





**A COMPARISON OF THE PERFORMANCE CHARACTERISTICS OF ORLON
BLANKETS AND RAYON-ORLON AND RAYON-NYLON BLENDS**

By

Barbara A. Spilker

A THESIS

**Submitted to the College of Home Economics of Michigan
State University of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of**

MASTER OF ARTS

Department of Textiles, Clothing and Related Arts

1957

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A COMPARISON OF THE PERFORMANCE CHARACTERISTICS OF ORLON
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AN ABSTRACT

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This study was composed of blankets of 100% Orlon, rayon-Orlon blends in different percentage compositions, and rayon-nylon blends. The blankets were divided into four groups of two each according to retail price and fiber composition. Weave construction was held as constant as possible among the groups.

The purposes of the study were to compare through a series of laboratory tests the performance of rayon-Orlon blends of different percentage compositions with 100% Orlon blankets and to compare rayon-nylon blends with rayon-Orlon blends of the same percentage composition. Other purposes were to determine any relationships of retail price to performance and fiber composition and to compare laundering and dry cleaning as cleaning procedures.

The blankets were laundered five times under home laundering conditions and samples were withdrawn for testing after one and five launderings. Other specimens were cleaned five times by a commercial dry cleaner and test samples withdrawn after one and five dry cleanings.

Analysis of the blankets confirmed fiber composition but revealed considerable variation in percentage of Orlon among the rayon-Orlon blends. Analysis of the specifications revealed that all blankets were of similar weave but varied considerably in fabric and yarn geometry. All blends had viscose warp yarns and blended filling yarns. Three of the

Orlon blends had core yarns in the filling. All napping was in the filling yarns only.

In all performance tests the 100% Orlon blankets were superior to the blends; their performance changing very little after launderings or dry cleanings. Dimensionally, the Orlon blankets were stable in laundering but shrank slightly in dry cleaning. There was considerable warp shrinkage in some blends in laundering but all were quite stable in dry cleaning.

The study did not reveal that a 30% addition of Orlon to a viscose blanket improved performance more than the addition of 8% except in one characteristic, resistance to abrasion. An addition of 7% or 8% nylon to a viscose blanket increased abrasion resistance as much as 13% Orlon; and more than 8% Orlon. In general, additions of Orlon or nylon increased the wet breaking strength of viscose although there was no evidence that one percentage blend was superior to another.

Performance in elongation, compressional resilience, compressibility, and thermal conductivity tests seemed to relate to fabric and yarn structure rather than to percentage fiber content. All blends were highly flammable but the 100% Orlon blankets did not burn.

Subjective analysis of hand and appearance change after cleaning treatments revealed: practically no color change, that the blanket blends pilled in dry cleaning and matted in

laundering, and that the Orlon blankets changed very little in either type of cleaning.

Performance results seemed to justify the retail price for the 100% Orlon blankets and one nylon blend. However, there was not enough difference in performance among the other blends to warrant the differences in price.

The data seemed to indicate that laundering was a preferable cleaning procedure for 100% Orlon blankets and dry cleaning for rayon blends.

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
REVIEW OF LITERATURE	3
EXPERIMENTAL PROCEDURE	22
A. Organization of the Study	22
B. Laboratory Tests	27
DISCUSSION OF RESULTS	38
A. Specification Tests	39
B. Performance Tests	48
C. Subjective Analysis	80
CONCLUSIONS	87
SUMMARY	90
LITERATURE CITED	97
APPENDIX	101

INTRODUCTION

With the development of a crimping process for manmade fibers it has become possible to spin staple yarns from which napped fabrics can be made. A survey of Lansing, Michigan, retail stores showed that blankets available to the consumer buyer represented a wide variety of fibers within a broad price range. One hundred percent constructions of wool, Orlon, Acrilan, and cotton as well as an almost infinite array of blends were available.

The relatively high cost of wool and many synthetics has encouraged the development of blends with rayon, a significantly lower cost fiber, to produce lower priced blankets. Besides effecting lower production costs, blending is a means of compensating for the less desirable properties of some fibers. For example, nylon or Orlon can add strength to a blend with rayon. Wool can increase the warmth of a cotton blanket because of its bulking power. Nylon can reduce shrinkage and drying time of wool as well as increase the strength of the fabric and its resistance to abrasion.

