. The tack point also seems condensed like that in yarn A. The twisted areas have been slightly increased, but not enough to make a noticeable difference in the appearance of the yarn.

The patterning in this fabric samples is similar to that in Figure 198. The patterning is not a repeat pattern, and seems to lessen by viewed in combination with the space-dyed warp yarns.



Figure 203: Yarn C



Figure 204: Fabric created using Yarn C

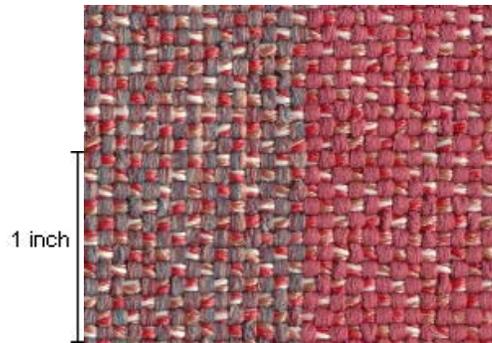


Figure 205: Detail of fabric created using Yarn C

Similar to the differences between yarn A and yarn B, the twisted areas in yarn C have been slightly increased while the tack point length has remained the same. While the differences between yarn B and yarn C are not visually obvious, the differences between yarn C and yarn A are noticeable. The tack point in yarn C does not seem as condensed secure.

The fabric shown in Figure 204 does not have a repeating patterning throughout the fabric. Unlike the previous two samples, though, the patterning is not lessened by the use of the space-dyed warp yarns; it merely represents two different color ways of the same fabric.



Figure 206: Yarn D

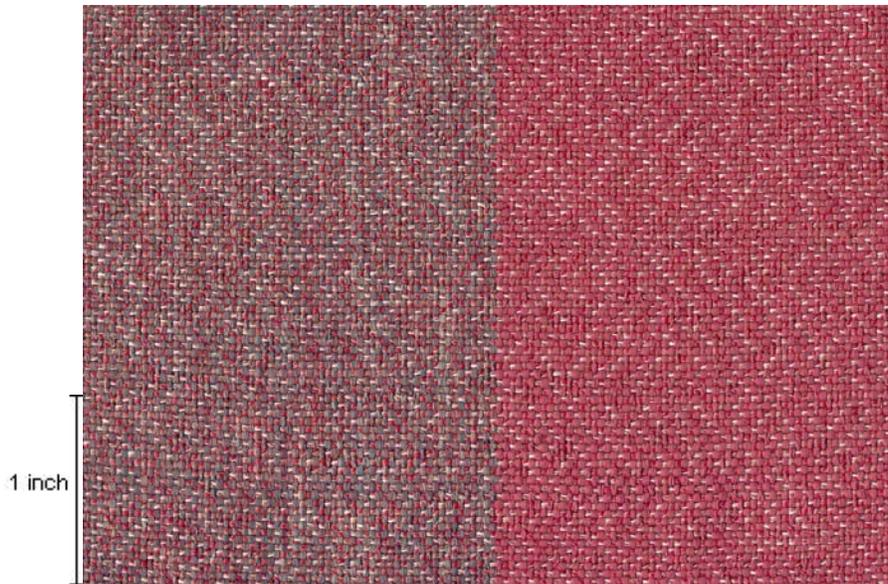


Figure 207: Fabric created using Yarn D

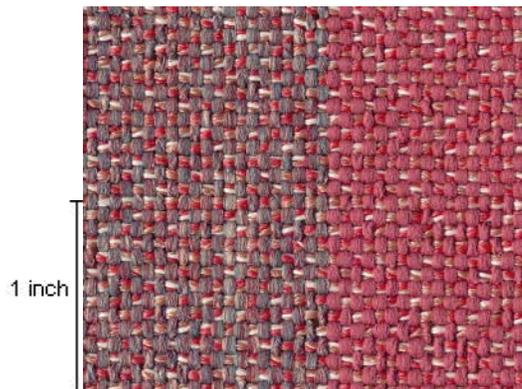


Figure 208: Detail of fabric created using Yarn D

The twisted sections in yarn D have been increased slightly relative to yarn C. In comparison to yarn A, the twisted sections have been almost doubled, but the tack point lengths remain the same. This increase, however, has no obvious effect on the appearance of the yarn.

The fabric shown in Figure 207 is similar to that created by yarn C. Like the previous fabric, the patterning is subtle, yet still present. Also, the patterning is not subdued by the use of the space-dyed yarns.



Figure 209: Yarn E

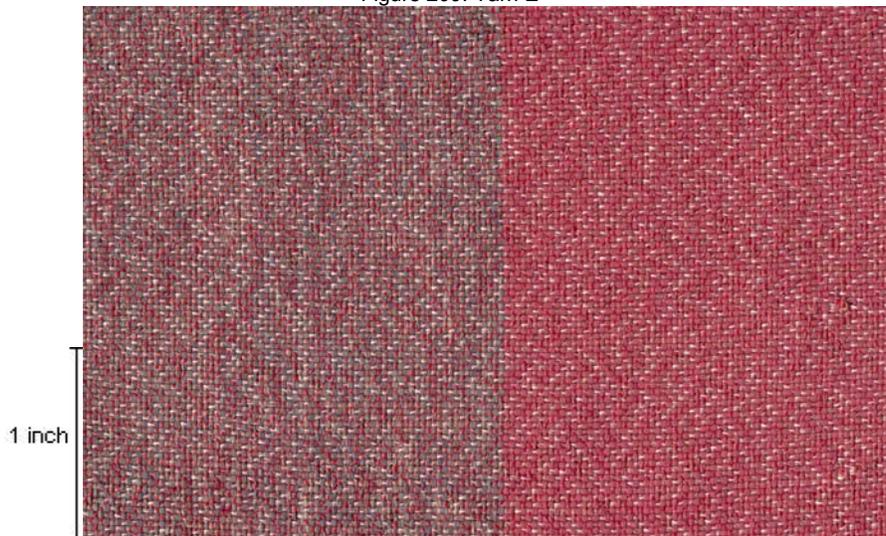


Figure 210: Fabric created using Yarn E

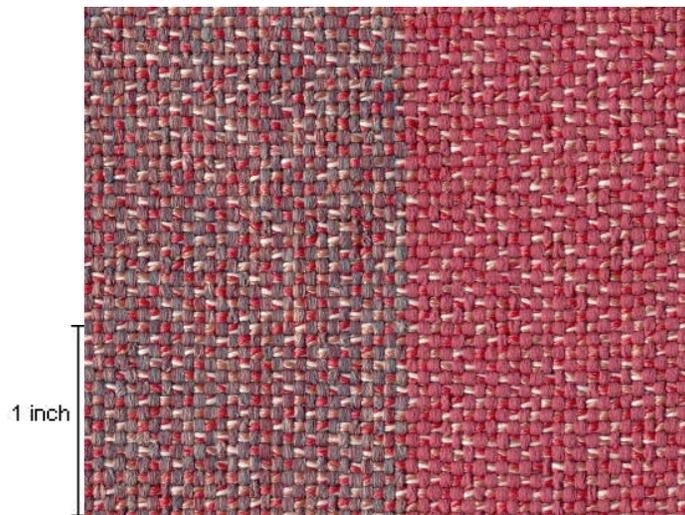


Figure 211: Detail of fabric created using Yarn E

The twisted sections in yarn E have been slightly increased. Relative to yarn A, the twisted lengths of the yarn have been doubled, while the tack point lengths have remained the same.

The fabric created by yarn E is similar to that created by yarn D. However, the patterning in this fabric, as shown in Figure 210, does begin to have some

more obvious zigzag patterning throughout. The use of the space-dyed yarn on the left side of the fabric does make the patterning more subtle.



Figure 212: Yarn F



Figure 213: Fabric created using Yarn F

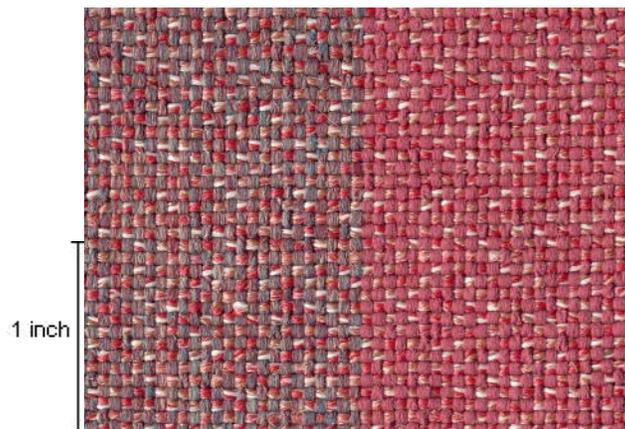


Figure 214: Detail of fabric created using Yarn F

The twisted sections in yarn F have been decreased, while the tack point lengths have been increased severely. Because of this, the tack points do not seem as condensed and secure.

The fabric created using yarn F actually has less patterning throughout than that shown in Figure 210. Similar to that shown in Figure 210, the left side of the fabric shows a more subdued patterning than the right.



Figure 215: Yarn G



Figure 216: Fabric created using Yarn G

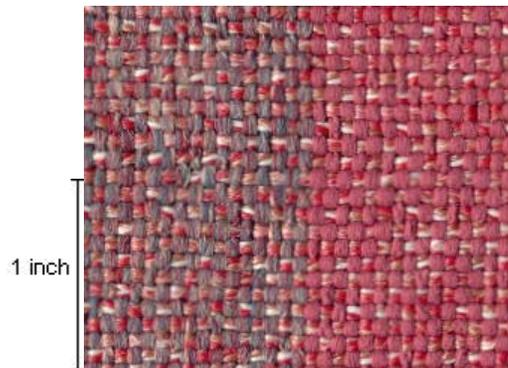


Figure 217: Detail of fabric created using Yarn G

The twisted sections in yarn G have been decreased by the same amount at which the tack points were increased. Due to these changes, the tack point lengths are now longer than the lengths of the twisted areas. These changes, however, do not have any obvious visual effects on the yarn.

The changes discussed do, however, affect the visual results of the fabric. The patterning in the fabric created by yarn G displays less patterning than that created by yarn F.



Figure 218: Yarn K

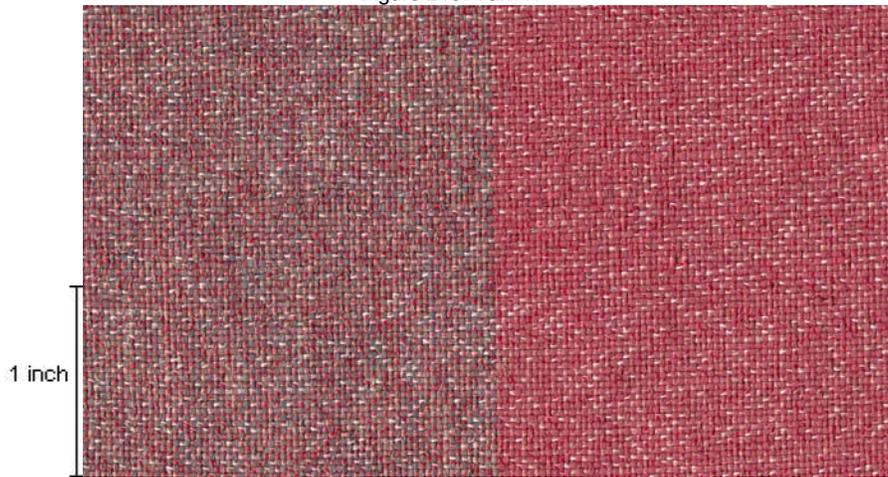


Figure 219: Fabric created using Yarn K

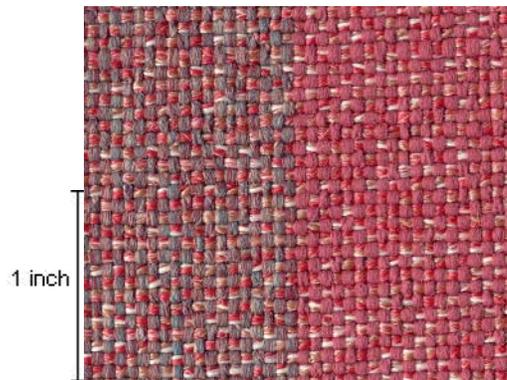


Figure 220: Detail of fabric created using Yarn K

The twisted areas in yarn K have been more than doubled in comparison to yarn G. The tack point lengths have been severely decreased. Other than these obvious differences, there is no visual effect on the yarn.

The patterning in the fabric shown in Figure 219 displays even less patterning than the shown in Figure 216. Both sides of the fabric show a marled, or heathered, effect.