Advertising claims for these new blends emphasizes their lower cost, launderability, quick-drying properties, lightness of weight, natural moth and mildew resistance, low shrinkage, and non-allergic properties. However, the consumer

has not been provided with information about the expected comparative performance of these new blankets under conditions of normal use and care.

Since the consumer is more familiar with wool blankets this study was limited to synthetics; specifically Orlon, and Orlon-rayon, and nylon-rayon blends.

One purpose of the study was to compare through a series of laboratory tests the comparative performance of Orlon-rayon blends of two different percentage compositions with 100% Orlon and to compare nylon-rayon blends with Orlon-rayon blends of comparable percentage composition. Another purpose was to determine relationships of retail price to performance and fiber composition. A third purpose was to compare laundering and dry cleaning as cleaning procedures for blankets of the above fiber compositions.

The average life of a blanket was arbitrarily determined to be approximately five years, requiring one cleaning each year, under normal conditions of use. Therefore, to simulate actual use, specimens were laundered or dry cleaned five times.

REVIEW OF LITERATURE

Viscose rayon (15) is a regenerated cellulosic fiber made by mercerizing cellulose with NaOH and xanthating it with CS₂. The xanthate is dissolved in NaOH to form a spinning solution and the extruded yarns are coagulated in an acid bath. Viscose is sold in both filament and staple form in a wide variety of deniers and staple lengths. It is also manufactured in a wide range of tenacities. Except for high tenacity forms it has a relatively low tensile strength which is reduced by one-half when the fiber is wet.

Its elastic recovery (16) is not as high as other fibers as it recovers only 30% from a 20% stretch. It is also subject to creep. Viscose moisture regain is 11% at standard conditions. It has a specific gravity of 1.52.

Chemically viscose (23) is sensitive to hot dilute and cold concentrated acids and swells in alkalies.

Nylon 66 (15) is a linear condensation polymer made by heating adipic acid and hexamethylene diamine. It is sold in both staple and filament forms. Available staple ranges from 1.5 to 15 denier in one to five inch lengths (25).

Its properties (15) include: (1) extra low density (sp. gr. 1.14), (2) high dry and wet tenacity, (3) great elongation and exceptional elastic recovery, (4) resistance to

abrasion, (5) low moisture regain (4%), (6) resistance to burning, (7) resistance to insects, mildew, and most chemicals, and (8) low shrinkage.

Orlon acrylic fiber (15) is an addition polymer of acrylonitrile dissolved in dimethyl formamide or other solvent and extruded into filaments. It, too, is produced in filament form (Type 81) and staple form (Type 42). Orlon is characterized by the following physical and chemical properties: (1) low density (sp. gr. 1.18), (2) high dry and wet tenacity, (3) good elastic recovery, (4) elongation comparable to nylon, (5) exceptional bulking power, (6) good abrasion resistance although not as good as nylon, (7) extremely low moisture regain (1%), (8) resistance to acids and fair resistance to alkalies, (9) resistance to moths, mildew, and (10) extreme insensitivity to sunlight. Orlon is destroyed by high temperatures but does not flash burn.

Crimp

As synthetic fibers emerge from the spinneret they are essentially rod-shaped. To produce napped fabrics from synthetic staple yarns it is necessary that crimp be introduced into the fibers. Crimping (26) not only increases bulking power (necessary by napping) but also improves abrasion resistance, and fiber resilience.

Since crimping was first developed during World War II (15) a variety of methods for incorporating it have been used. Hartsuch reports the following two: (1) passing the filaments through hot fluted rollers and then cutting them into short lengths, and (2) introducing crimp at extrusion by extruding the yarn four times as fast as it is drawn off. This causes coagulation when the fiber is in the bent state.

In 1950 the Alexander Smith and Sons Carpet Company originated the "texturalizing" process (26) which put an angular crimp in the fiber. It was done by packing the fiber tightly into a closed chamber until the desired crimp was attained and then heat setting it.

A very permanent crimping process (3) for viscose involves developing assymetry in the fiber cross section. In manufacture opposite sides of the fiber are made to contract differently causing a helical form in which the fiber skin on one side becomes thicker than on the other.