Figure 221: Yarn L

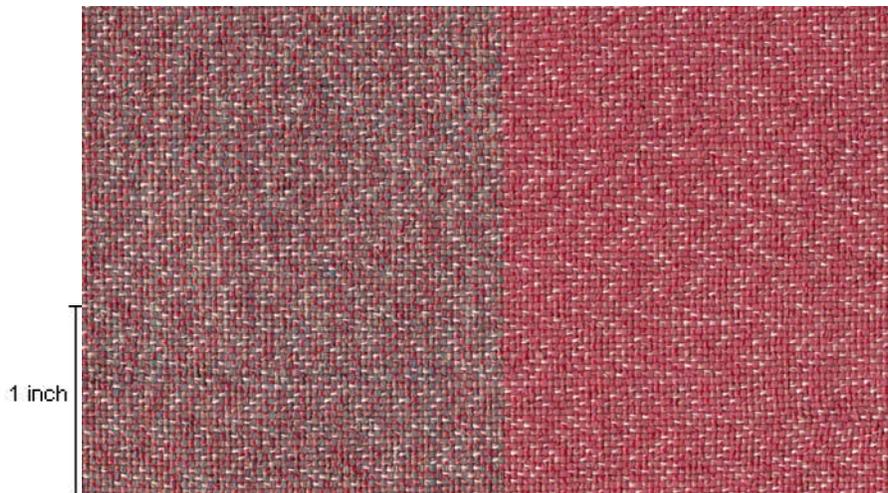


Figure 222: Fabric created using Yarn L

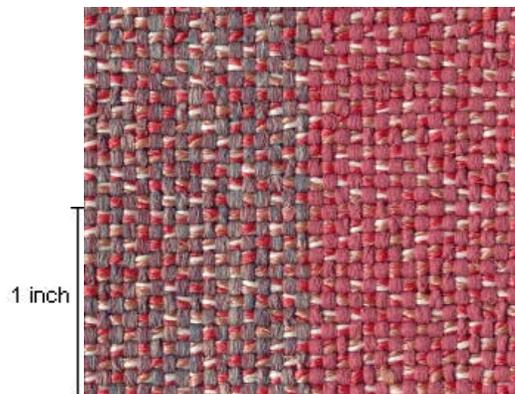


Figure 223: Detail of fabric created using Yarn L

The twisted areas of yarn L have remained the same length, while the tack point lengths have been increased. Given the minimal change in length, there is no obvious change in the appearance of the yarn.

The fabric shown in Figure 222 is the first in this set of samples to show a distinct zigzag patterning. However, similar to previous samples, the patterning is less obvious on the left side of the fabric than on the right due to the use of space dyed yarns in the warp.



Figure 224: Yarn M



Figure 225: Fabric created using Yarn M

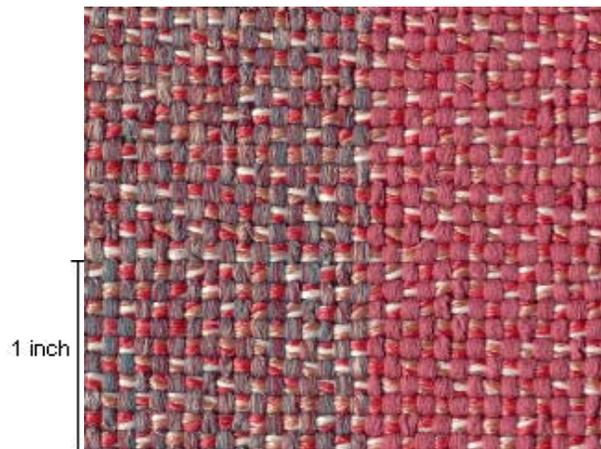


Figure 226: Detail of fabric created using Yarn M

The twisted regions of yarn in yarn M have remained the same length while the tack point lengths have been increased. These minimal changes have had no effect on the appearance of the yarns.

The fabric shown in Figure 225 does show a more distinct patterning than that in the previous sample. While the patterning on the right side of the fabric is only slightly more obvious, the patterning on the left side is much more distinct.



Figure 227: Yarn N



Figure 228: Fabric created using Yarn N

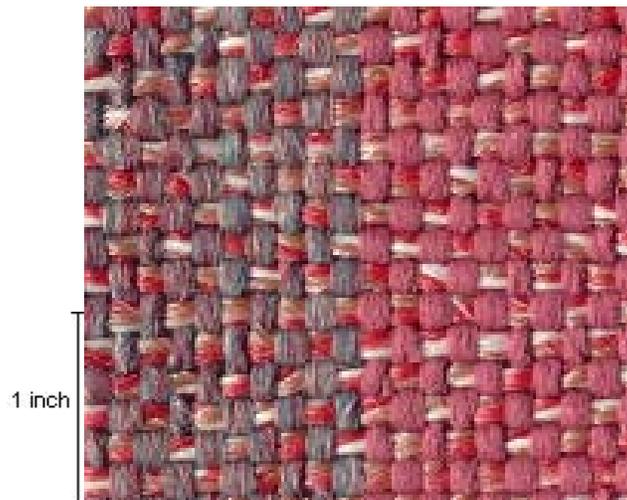


Figure 229: Detail of fabric created using Yarn N

Yarn N includes regions of tacked yarn that has been doubled in length, while the twisted regions remain the same length. These changes have no visual effect on the appearance of the yarn.

The appearance of the fabric shown in Figure 228 is similar to that shown in Figure 225. As stated above, the appearance of the yarn was not affected by the changes made, nor was the appearance of the fabric.

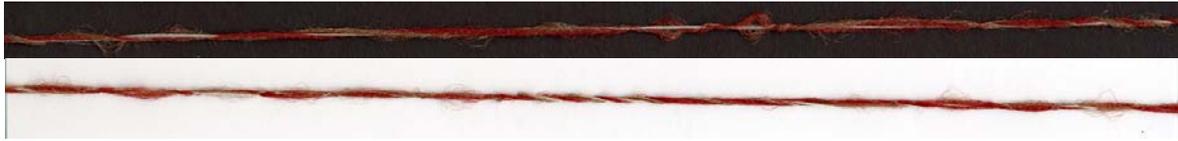


Figure 230: Yarn O



Figure 231: Fabric created using Yarn O

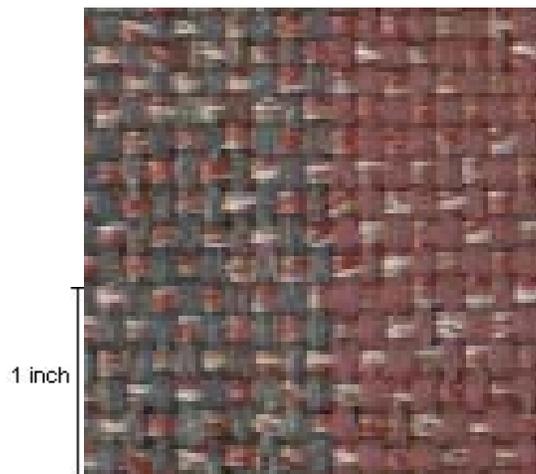


Figure 232: Detail of fabric created using Yarn O

Yarn O has regions of twisted and tacked yarn that are equal in length. While not affecting the appearance of the yarn, the changes in the lengths have allowed for a more balanced yarn to be created.

The fabric shown in Figure 231 does have distinct patterning, like that in the previous sample. This sample, however, begins to show horizontal bands as a

part of the patterning.

5.1.4 Experiment Four

The input feedstocks for this experiment included six different yarns: white, blue, red, gold, green, and brown. Samples beginning with the number 2 contain two yarns, beginning with 3 contain three yarns contain three; as the sample number increases, as do the number of input yarns in the resultant yarn.



Figure 233: Yarn 2-A



Figure 234: Fabric created using Yarn 2-A



Figure 235: Detail of fabric created using Yarn 2-A

Yarn 2-A is composed of red and brown input yarns. It has a relatively greater length of twisted area throughout the yarn than tack points. The tack point, having a short length, appears condensed and secure.

Yarn 1, along with all of the samples that follow were woven using plain weave construction. The warp used was a split warp that consisted of two colors

of yarn, a spaced-dyed blue and rose colored yarn and a rose colored yarn. The warp yarns are synthetic air entangled yarns, and the weft is wholly made up of the samples created for this research. Each sample is woven at 16 ends per inch, but the picks per inch for each sample vary due each yarn's diameter.

The fabric created by Yarn 2-A does not show any amount of patterning on either side of the fabric. This is most likely due to the fact that the red yarn used to create yarn 2-A is similar in color to the rose colored yarn used in the warp. This same rose color is also present in the space-dyed yarn. The fabric was woven at 15 picks per inch.



Figure 236: Yarn 2-B

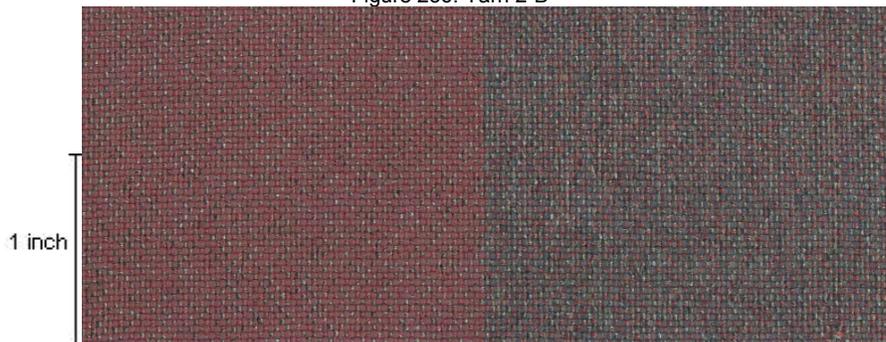


Figure 237: Fabric created using Yarn 2-B

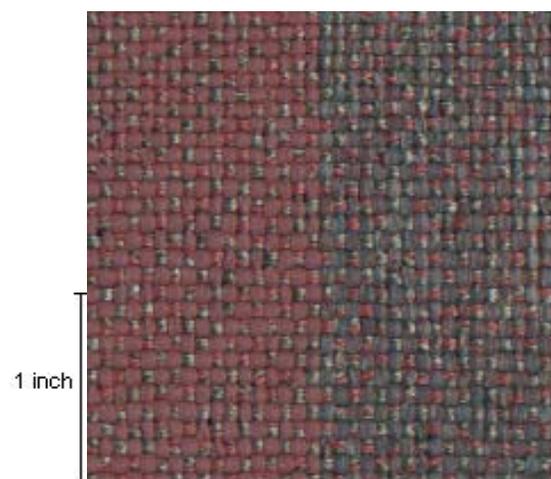


Figure 238: Detail of fabric created using Yarn 2-B

This yarn has similar tack point lengths while the twisted areas have been increased slightly. Due to the slight change in value in the twisted length, the effect on the appearance of the yarn is negligible.

The fabric shown in Figure 237 does not contain an obvious amount of patterning. This is most likely because of the same reason discussed above, as it pertains to yarn 2-A. The fabric was woven at 15 picks per inch.



Figure 239: Yarn 2-C

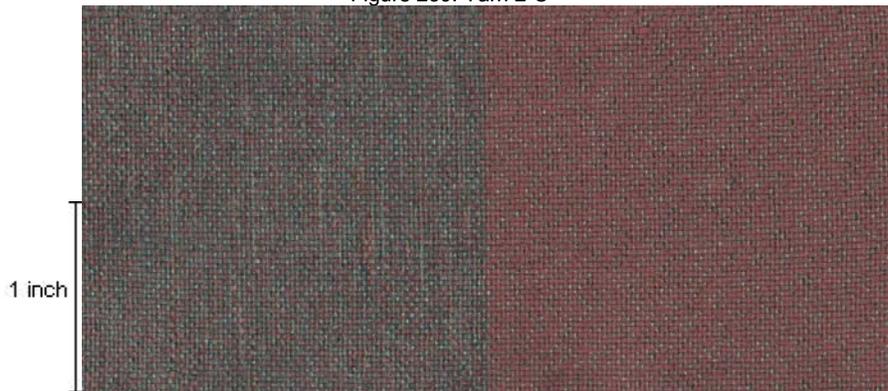


Figure 240: Fabric created using Yarn 2-C

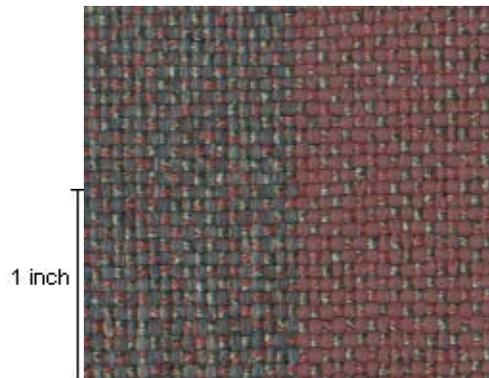


Figure 241: Detail of fabric created using Yarn 2-C

Yarn 2-C has similar tack point lengths, while the twisted areas have been slightly increased. While the change in length of twisted areas is slight, the tack point does not seem as condensed and the number of twist per inch seems to be

smaller.