Relation to Fiber Properties to Fabric Properties

Specific fiber properties may or may not be carried over as yarn and fabric properties.

Fibers with good elastic recovery can be expected to produce resilient fabrics. High tensile strength synthetics except nylon tend to have reduced elongation which is important to abrasion resistance. If the molecules have been

aligned (fiber drawing) to produce high tensile strength there is little orienting left to permit stretch without rupture (10).

Heckert (16) reports the high bulking power of Orlon (30% more than unfulled wool) will yield a high bulk fabric. However, investigation showed that Orlon and Dacron fabrics which possessed the resilience and wrinkle resistance of wool had a stiff hand.

Compressional Resilience

Hamburger (14) states elasticity and resilience ". . . are not properties per se, but are rather complex interactions of many factors, both inherent in the fiber and resulting from the geometry of the fabric structure." Retention of properties of hand, thickness, and bulk are all dependent on the resilience of the fabric. Since maintenance of thickness is a criterion of warmth and compressional resilience affects thickness, compressional resilience also affects warmth.

Schiefer (32) defines compressional resilience as ". . . work recovered from the specimen when the pressure is decreased from 2.0 to 0.1 lb./in.² expressed as a percentage of the work done on the specimen when the pressure is increased from 0.1 to 2.0 lb./in.²." He states compressibility denotes deformity and compressional resilience depicts energy recovered.

Cassie (11) reports that wool has a unique resistance to close packing. The most densely packed is 60% air and 40% wool whereas compressed cotton is 80% fiber and 20% air. Continuous filaments pack very closely.

Thermal Conductivity

Most investigators agree with Kaswell (20) that ". . . the thermal insulation ability of textile fabrics is substantially independent of the nature of the fiber but is rather a function of the state of aggregation of fibers in the textile structure."

Rees (28) states that though thickness is not the only factor which determines insulating qualities it is the most important. In another work he notes that fabric structure is also of the utmost importance.

Others point out that the insulating value of a fabric depends upon the quantity of still air (a very good insulator) it can entrap within its structure.

Cassie (11) in discussing this aspect states that air clings to solid surfaces of which fibers have a great amount. Clinging air drags on air permeating the fabric and stops it. Therefore, fibers such as wool which have a low bulk density allow for more air entrapment. When relating the above to viscose he states that it packs in such a way that the available fiber surface is only 70% to 80% that of wool, perhaps due to wool's natural crimp and resiliency.

Baxter and Cassie (6) found rough surfaced wool blankets gave lower surface emissivity than smooth fabrics. When tested against a hot plate blankets lowered the temperature less than smooth cottons and became warm sooner.

In a study of thermal properties of moist fabrics, Hock, Sookne, and Harris (17) concluded that napped fabrics which afford the poorest skin contact give the least chilling effect. They felt that the crimp and resilience of wool helped to minimize skin contact with the fabric.

Schwarz (32) in discussing the entrapment of still air in fabrics states the traps must be arranged to prevent straight-line passage of air through the textile.

In this regard Amory (2) states that blankets must allow some slow air passage so that perspiration does not condense on the skin causing the person to feel cold because of evaporation.

Morris (25) studied the relative insulating value of single and multiple layers of fabrics by testing several layers at one time and comparing the results with the sum total of results for each layer tested separately. Consistently the multiple layers gave higher insulating values than the sum of the single layers. Results revealed there is a close linear relationship between thermal insulation and fabric thickness and thermal insulation and volume of air per unit area. When fabric contact was poor due to rough fabric

surfaces the largest difference between added and measured values occurred.

In a very recent report Bogaty, Hollies, and Harris (9) added to the importance of air entrapment, fabric thickness, and low bulk density the influence of fiber arrangement. They studied conductance at various pressures. At very low pressures many fibers in napped and pile fabrics are parallel to heat flow. As pressure increased fibers are bent and become perpendicular to heat flow. In a former study conductivity was found to be increased two or three times by such parallel arrangement.

However, these investigators found little change in conductance with increased pressure. An increase in pressure increases bulk density which reduces insulation because air is excluded. This reduction is probably compensated for by the bending of the fibers placing them perpendicular to heat flow. From this study they concluded low conductance fibers may influence fabric thermal insulating properties but that it is still minor in relation to fabric structure.

Abrasion Resistance

Susich (37) reports that fiber tests show abrasion resistance diminishes from nylon to Orlon, to viscose, to acetate approximately at the ratio of 1000 : 237 : 165 : 83. Good resistance to abrasion depends upon fiber elasticity. It is

not so much the total energy required to break the fiber as the amount of energy absorbed during repeated deformations. It is obvious, then, that the energies necessary for breakdown in compression, bending, and shear are as important in evaluating abrasion as force necessary for rupture in tension.

Drawn nylon requires the highest energy to rupture because of exceptional elasticity and elastic recovery. Nylon staple is more extensible than filament yarn but it is lower in tenacity and elastic recovery due to lack of fiber cohesion within the yarn. In general, staple yarns have less abrasion resistance than filaments. Smooth fibers may not yield as rapidly when abraded because of a reduction in inter-fiber friction.

Pilling

Baird, Hatfield and Morris (5) in studying the pilling propensity of nylon blended fabrics found ". . . the magnitude of pilling depends on the number and lengths of protruding fibers and the ease with which they can bend round one another."

They state pills may appear in balls or in ridges. If the fabric is made of weak fibers the pills will break off without being noticed. Propensity to pilling is increased by the addition of nylon to blends. However, the type of spinning system used can also cause variation.

Pilling can be reduced by increasing yarn twist, weaving with doubled yarns, increasing yarn count appreciably, and using plain instead of twill weave.

Flammability

Committee A of the Textile Institute (36) reported that napped fabrics flash burn when oven dry but react more slowly when conditioned. However, the low moisture regain of hydrophobic fibers might be a hazard in some climates.

Sayre (30) found little difference in the burning rate of 100% rayon, 100% Orlon and blends of the two. However, flammability is a major concern in sheer and napped fabrics in general. He also states that nylon in blends decreases the tendency of fabrics to burn.

Blends

Quig and Dennison (27) give the following reasons for blending:

- (1) to obtain maximum function for some definite property--crease resistance, abrasion resistance, etc.
- (2) to compromise on a specific functional property to get--improved hand or drape, flame resistance, static resistance, or to control selling price.
- (3) to enhance the fabric's function by a small addition of another fiber--reinforce hosiery, etc.

In blending Orlon and rayon, the Du Pont Company (8) recommends 80% Orlon to 20% rayon. "Fabrics containing less than 65% Orlon are characteristically rayon-like."

As little as 10% rayon, however, will reduce static electricity and a 20% to 25% addition of rayon brings the static properties to the 100% cotton or rayon level.

For blends of rayon and nylon, Du Pont recommends at least 30% nylon for good performance although fabrics with less have good abrasion resistance. Fabrics not otherwise stabilized require 30% to 40% nylon for dimensional stability.

Greenwood (13) states that for blending, staple length and denier are chosen according to the handle and texture desired for the fabric. Usually both staple and denier are comparable to the blend fiber. When producing fabrics with raised surfaces it is a good thing to blend fibers of different deniers because the coarser ones give resilience and the finer ones add depth to the pile or nap.

Hoffman (18) points out some possible problems in blending fibers of varying densities. The amount of air space is dependent upon the manner in which the fibers pack together. Fiber characteristics which influence packing are: (1) crimp, (2) fiber stiffness, (3) recovery behavior, (4) yarn construction (ply and twist), and (5) shape, size, and size distribution of fiber cross sections. Geometrically, it may be assumed that rod-shaped fibers of certain dissimilar diameters may pack very closely. If yarn or low bulk density is desired a problem arises.

In a series of articles on blending and fabric performance, Sayre (30) states that the properties of synthetics

and man-mades are highly complementary if care is taken in the selection of fibers and proportions for the blend. Of Orlon and rayon blends he states the best performance blend was 75% Orlon and 25% rayon. Such a blend excelled in launderability and dimensional stability. Abrasion resistance, tear strength, and tensile strength were little affected by variation in percentage blends. Orlon's outstanding contribution to blends was bulking power. This fiber was found to be subject to static electricity but as little as 10% rayon in the blend significantly reduced it.