The fabric created using yarn 2-C, like the first two fabrics created for this experiment, does not contain an obvious amount of patterning. The fabric was woven at 15 picks per inch.



Figure 242: Yarn 2-D



Figure 243: Fabric created using Yarn 2-D

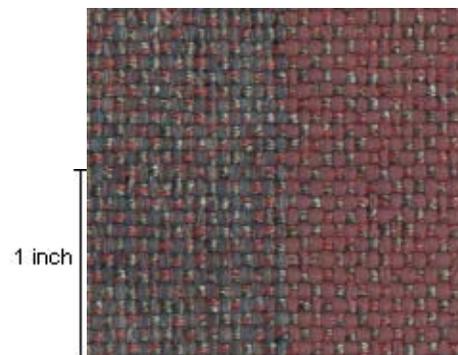


Figure 244: Detail of fabric created using Yarn 2-D

The length of the tack points in this yarn are the same as the previous three samples. The length of the twisted portions of the yarn, however, has increased to be double that of yarn 2-A. Regardless of the large change in this variable from the first sample, there is no obvious effect on the appearance of the yarn.

In the fabric shown in Figure 243, there is almost no patterning present. This is most likely due to the choice of colors in the warp yarns. The fabric

created using yarn 2-D was woven using 15 picks per inch.



Figure 245: Yarn 2-E



Figure 246: Fabric created using Yarn 2-E

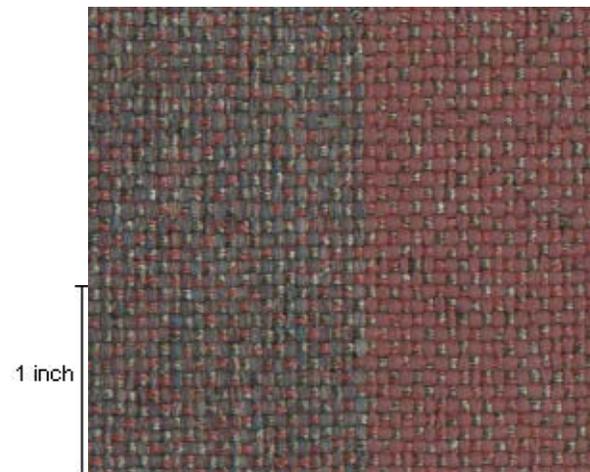


Figure 247: Detail of fabric created using Yarn 2-E

Yarn 2-E has twisted portions of yarn that are the same length as the previous sample. The tack point lengths in this yarn have been increased slightly from that of the previous sample. This slight change has had no large visual effect on the yarn.

The fabric created using yarn 2-E does contain a small amount of patterning. It is barely visible on the right side of the fabric, but the space-dyed

yarn used on the left side of the fabrics subdues the patterning. The fabric was woven at 15 picks per inch.

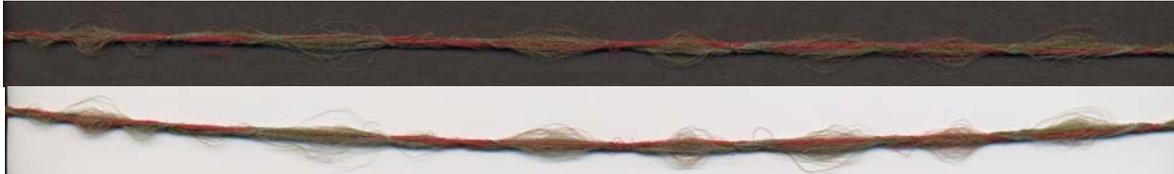


Figure 248: Yarn 2-F



Figure 249: Fabric created using Yarn 2-F

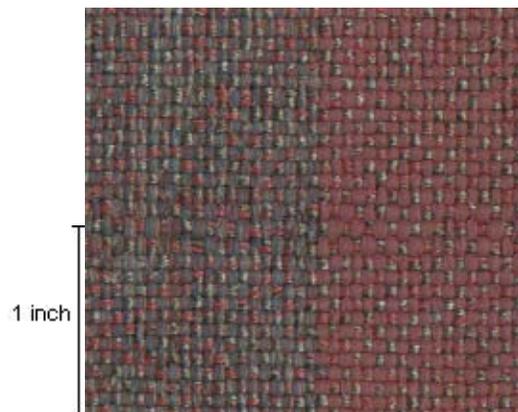


Figure 250: Detail of fabric created using Yarn 2-F

This yarn has increased length of tack point areas, while still keeping the same length of twisted areas. The change in length of tack points give the appearance of appearing more regularly throughout the length of the yarn.

There is very little patterning shown in the fabric created by yarn 2-F. While it is barely visible on the right side of the fabric, the left side of the fabric contains no patterning. The fabric was woven at 15 picks per inch.



Figure 251: Yarn 2-G



Figure 252: Fabric created using Yarn 2-G

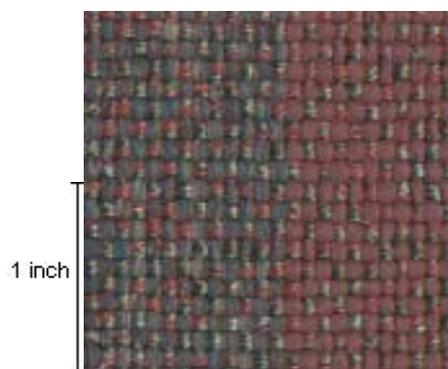


Figure 253: Detail of fabric created using Yarn 2-G

Yarn 2-G has similar twisted lengths, but the tack point lengths have doubled from that of the previous sample. The tack points in this sample, while the length of area is lengthened, seem more spread out and less regular than in the previous area.

The fabric shown in Figure 253 shows a small amount of irregular patterning. There is no obvious motif throughout the fabric, and the patterning is only evident on the right side of the fabric. The fabric was woven at 15 picks per inch.

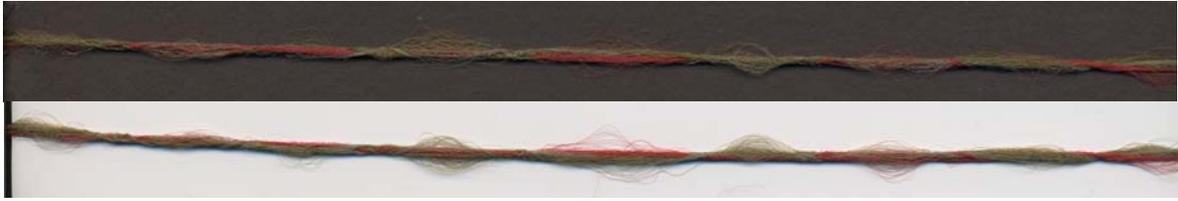


Figure 254: Yarn 2-H



Figure 255: Fabric created using Yarn 2-H

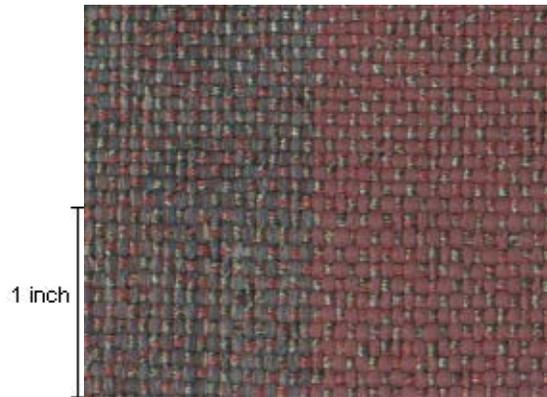


Figure 256: Detail of fabric created using Yarn 2-H

This yarn has increased length in the tack point area. The change, while not severe, is enough to increase the length of the tack point areas to be equal to that of the twisted sections. This equality results in a balanced yarn.

There is very little patterning visible in the fabric created by yarn 2-H. The patterning is more visible on the left side of the fabric, but is still not as distinct as the patterning previously seen in experiments 1,2, and 3. The fabric was woven at 15 picks per inch.



Figure 257: Yarn 3-A



Figure 258: Fabric created using Yarn 3-A

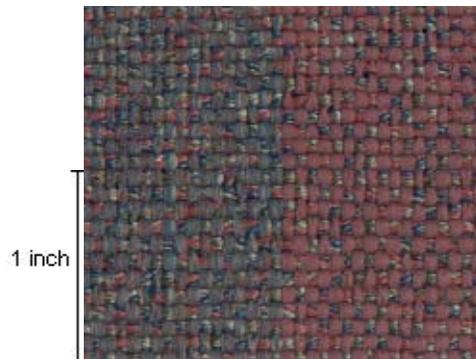


Figure 259: Detail of fabric created using Yarn 3-A

Yarn 3-A exhibits similar parameters to that of yarn 2-A, the difference being that a navy blue yarn was added to the feedstock for this and the seven following yarns. While this yarn resembles yarn 2-A in parameter values, the addition of the blue yarn makes the tack point not seem as compressed and tightly entangled.

The fabric created using yarn 3-A shows a very small amount of patterning. This is most likely due to the navy yarn that has been added to the feedstock for this sample set of yarns. The patterning is more visible on the right side of the

fabric than on the left. This is due to the large amount of blue within the warp yarns on the left side of the fabric. The fabric was woven at 12 picks per inch.



Figure 260: Yarn 3-B



Figure 261: Fabric created using Yarn 3-B

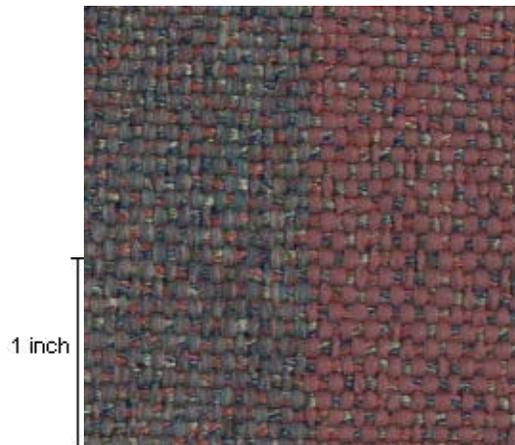


Figure 262: Detail of fabric created using Yarn 3-B

Yarn 3-B has similar tack point lengths to the previous sample. The twisted areas of yarns have been increased slightly. While the change occurred in the twisted lengths, the tack points seem longer. This is most likely due to the fact that the same amount of pressure is used to insert these tack points as is used to

insert tack points in the yarns that only have two input feedstock yarns.

The fabric shown in Figure 261 has very little patterning shown on the right side. The left side shows even less patterning due to the space dyed yarn used in the warp. The fabric was woven at 12 picks per inch.



Figure 263: Yarn 3-C



Figure 264: Fabric created using Yarn 3-C

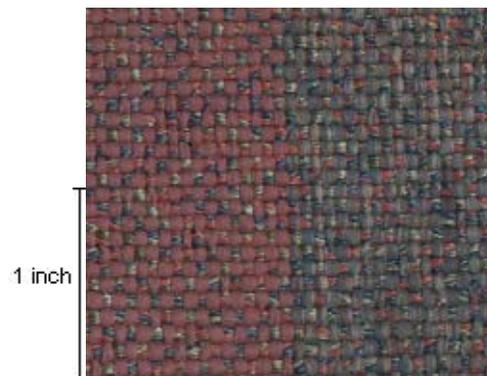


Figure 265: Detail of fabric created using Yarn 3-C

Yarn 3 has tack points throughout the yarn which are similar in length to that of the previous sample. The twisted regions have increased slightly in length. This change has no visual effect on the resultant yarn.

The fabric shown in Figure 264 does contain zigzag patterning throughout the fabric. This is mostly obvious on the right side of the fabric because of the

contrast between the navy yarn and the rose colored warp yarns. The fabric created using yarn 3-C was woven at 12 picks per inch.

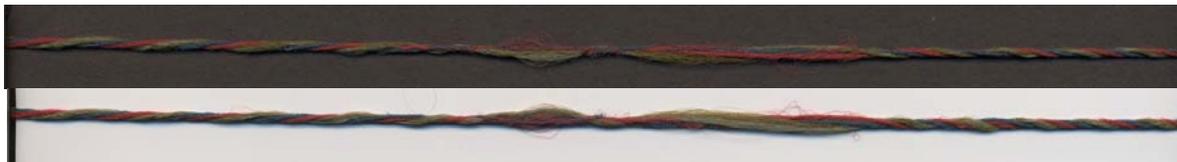


Figure 266: Yarn 3-D



Figure 267: Fabric created using Yarn 3-D

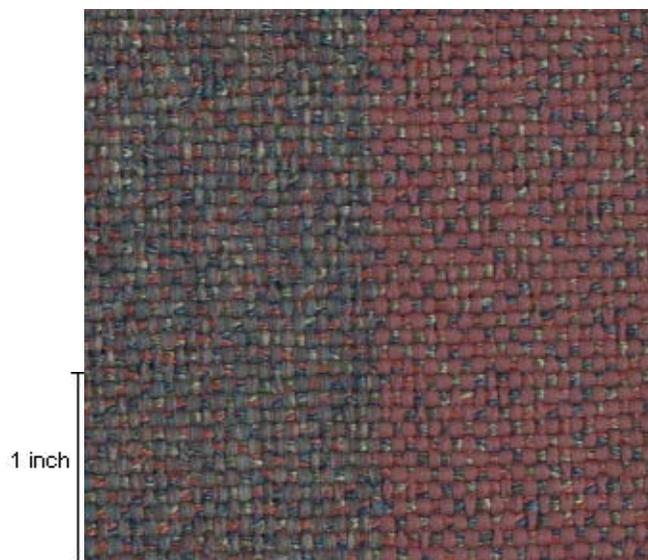


Figure 268: Detail of fabric created using Yarn 3-D

This yarn, while have an increased length of twisted area, appears the

same, visually, as the previous yarn.