Sayre agrees with other investigators that 10% nylon blended with rayon is enough to increase abrasion resistance. To appreciably increase tensile strength the blend must be 40% to 50% nylon. A minor addition of rayon to nylon reduces static electricity. The difference in bulking power between nylon and cellulose is small. Rayon was found to increase the liveliness of nylon in 50-50 blends.

Ashton and Boulton's (3) findings substantiate information already given for blends of rayon and nylon and rayon and Orlon. In addition, they state that nylon, Dacron, and Orlon staples can be made by hot stretch breaking the tow. The sliver is then crimped and the crimp heat set. The fibers are then relaxed by steaming to recover from the stretch. If some hot stretched staple is combined with regular staple and spun before steaming the hot stretched fibers will relax to a greater extent and a much higher bulk yarn will result.

In a study of serges made of blended fabrics Quig and Dennison (27) found an addition of Orlon staple to rayon reduced the tensile strength of the resultant fabric slightly. This was probably due to a difference in the stress-strain characteristics of the two fibers. Although small amounts of nylon greatly increased abrasion resistance, Orlon increased it very little. In this study the low moisture sensitivities of Orlon and nylon were found to lend dimensional stabilizing effects to rayon in laundering and dry cleaning.

Blankets

Literature reveals that research in household blankets has not been extensive, particularly for blankets made of newer fibers and blends. The following studies are reported for the pertinence they have to the subject in general.

Smith (35) lists the following as qualities the consumer wants in a blanket. They are: (1) a warm and pleasing touch, (2) warmth without excess weight, (3) nap that will not shed, (4) dimensional stability, (5) launderability without matting, (6) clear durable colors, (7) moth resistance, and (8) a reasonable price.

Rogers, Hays, and Hardy (29) studied blends of different qualities of wool and mohair noil after use and laundering in a U. S. Naval hospital. They found all blankets shrank in the first 12 launderings but did not continue to

shrink. As shrinkage occurred thickness, weight per square yard, and tensile strength also increased. As fabrics became felted during laundering their compressibility decreased but compressional resilience increased.

The investigators concluded that fiber content apparently had little effect on thermal transmission but that laundrerings up to 12 significantly reduced heat flow through the fabrics. In overall performance there was little difference among the blankets though they were made of different qualities of wool.

Viemont, Hays, and O'Brien (39) found in studying blankets of wool and cotton that the blanket must contain at least 25% wool before its insulating qualities are affected. The natural crimp and resilience of wool permit air entrapment in the fabric. The most satisfactory blends employed cotton in the warp and wool in the filling. Core yarns were found in the fillings where excessive napping might otherwise have caused a loss in strength. As optimum napping was believed to be important for warmth, a twill weave which throws more filling to the fabric surface was recommended. Long fibers which remained anchored in the weave after napping were more desirable.

Schiefer, Stevens, Mack, and Boyland (32) studied the properties of 156 household blankets made of 100% wool, 100% acetate, blends of wool and cotton, wool and viscose,

wool and acetate, and wool, cotton, and acetate. Their findings showed that most shrinkage occurred after the first laundering and weight, tensile strength, and thickness increased with shrinkage.

Compressibility decreased with launderings, but brushing of the nap restored it to some extent. The authors state that a high value of compressibility indicates a greater amount of napping whereas a lower value indicates matting or felting. Compressional resilience will increase with felting or matting because there is less motion of fibers relative to each other when the load is applied owing to reduced compressibility. "The energy which is lost, frictional forces between fibers times relative movement of fibers, is therefore considerably reduced and the compressional resilience, which is the ratio of the energy recovered when the compressive load is removed to the total energy expended when the compressive load is applied, is increased."

Laundering, in this study (32), was found to have little effect on thermal transmission. In explanation the authors state that in general thermal transmission changes inversely with thickness and compressibility. If thickness increases and compressibility decreases these changes balance one another, hence the possibility of no change in transmission after laundering.

There was no correlation found between blanket properties and fiber composition with the exception of compressional resilience. There was a linear relationship between the wool content of wool-cotton blankets and compressional resilience. An increase in wool beyond the 5% level increased the resilience of the fabric. If a portion of cotton was replaced by viscose compressional resilience was significantly decreased.

Gilmore and Hess (12) studied the effect of fiber content and laundering and dry cleaning on resilience, thickness, and thermal conductivity of blankets. Their data also revealed, in most cases, that thickness rather than fiber content influenced thermal conductivity. Laundering and dry cleaning consistently increased the protective value of wool and wool blend blankets. Laundering decreased the protectiveness of cotton and dry cleaning slightly reduced it. This was attributed to the natural resilience of wool. Cotton and rayon blankets, however, became harsh and lost fluffiness after laundering but dry cleaning did not change this noticeably.

Consumers Union investigators (41) agree that at least 25% wool is necessary in a wool-cotton blend if warmth is to be increased. Their findings showed permanently crimped rayon to be more resilient than cotton after laundering. They also found that rayon blankets did not shrink as much as wool. They

considered napped cotton and rayon a fire hazard and suggested such fabrics be flame-proofed before being sold.

In discussing possibilities for the use of synthetic fibers in blankets Lake (21) states it is the geometric and mechanical nature of the fiber which contributes to the thermal insulation of the fabric. This particularly refers to bulking power and/or resilience. The cross section shape plays an important role in bulking power. For example, fibers such as Orlon, dynel, and possibly Acrilan with irregular cross sections give more bulk than more nearly circular fibers such as Dacron, nylon, or even rayon. The fiber must retain its resilience after laundering. In this respect the cylindrical fibers such as nylon and Dacron are superior. Although some hydrophobic fibers such as dynel had many acceptable blanket characteristics they were subject to static electricity to such an extent they were rejected.

In a report on the use of rayon in modern blankets Smith (35) states rayon has been used in blankets for 15 years. It is always blended with another fiber, particularly wool. Some blends contain as much as 95% rayon, while two more popular ones contain 60% and 80% rayon. The author states that rayon is used in other parts of the blanket but is outstanding in the nap. The filling is usually a blend of 3 to 5.5 denier fibers although some 8 denier fibers are used. Rayon blankets are constructed with a double face weave as opposed to the

single twill weave construction of wool blankets. The two sets of filling yarns to one set of warps give added thickness and expose more filling for napping. The weave is a one to three right hand twill on one face and a one to three left hand on the other. Most warps are bright staple of 1.5 to 3 denier fibers cut in 1-9/16 inch to two inch lengths. The yarn count is usually 32 to 48 ends and 16/1's to 25/1's picks per inch.

This same study also indicates that increased napping with sufficient filling strength is gained by the use of a core yarn in the filling. The core is usually the same type yarn as the warp. The yarn twist varies with the weave. If a twill weave is used to expose more filling surface for napping a higher twist is imparted for strength. A 1.4 run filling with core has about four turns per inch.

Strict manufacturing control of denier assures a more uniform hand. The number of crimps per inch have bearing on the uniformity and fullness of hand, also.

The Federal Government (7) does not have specifications for blankets made of synthetic fibers only, but it does list requirements for blends of nylon, wool, rayon, cotton, and other fibers. The fiber content must not be less than 80% wool by weight, more than 10% cotton or rayon, or less than 10% nylon. Shrinkage in the first laundering or dry cleaning must not exceed 10% in warp or filling. For blankets 72" x 90" the total minimum weight is 4.4 lbs. and the maximum is 4.6 lbs.

The yarn count is a minimum of 22 ends per inch and 20 picks per inch. The grab breaking strength minimum is 35 lbs./inch in the warp and 30 lbs./inch in the filling.

Laundering

Johnson (19) reports the commercial laundryman's problem is identifying fiber composition in textiles in order to clean them correctly. Usually, if the fabric looks like wool it is washed as wool. Fortunately those laundering conditions are satisfactory for synthetics except in two cases. Rayon blankets may pill and tumble-dried Orlon pile fabrics may shrink.

Weaver, Plonk and Bordt (40) in laundering blankets in automatic washers found the agitator type washer to be most satisfactory. The pulsator and conventional types produced similar results and the cylinder type washers gave the least satisfactory laundering. They felt reducing the length of the operating time might make the last type more acceptable. A wash period not exceeding two minutes in a mild soap solution at 100° F. with two deep rinses not exceeding two minutes each was considered sufficient to remove an average amount of soil. To reduce agitation automatic washers were manually controlled. Increasing washing time from two to four minutes doubled warp shrinkage in 100% wool and 50% wool blankets and in some cases tripled the filling shrinkage.