Similar to the likeness of the yarns, the fabrics produced by yarns 3-C and 3-D are similar in the respect that the zigzag patterning is evident on the right side of the fabric, rather than on the left. The fabric was woven at 12 picks per inch.



Figure 269: Yarn 3-E



Figure 270: Fabric created using Yarn 3-E

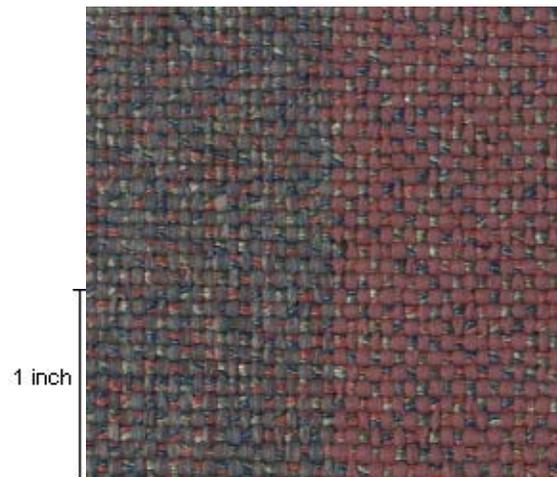


Figure 271: Detail of fabric created using Yarn 3-E

This yarn, while having a similar length of twisted area, has an increased length of tack points. Considering this increase, the tack points in this yarn seem to be more compact and more tightly entangled.

The patterning shown in the fabric in Figure 270 is very subtle. While barely visible on the right side of the fabric, the blue in the left warp yarns obliterate any patterning. The fabric was woven at 12 picks per inch.



Figure 272: Yarn 3-F

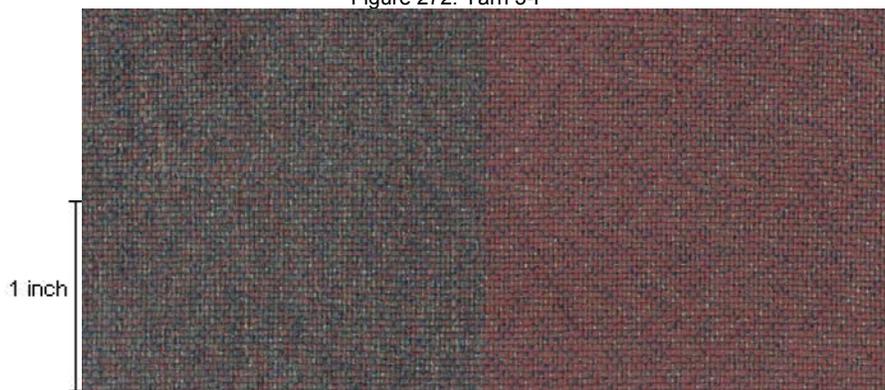


Figure 273: Fabric created using Yarn 3-F

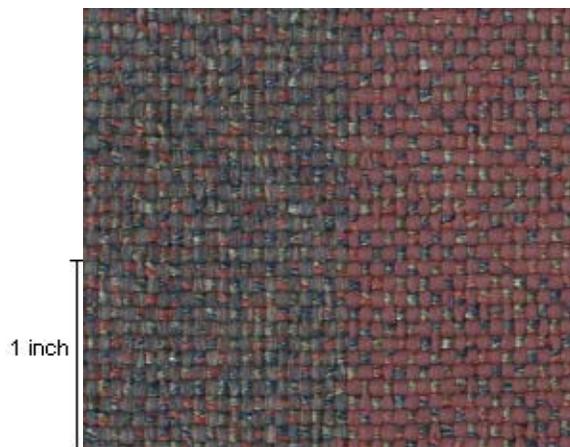


Figure 274: Detail of fabric created using Yarn 3-F

While the twisted lengths of yarn are the same, the lengths of tack points have been increased greatly. For this reason, the density of the tack points seem less; they seem less compact and less tightly entangled.

There is some visual patterning in the fabric displayed in Figure 273. It is visible on each side of the fabric, but most obvious on the right side. The fabric

was woven at 12 picks per inch.



Figure 275: Yarn 3-G



Figure 276: Fabric created using Yarn 3-G

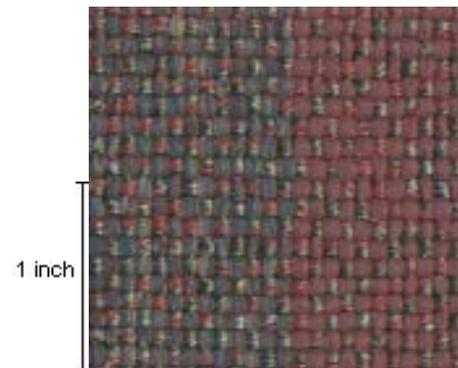


Figure 277: Detail of fabric created using Yarn 3-G

This yarn is similar to the previous in the aspect that the density of tack points seems lower than previous samples. The length of the tack point regions has increased while the length of twisted yarn has remained the same.

The patterning shown in the fabric in Figure 275 is obvious on the right side. While not as obvious on the left side, the patterning is visible. The fabric was woven at 12 picks per inch.



Figure 278: Yarn 3-H



Figure 279: Fabric created using Yarn 3-H

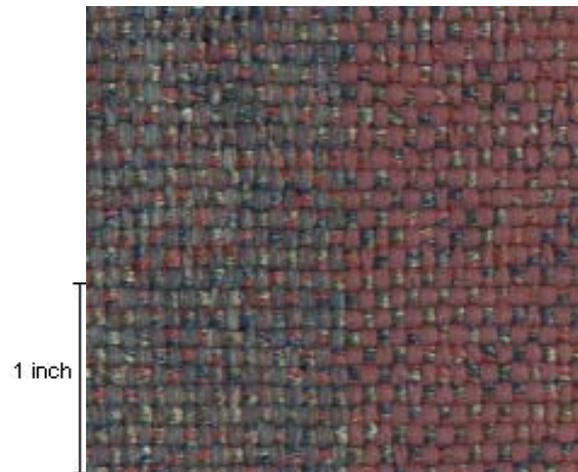


Figure 280: Detail of fabric created using Yarn 3-H

This yarn has equal lengths of tack points and twisted areas, therefore being balanced. Given that the tack point lengths are so great, the density of the tack points throughout this length is low. This creates a tacked area of yarn that looks loose and less compact.

The fabric created using yarn 3-H shows a small amount of patterning on the right side of the fabric. It was woven at 12 picks per inch.



Figure 281: Yarn 4-A

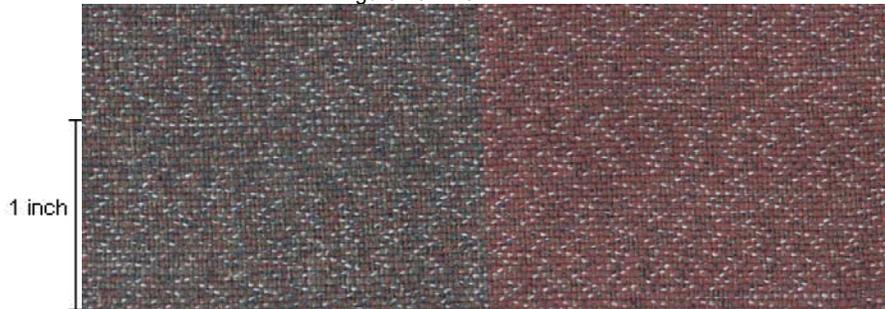


Figure 282: Fabric created using Yarn 4-A

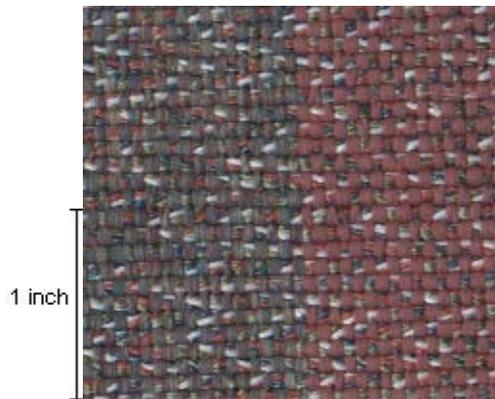


Figure 283: Detail of fabric created using Yarn 4-A

Yarn 4-A was created with the same parameters as yarns 2-A and 3-A. The twisted lengths of yarn are much larger than the tack point lengths of yarn. Similar to yarn 3-A, the addition of the white input feedstock yarn has decreased the density of the tack point.

The addition of the white yarn into the input feedstock makes the patterning throughout the fabric shown in Figure 282 immediately visible. While there is no obvious motif throughout the fabric, the patterning is visible on each side of the fabric. The fabric created using yarn 4-A was woven at 11 picks per inch.

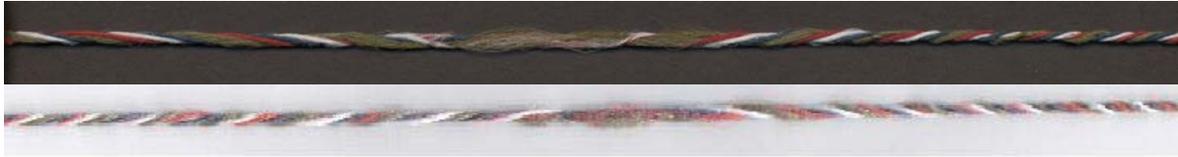


Figure 284: Yarn 4-B

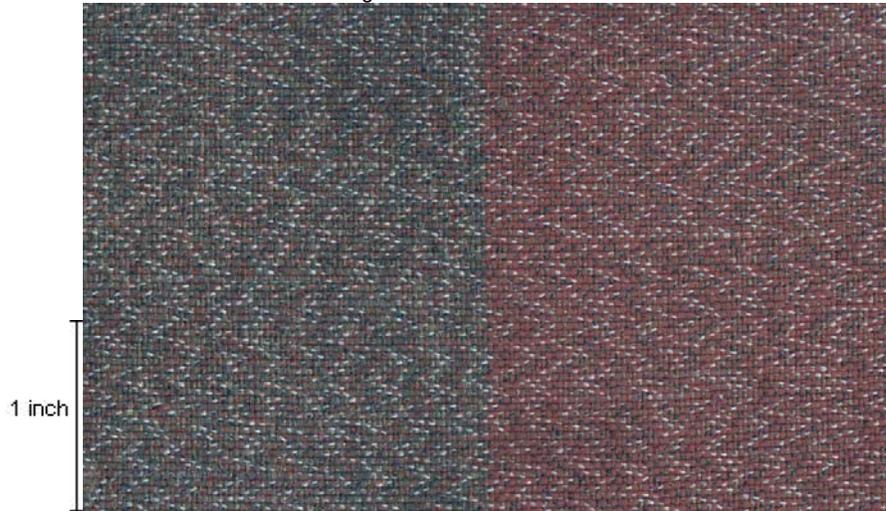


Figure 285: Fabric created using Yarn 4-B

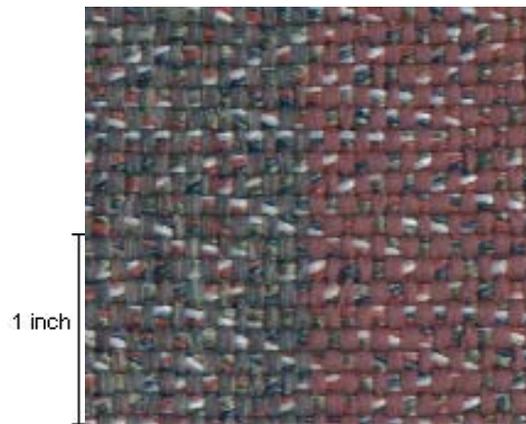


Figure 286: Detail of fabric created using Yarn 4-B

Yarn 4-B has the same lengths of tack point area as the previous yarn, while the twisted lengths are slightly increased. This change in twist length does not have an apparent effect on the appearance of the yarn.

The fabric shown in Figure 285 shows severe patterning on both sides of the fabric. This is most likely due to the high contrast of the white input yarn used to create the yarns in the fourth sample set in relation to the warp yarns used. The

fabric was woven at 11 picks per inch.

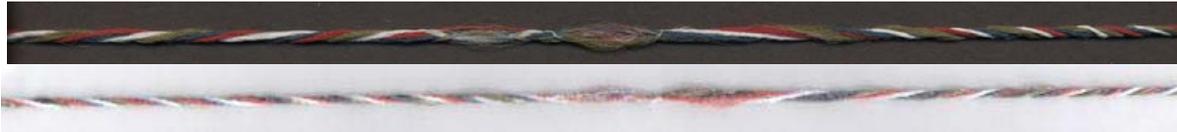


Figure 287: Yarn 4-C

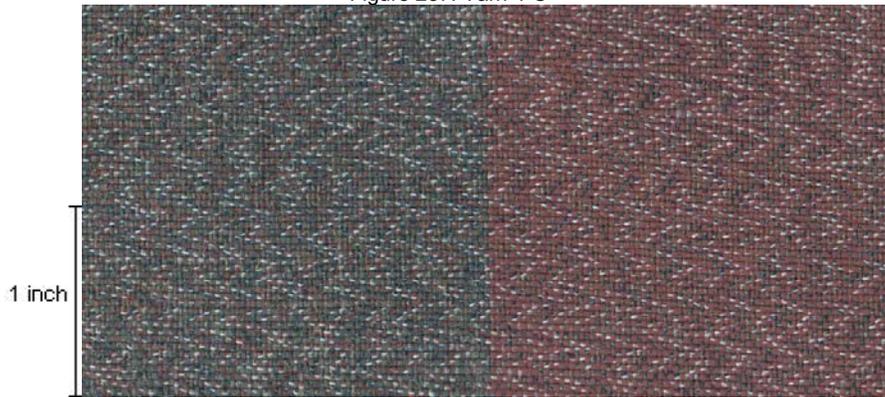


Figure 288: Fabric created using Yarn 4-C

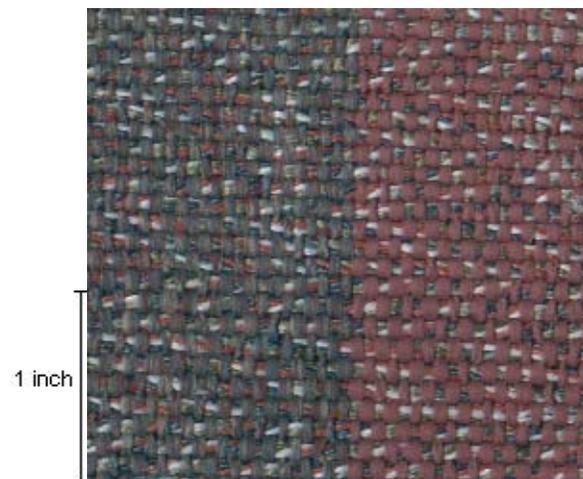


Figure 289: Detail of fabric created using Yarn 4-C

The twisted length of this yarn is increased while the tack point length remains the same. This subtle change, like the one in the previous yarn, does not have a noticeable effect on the appearance of the yarn.

The fabric created using yarn 4-C contains patterning on each side of the fabric. It consists of vertical zigzags covering the entire fabric. The fabric was woven at 11 picks per inch.



Figure 290: Yarn 4-D



Figure 291: Fabric created using Yarn 4-D

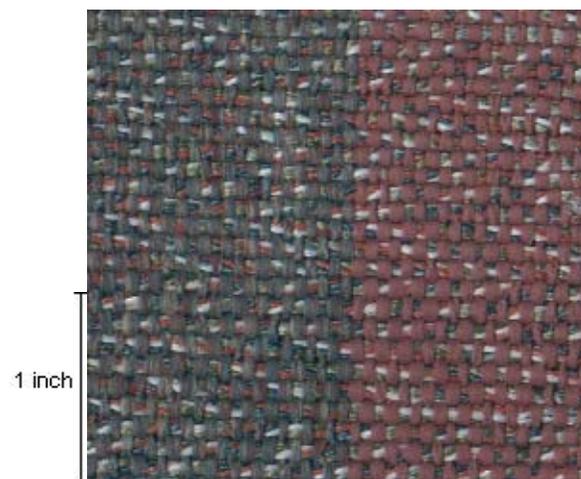


Figure 292: Detail of fabric created using Yarn 4-D

This yarn, like the previous three yarns, has similar tack point lengths with a much greater twisted length of yarn. This yarn, like its predecessors does not exhibit a visual change in relation to its changing parameters.

The fabric created by yarn 4-D is similar to the other yarns created in the fourth sample set. This fabric, like the others in this sample set shows very distinct

patterning throughout the entirety of the fabric. It was woven at 11 picks per inch.



Figure 293: Yarn 4-E

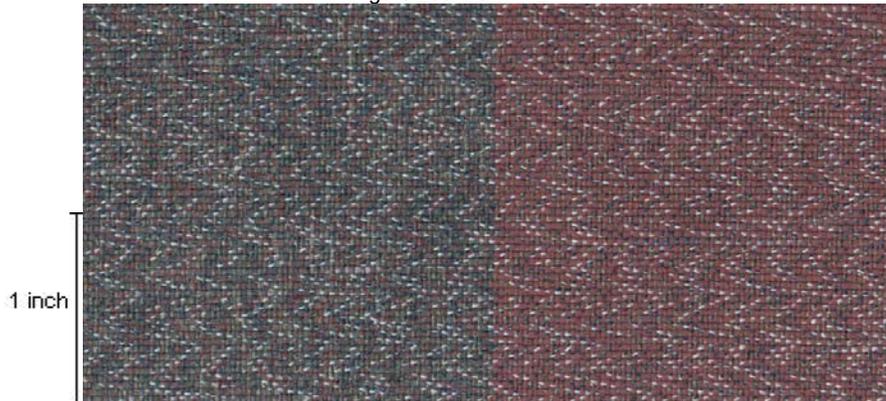


Figure 294: Fabric created using Yarn 4-E

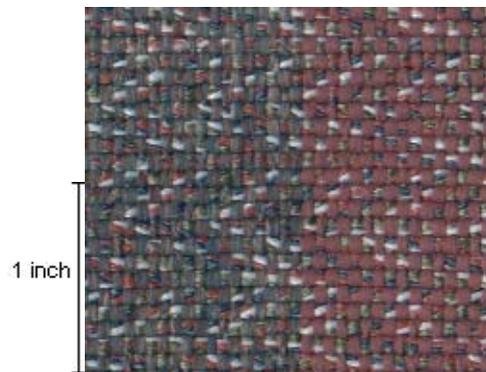


Figure 295: Detail of fabric created using Yarn 4-E

The twisted lengths of yarn 4-E remain the same as the previous yarn, while the tack point regions of the yarn have more than doubled in length. Aside from the obvious additional length to the tack point region, the actual appearance of the yarn remains unchanged.

The fabric shown in Figure 294 contains very obvious zigzag patterning throughout both sides. It was woven at 11 picks per inch.



Figure 296: Yarn 4-F



Figure 297: Fabric created using Yarn 4-F

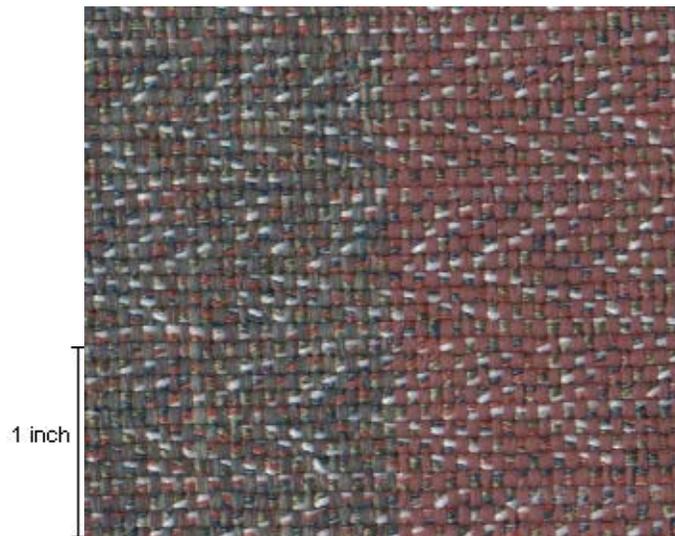


Figure 298: Detail of fabric created using Yarn 4-F

The tack point lengths for this yarn have been increased, while the lengths of the twisted regions have remained the same. This creates tack points that do not seem to be as stable, and seem to be less dense.

The fabric shown in Figure 287 has severe patterning throughout, along with vague horizontal bands across the width of the fabric. It was woven at 11 picks per inch.



Figure 299: Yarn 4-G

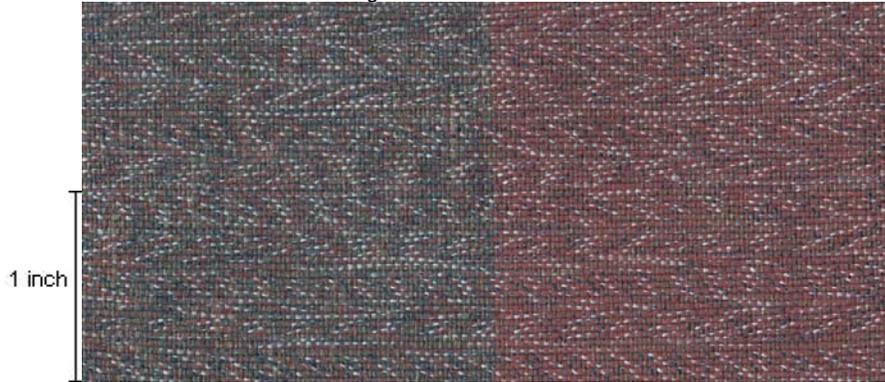


Figure 300: Fabric created using Yarn 4-G

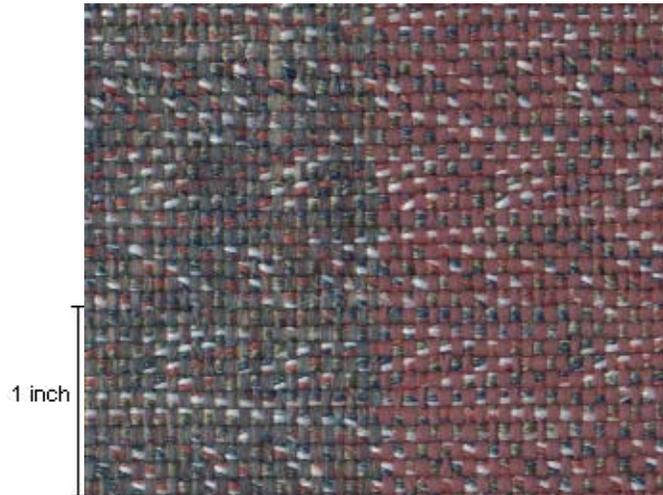


Figure 301: Detail of fabric created using Yarn 4-G

The tack point lengths of this yarn are double that of the previous yarn and the twisted regions remain the same length. While the change in the tack point lengths is extreme, the effect on the appearance of the yarn is negligible.

The fabric shown in Figure 300 has obvious patterning throughout the width of the fabric. In this sample, however, the horizontal bands across the width of the fabric are becoming more prominent. The fabric in Figure 300 was woven at 11 picks per inch.

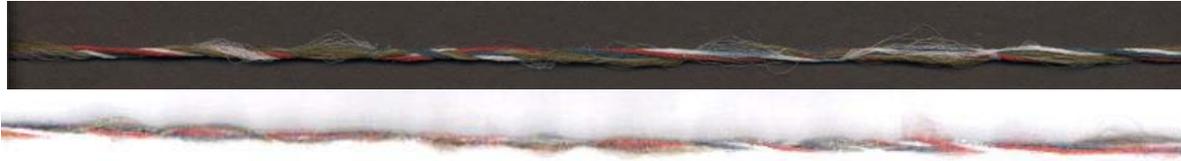


Figure 302: Yarn 4-H



Figure 303: Fabric created using Yarn 4-H

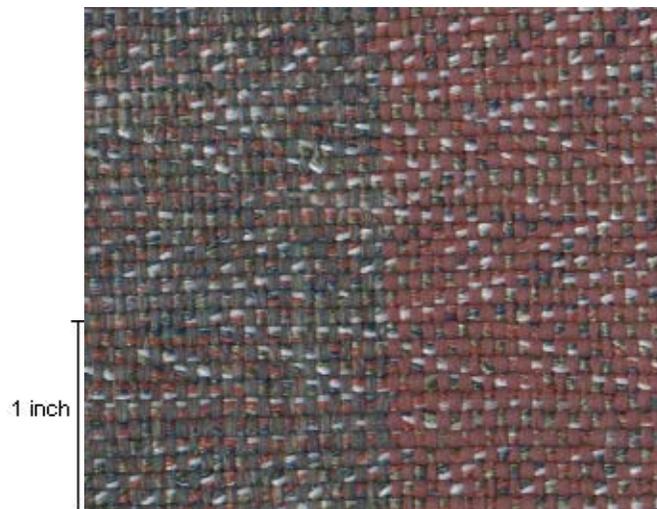


Figure 304: Detail of fabric created using Yarn 4-H

Yarn 4-H was created by manipulating the parameters so that the lengths of the tack points and twisted areas are equal. Because of this, the yarn is balanced. Also, because the length of the tack point is greater than its usual value, the tack point seems loose and less dense than previous yarns.