Synthetic detergents were considered more satisfactory than soap because they reduced the surface tension of the water, did not react with minerals to form soap scum, and were more easily rinsed away.

EXPERIMENTAL PROCEDURE

A. Organization of the Study

Selection of the Blankets

This study was limited to four groups of blankets of the following fiber compositions:

Group I	100% Orlon
Group II	25% Orlon, 75% rayon (approximately)
Group III	10% Orlon, 90% rayon (approximately)
Group IV	10% nylon, 90% rayon

Each group contained two blankets of similar fiber percentage composition purchased from several different Lansing stores. However, four blankets (one in each group) were purchased at one store.

Price and fiber content were kept as constant as possible within each group but varied among the four groups. Unit cost in each group was as follows: Group I--\$13.75 and \$11.99; Group II--\$9.90 and \$10.95; Group III--\$7.90 and \$6.98; and Group IV--\$5.90 and \$4.98. The exact percentage fiber composition appeared on the labels of blankets in Groups I and IV. One blanket each in Groups II and III was labeled with percentage fiber composition but the other two were merely specified as rayon and Orlon.

All of the blankets were of double-faced twill weave construction with nylon or acetate bindings. Each was labelled

as measuring 72 inches by 90 inches with the exception of one blanket in Group IV which was labelled as 72 inches by 84 inches.

Experimental Procedure

Each blanket was sectioned to provide adequate sampling for physical testing for the original untreated fabric and test specimens after one and five launderings and one and five dry cleanings.

Specimens were laundered according to a procedure to be described and dry cleaned by a commercial dry cleaning establishment.

Specification tests on the original specimens included: quantitative and qualitative fiber analysis, yarn count, yarn number and twist count, moisture regain, fabric thickness, weight per square yard, and width and length measurements. After the first and fifth launderings and dry cleanings samples were withdrawn for physical testing to determine any change in yarn count, fabric thickness, and weight per square yard.

The following performance tests were made on the original blanket specimens and after the first and fifth launderings and dry cleanings. Colorfastness, hand and appearance after launderings and dry cleanings were judged by a panel of 25 women.

Physical tests were performed in accordance with the standard procedures of the American Society for Testing Materials and under standard conditions of temperature (70° F. $\pm 2^{\circ}$ F.) and relative humidity ($65\% \pm 2\%$) unless otherwise specified.

Laundering and Dry Cleaning Procedures

The laundering procedure was a modification of one recommended by the Westinghouse Corporation for laundering blankets and the manufacturers' directions from each blanket label.

The indicator dial of the Laundromat was set for a "regular" load (6.4 gallons of water) and the temperature control set at "warm" (36° C.). Before filling the machine one-third cup of low-sudsing synthetic detergent and 80.6 grams of water softener were added. (The Calgon Corporation recommends 12.6 grams of water softener per gallon of water of 20 grains hardness.)

The machine was allowed to fill with water and then shut off. The equivalent weight of one blanket was submerged and allowed to soak for two minutes after which it was turned once. It was allowed to soak an additional five minutes and then turned again. An additional three minutes was allowed constituting a total of 10 minutes which is a minimum recommended for removing soil.

The machine was started and the control dial was advanced to the drain position and allowed to operate until the water had been extracted and the tub filled for a deep rinse. The dial was immediately advanced to the drain position. When the water was extracted the dial was advanced to the second deep rinse and the machine allowed to fill. The dial was then advanced to the drain position and the machine allowed to operate to the end of the cycle.

The specimens were removed from the washer, spread flat without tension on metal screens and dried at room temperature.

Dry Cleaning Procedure

The commercial dry cleaner washed the blankets for twenty minutes in Stoddard solvent with a soap charge of 4% and dried them in a tumbler for thirty minutes at 110° F.

Dimensional Change

The method for determining dimensional change was one recommended in Commercial Standards Bulletin CS 59-44.