The fabric created using yarn 4-H contains distinct patterning across its width. The increased length of tack points within yarn 4-H creates horizontal

bands across the width of the fabric. The fabric was woven at 11 picks per inch.

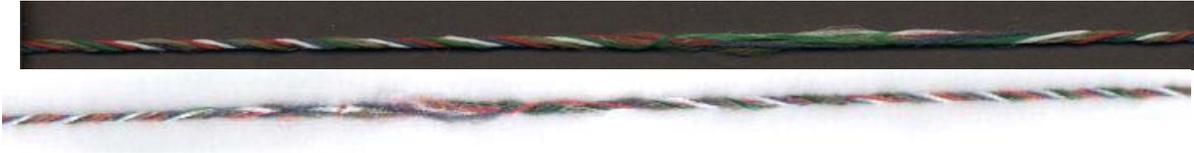


Figure 305: Yarn 5-A

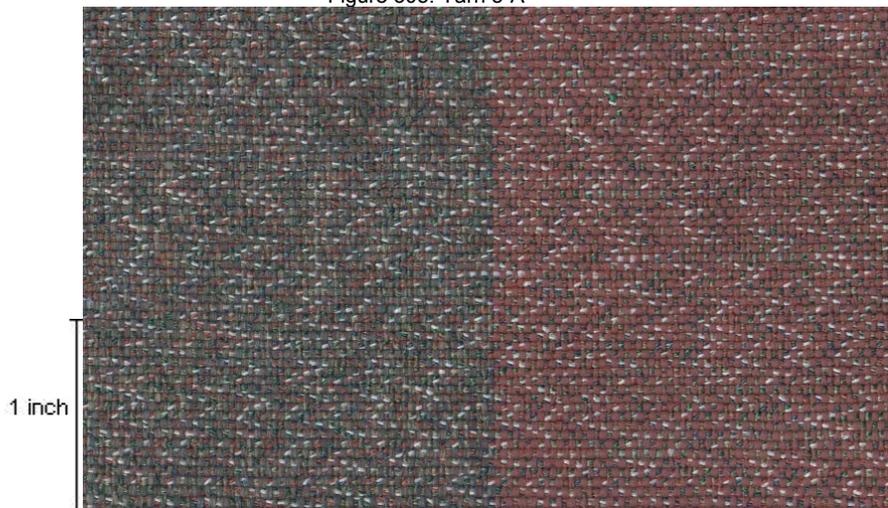


Figure 306: Fabric created using Yarn 5-A



Figure 307: Detail of fabric created using Yarn 5-A

This yarn, like the other first yarns in each sample set, has twisted lengths of yarn that is much larger than tack point lengths. Also like the previous yarns, the addition of the green yarn lends to a less compact and secure tack point.

The fabric shown in Figure 306 shows extreme patterning, though it is not quite reached the severity of zigzag patterning yet. The patterning is similar on both sides of the fabric. It seems that the addition of the green yarn into the feedstock has a negligible effect on the appearance of the fabric. The fabric shown in Figure 306 was woven at 11 picks per inch.

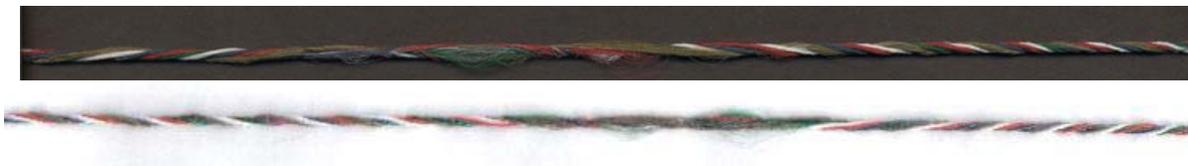


Figure 308: Yarn 5-B



Figure 309: Fabric created using Yarn 5-B

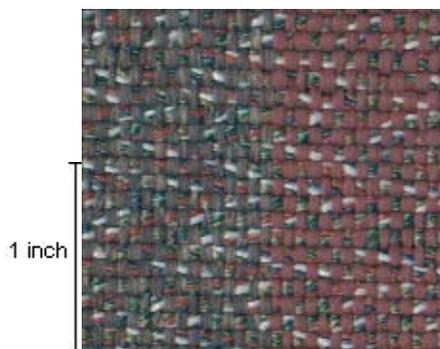


Figure 310: Detail of fabric created using Yarn 5-B

The length of twisted yarn has been increased in yarn 5-B, while the tack point remains the same length. The increase in the length of twisted area, however, has a negligible effect on the appearance of the yarn.

The fabric created using yarn 5-B has severe zigzag patterning throughout both sides of the fabric. It was woven at 11 picks per inch.

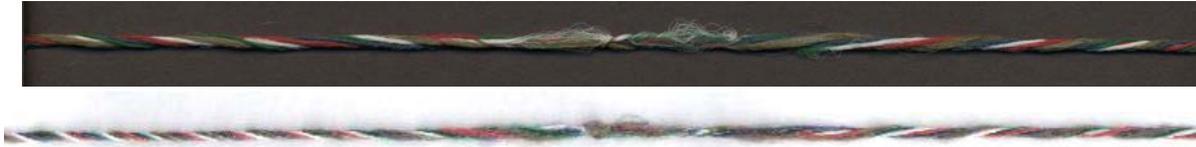


Figure 311: Yarn 5-C



Figure 312: Fabric created using Yarn 5-C

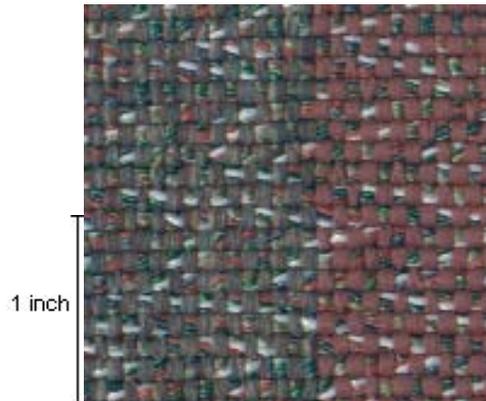


Figure 313: Detail of fabric created using Yarn 5-C

The length of twisted area in yarn 5-C has increased and the length of the tack point has remained the same. Because the length of the twisted regions of yarn has lengthened, the amount of twist per inch has been decreased.

The fabric shown in Figure 312, like the previous fabric displays severe zigzag patterning throughout. It was also woven at 11 picks per inch.

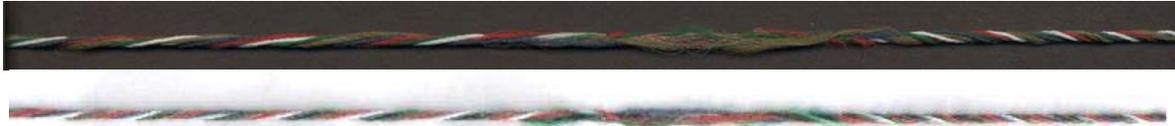


Figure 314: Yarn 5-D



Figure 315: Fabric created using Yarn 5-D

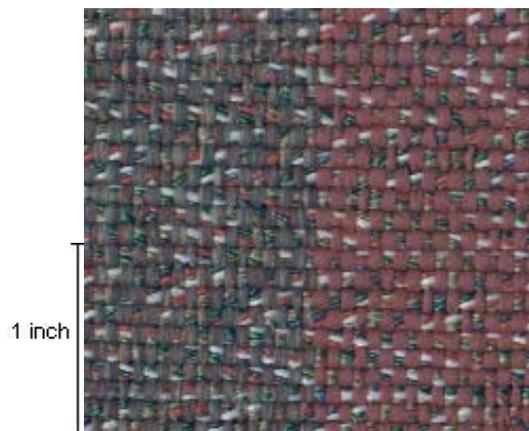


Figure 316: Detail of fabric created using Yarn 5-D

The length of twisted area in yarn 5-D is much larger than the length of tack points in the yarn. While the length of twisted region has been increased, the effect on the appearance of the yarn is negligible.

The patterning shown in the fabric created by yarn 5-D is extreme throughout. While zigzags are still apparent in this fabric, they are starting to turn into horizontal lines. The fabric was woven at 11 picks per inch.

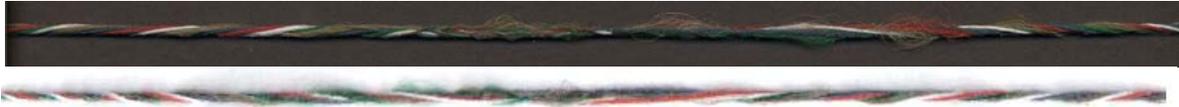


Figure 317: Yarn 5-E



Figure 318: Fabric created using Yarn 5-E

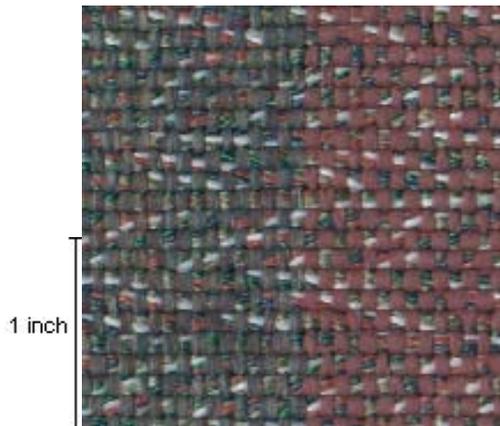


Figure 319: Detail of fabric created using Yarn 5-E

The lengths of the tack points in yarn 5-E have been increased, while the lengths of twisted yarn has remained the same. Aside from the obvious additional length of the tack point, there is no effect on the appearance of the yarn.

The patterning shown throughout the fabric in Figure 318 is similar to the previous fabric in the respect that, while still zigzag in shape, the effect is starting to become more horizontal. The fabric was woven at 11 picks per inch.

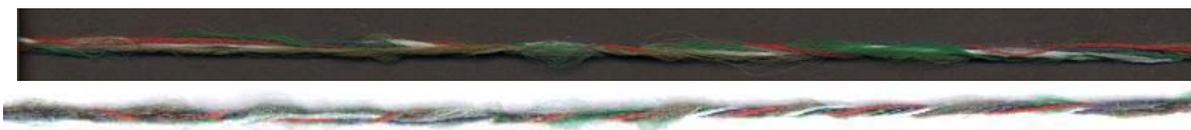


Figure 320: Yarn 5-F

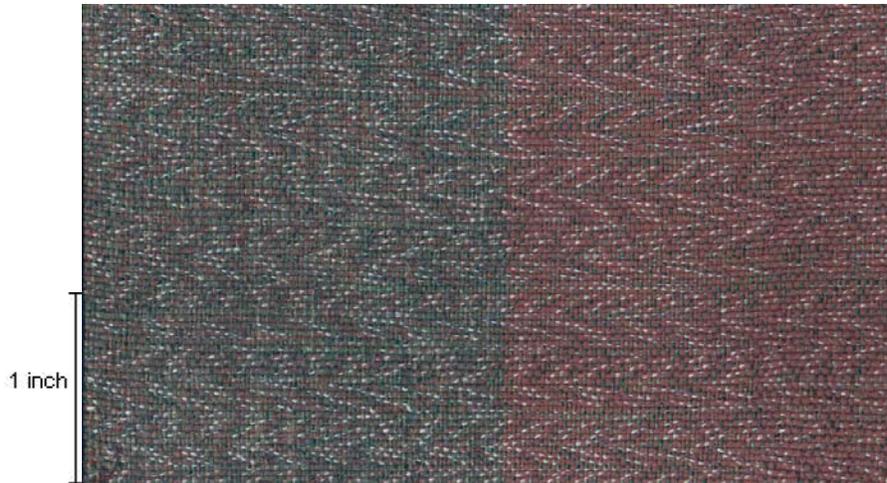


Figure 321: Fabric created using Yarn 5-F

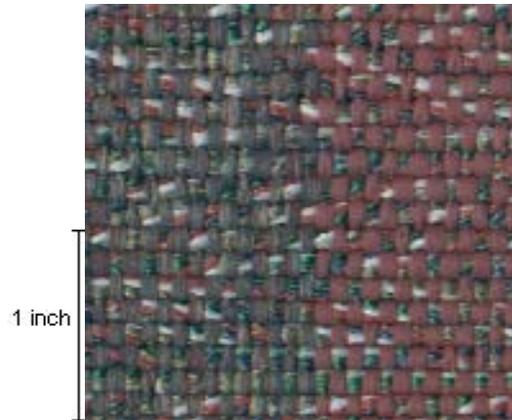


Figure 322: Detail of fabric created using Yarn 5-F

Yarn 5-F has tack points whose lengths have been increased, while the twisted regions have remained the same length. The increase in length of the tack points has rendered tack points that look less dense and stable.

The fabric created by yarn 5-F still displays zigzag patterning throughout, but horizontal bands are beginning to appear more prominently. The fabric was woven at 11 picks per inch.

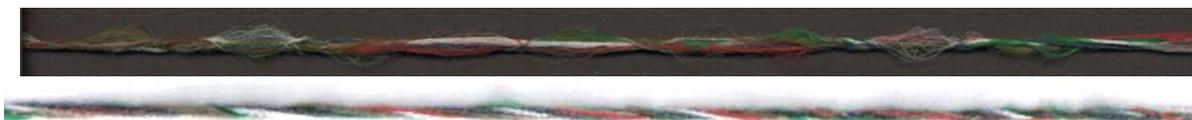


Figure 323: Yarn 5-G

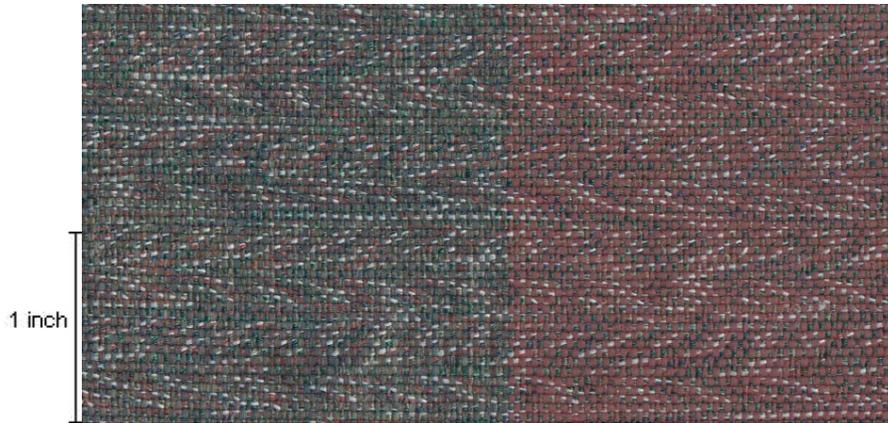


Figure 324: Fabric created using Yarn 5-G

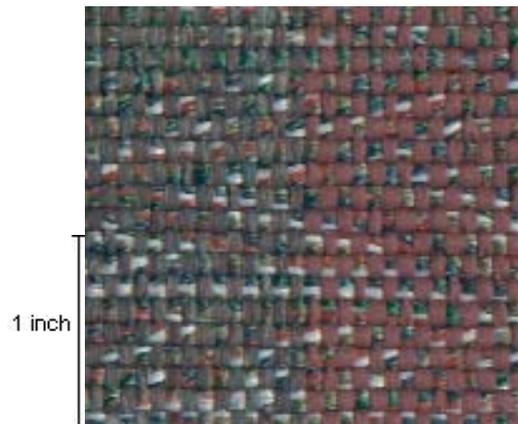


Figure 325: Detail of fabric created using Yarn 5-G

Yarn 5-G has increased lengths of tack points and similar lengths of twisted yarn. The tack points seem to be dense and tightly entangled.

Figure 324 shows a fabric that shows both severe zigzag and horizontal patterning. It was woven at 11 picks per inch.



Figure 326: Yarn 5-H

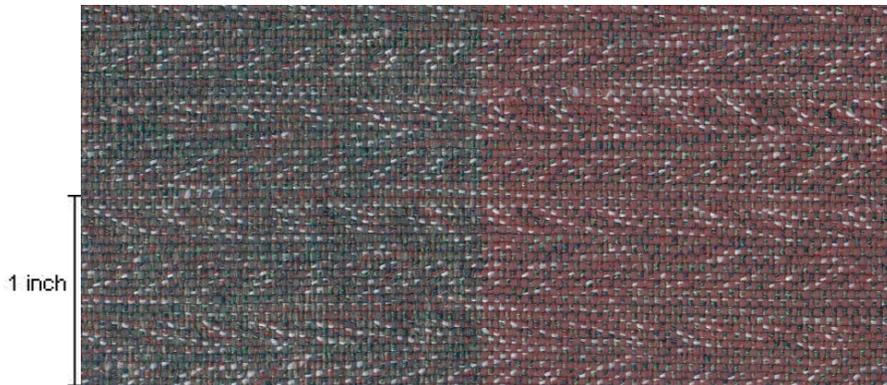


Figure 327: Fabric created using Yarn 5-H

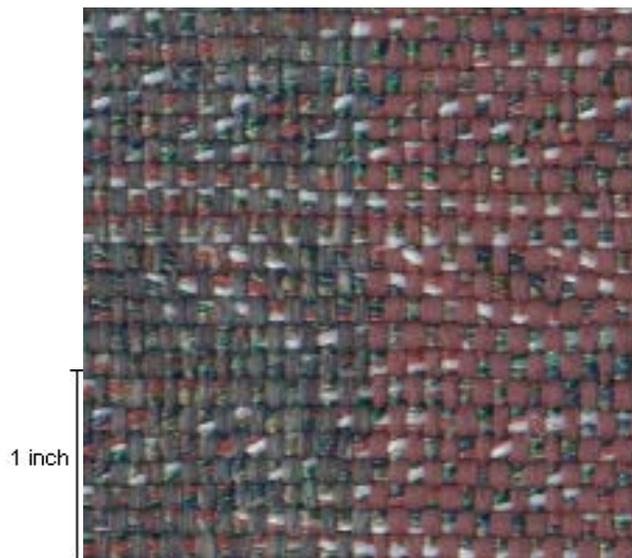


Figure 328: Detail of fabric created using Yarn 5-H

This yarn has equal lengths of twisted and tack point yarn. This causes the resultant yarn to be balanced. The density of the tack points seem to be similar to that of the previous yarn.

The fabric created by using yarn 5-H has intermittent horizontal banding throughout its width. This banding is separated by areas of zigzag patterning. The fabric was woven at 11 picks per inch.

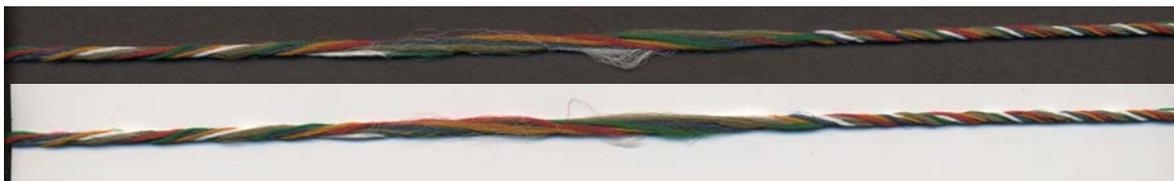


Figure 329: Yarn 6-A



Figure 330: Fabric created using Yarn 6-A

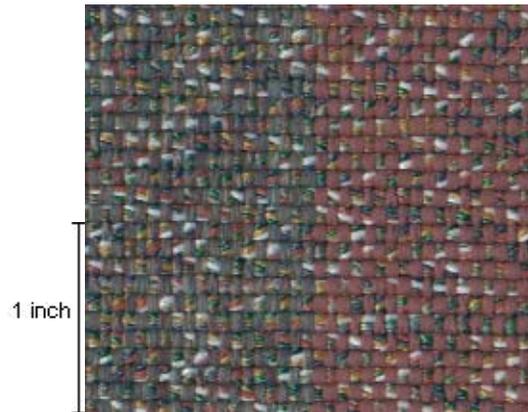


Figure 331: Detail of fabric created using Yarn 6-A

Upon creation of yarn 6-A, the length of tack points is drastically smaller than that of the twisted regions. This, combined with the addition of the gold yarn, leads to a tack point that does not seem to be tightly entangled and dense.

The patterning in Figure 330 is overall throughout the fabric. The patterning does not have a strong zigzag, or chevron effect; it has more of a heathered effect. The fabric was woven at 11 picks per inch.

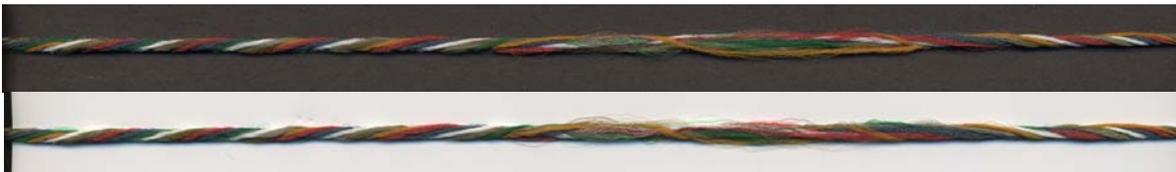


Figure 332: Yarn 6-B



Figure 333: Fabric created using Yarn 6-B

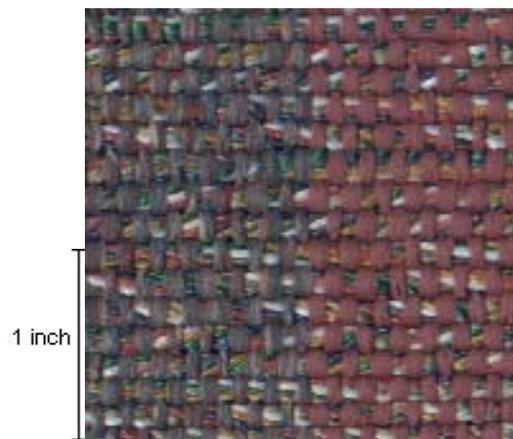


Figure 334: Detail of fabric created using Yarn 6-B

The lengths of the tack points in yarn 6-B remain the same, while the twisted lengths have increased. The amount of twist per inch seems to have decreased.

The patterning shown in Figure 333 is an irregular zigzag patterning. The fabric was woven at 11 picks per inch.



Figure 335: Yarn 6-C



Figure 336: Fabric created using Yarn 6-C

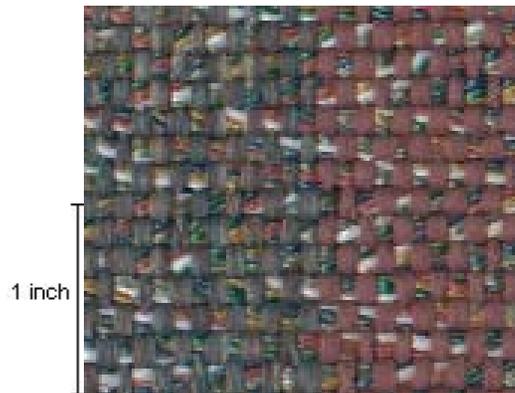


Figure 337: Detail of fabric created using Yarn 6-C

Similar to yarn 6-B, the length of twisted yarn remains increases, while the lengths of tack points remain the same. The change in length of the twisted portion of yarn has no visual effect on the overall appearance of the yarn.

The fabric created by using yarn 6-B is similar, visually, to the previous fabric, shown in Figure 333. Both have distinct zigzag patterning throughout the fabric; both were woven at 11 picks per inch.

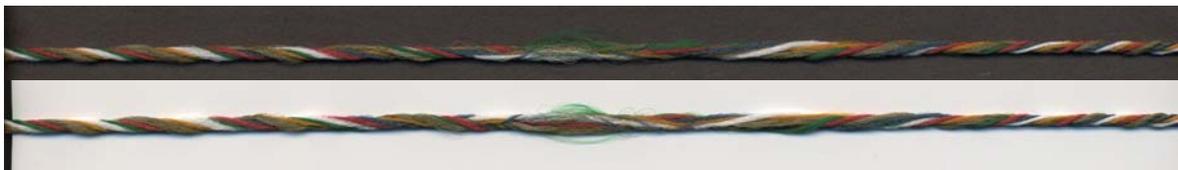


Figure 338: Yarn 6-D

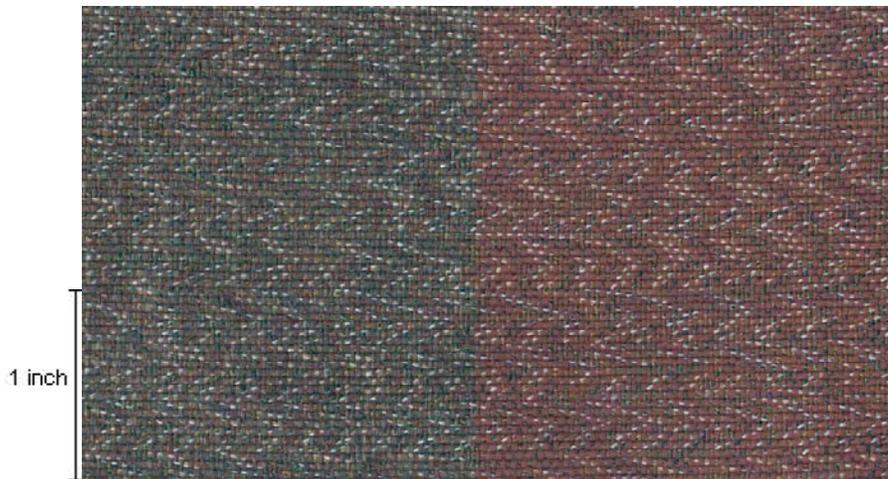


Figure 339: Fabric created using Yarn 6-D

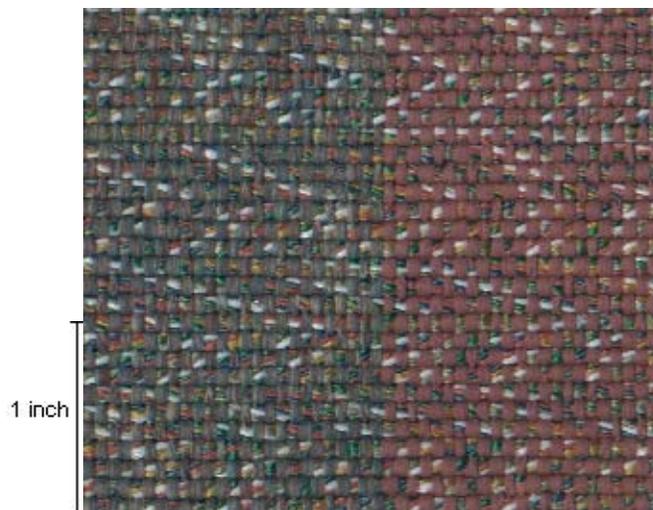


Figure 340: Detail of fabric created using Yarn 6-D

The lengths of the twisted portions of yarn 6-D have been increased while the tack point lengths have remained the same. The former length increase has negligible effect on the appearance of the yarn.

The fabric created by using yarn 6-D, like the previous sample, shows evident zigzag patterning throughout. This fabric was also woven at 11 picks per inch.



Figure 341: Yarn 6-E



Figure 342: Fabric created using Yarn 6-E

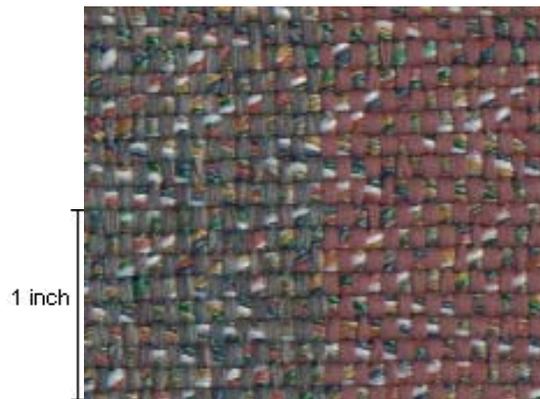


Figure 343: Detail of fabric created using Yarn 6-E

The length of the entangled portions of yarn has been increased, while the twisted lengths have remained the same. This change has had no effect on the appearance of the yarn.

The fabric shown in Figure 342, while showing evident zigzag patterning, is beginning to show signs of the same horizontal banding seen in previous samples, like in Figures 324 and 327. This fabric was also woven at 11 picks per inch.

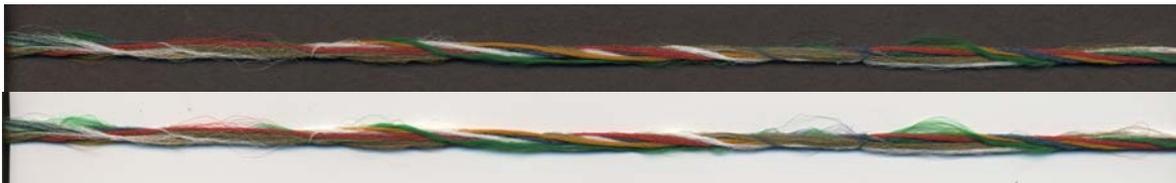


Figure 344: Yarn 6-F

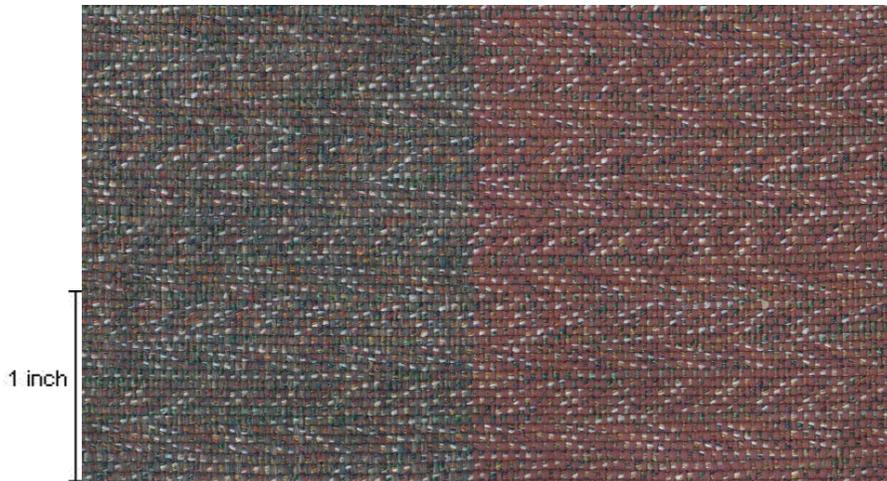


Figure 345: Fabric created using Yarn 6-F

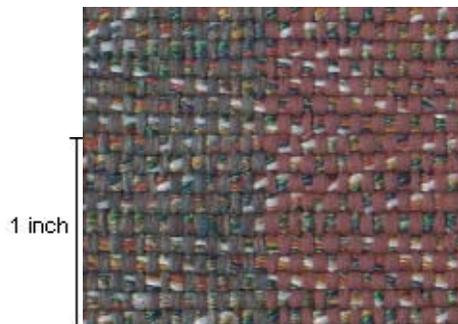


Figure 346: Detail of fabric created using Yarn 6-F

While the twisted lengths of yarn have remained the same, the lengths of tack point regions in the yarn have quadrupled. Due to the extreme increase in the lengths of tack point regions, along with the number of input yarns being used, the tack points do not seem very stable and compact.

The fabric shown in Figure 345 shows both distinct zigzag patterning, along with subtle horizontal banding. It was woven at 11 picks per inch.



Figure 347: Yarn 6-G



Figure 348: Fabric created using Yarn 6-G

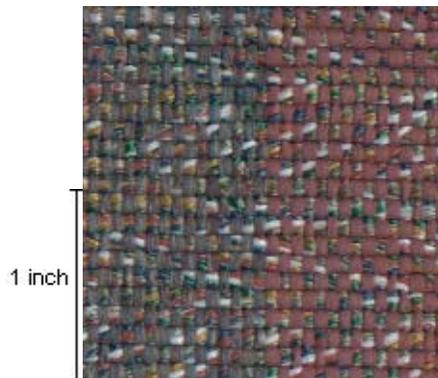


Figure 349: Detail of fabric created using Yarn 6-G

Similar to the effect of the previous yarn, the lengths of the tack point areas in this yarn have been doubled. For reasons discussed previously, the tack points seem less tightly entangled and sturdy.

The fabric shown in Figure 348 displays regularly occurring horizontal bands separated by areas of zigzag patterning. It was woven at 11 picks per inch.



Figure 350: Yarn 6-H



Figure 351: Fabric created using Yarn 6-H

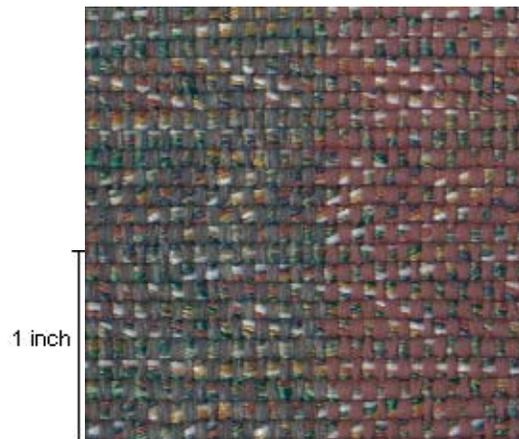


Figure 352: Detail of fabric created using Yarn 6-H

Yarn 6-H has equal lengths of twisted and tack point areas throughout its length. This creates a balanced yarn. The tack points in this yarn, like the previous few, seem to be less tightly entangled.

The fabric created by using yarn 6-H is similar to the previous fabric in the respect that it contains both horizontal banding and zigzag patterning. It was woven at 11 picks per inch.

There are several trends that were exhibited throughout this series of experiments. These trends dealt with the number of yarns in the sample sets, as well as the lengths of the twisted regions and tack point regions of yarn.

As the experiment progresses, a new color of yarn is added to signify the beginning of a new sample set. When this new color of yarn is added, the tack point is affected. Given that the same amount of air pressure is used to insert the twist and tack points, when an additional yarn is added to the input feedstock, each yarn is introduced to a lesser amount of air pressure. Given this, with the increased amount of input feedstock yarns, the tack points seem less compact and secure.

Additionally, when the length of either tack points or twisted areas of yarn is increased, there is a theoretical effect on the appearance of the yarn. While not always being evident by visual assessment, increasing either of these lengths decreases the amount of air pressure per each area unit of yarn. When the length of tack point is increased, the density of the tack point is decreased. Similarly, when the length of twisted yarn is increased, the amount of twist per inch is decreased.

6. Conclusions

The main purpose of the experiment was to identify a new technology from which fancy yarns could be created. Gilbos' Air Twist system was identified to be a viable resource for fancy yarn creation. The potential for fancy yarn creation on this machine is vast, though this experiment hardly scratched the surface.

The fabrics that were created would be suitable fabrics for certain aspects of the textile industry. The fabrics that display the distinct patterning are reminiscent of fabrics popular in the mass transportation industry. Those with more subtle patterning could be suitable for the upholstery, be it contract or otherwise, or even industrial wall coverings.

The experiments that were performed were limited in scope. This could be mostly attributed to a limited amount of time, access to machinery, and access to suitable resources such as input yarn.

Given that this research was intended as an overview of a new approach, further research could be done to look more in depth to the scenario. Further research could be done to this project that includes further exploration into the lengths of twist and entanglement zones, number of colors, yarn counts, and performance characteristics.

The colors and counts of input yarns used for this research were limited due to the constraints of the showroom where the yarns were created. While Gilbos' Air Twist system has the possibility of using twelve input feedstocks, a maximum of six were used for the purpose of this research. Also,

given that all of the feedstock materials were donated by Gilbos, they were all of similar counts to carpet yarns. Further research, using different yarns of different counts could be conducted.

Another possibility for extension of this research is the possibility to quantify the qualities of the resultant fabrics. The chevron patterning displayed throughout the fabrics in this experiment was measured qualitatively. Other resources could be applied to quantify the amount of chevron patterning. It has been concluded from this research that the lengths of the twisted areas and tack point areas directly correlate to the amount of patterning that results in the fabric. If these results, through further research, were measured quantitatively, measures to create yarns with the optimal amount of patterning could be taken.

The performance characteristics of these yarns have not been tested as a part of this research. Since the input feedstock is that traditionally used for carpet yarn manufacture, it was merely taken on good faith that the performance characteristics would be suitable for use in this research. Quantifying, along with controlling the performance characteristics of the yarns, would be another possible extension of the research.

Gilbos is eager to expand their marketing capabilities by being able to market their product as more than a carpet yarn machine. Another student would be well served by following up this untraditional approach to fancy yarn creation.

7. Glossary

“BCF; BCF yarn; bulked continuous filament: A textured continuous-filament yarn, generally used either as a pile yarn in carpets or for upholstery fabrics. BCF yarn is usually made by hot-fluid jet texturing.” (Textile Terms and Definitions, 22)

e.p.i.: ends per inch

“nep: a small knot of entangled fibres.” (Textile Terms and Definitions, 232)

p.p.i.: picks per inch

p.s.i.: pounds per square inch

t.p.i.: turns per inch

“Traveller (Traveler): The metal or plastic component through which yarn passes on its way from the ballooning eye to the package surface in ring spinning or twisting. It is mounted on a ring and is dragged round by the yarn.” (Textile Terms and Definitions, 358)

“Twist-liveliness: “The tendency of a yarn to twist or untwist spontaneously.” (Textile Terms and Definitions, 367)

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