For each laundering and dry cleaning two 10-inch squares, with sides placed parallel to the warp and filling yarns were outlined on the specimens. A basting stitch was used for making the outline. The midpoints of each side of the square were marked with a basting stitch also.

Three measurements correct to the nearest sixteenth of an inch were taken in both the warp and filling directions on each square. Averages of the warp and filling readings were recorded and the percentage dimensional change from the original measurements was calculated.

B. Laboratory Tests

Analysis for Fiber Content

Qualitative Analysis

Fiber content of the blankets was analyzed by burning, stain, and solubility tests and by microscopic examination.

For staining, samples were stripped of dye and stained with Calco Identification Stain #2. Fibers from the stained samples were then examined under the microscope.

For further confirmation viscose rayon was distinguished from acetate by the acetone solubility test. Nylon was identified by solvency in 80% phenol solution.

Quantitative Analysis

Solubility tests were used to determine percentage fiber composition of the blended blanket fabrics.

Orlon-rayon blends were analyzed by drying samples of approximately two grams to constant weight in an oven at 105° C. The dried samples were cut into 1/4-inch squares and put into 120 ml. of dimethyl formamide which had been heated in a water bath to 71° C. The solution was stirred while the temperature rose to 90° C. where it was held for five minutes. The residue was placed in a Buchner funnel, rinsed with dimethyl formamide and then rinsed with distilled water. The residue was dried reasonably well with a vacuum flask then transferred to an oven

for complete drying. The dried residue was weighed and recorded and the percent Orlon calculated from this weight and the weight of the original sample.

The nylon-rayon blends were analyzed quantitatively by the method recommended by ASTM.

A dried sample of known weight was submerged in HCl (sp. gr. 1.139) for thirty minutes. The residue was washed with HCl of the above concentration, distilled water, NH_4OH (8 parts NH_4OH sp. gr. 0.90 to 92 parts water), and again in distilled water. The residue was drained with a Buchner funnel and vacuum flask then transferred to an oven for thorough drying.

The dried residue was weighed and the nylon content was calculated from the recorded weights. Since HCl destroys some viscose as well as nylon the weight of the viscose residue was increased by 1.2%.

Yarn Count

The actual number of warp yarns in one inch were counted at five places in the fabric, and the average number of warp yarns per inch calculated. No two areas counted included the same yarns. No count was made nearer the selvage than one-tenth the width of the fabric.

The average number of filling yarns per inch was determined in accordance with the above described test.

Yarn Number

The Universal Yarn Numbering Balance was used to determine yarn number.

The count was determined as the average of ten warp and ten filling yarn readings.

For spun rayon a length of six inches was weighed and the reading multiplied by six to be the equivalent of one yard weighed. Spun filling yarns containing cores were treated as spun yarns and then the core was removed and its size calculated.

Each yarn was cut, and twisted into a circle so that it hung centrally on the hook of the balance scale by one strand.

The balance was operated by leveling the machine, moving the index lever to zero and locking the beam. The specimen was placed on the balance hook and enclosed in the balance chamber. The beam was unlocked and the index lever rotated until the beam was in balance. The number on the dial at which the index lever was stopped was recorded; yarn number being read on the inside scale.

Twist Count

The Alfred Suter Twist Tester was used for this test. The procedure for warp yarns was a modification of one recommended by Skinkle.

The direction of twist was determined and the machine was adjusted to test a five inch length of yarn. The counter was set at zero and one end of the yarn was fastened in the rotatable clamp. The other end was placed in the fixed clamp and the yarn pulled taut. A three-gram deflection load was placed on the yarn to permit a slack of 1/8 inch. The fixed clamp was tightened and the deflection load removed. The yarn was twisted until broken and the number of twists recorded. Another five inch length was untwisted and retwisted in the opposite direction until broken.

The following formula was used to calculate twists per inch:

$$\frac{N_2 - N_1}{2 \times l} = T$$

N_1 = number of turns to twist and rupture

N_2 = number of turns to untwist and retwist to rupture

l = length of yarn

T = twists per inch.

Ten warp and ten filling determinations were taken and the average reported as twists per inch for warp and filling, respectively.

\ Moisture Regain

A 100 ml. weighing bottle and cover were dried at 105-110° C. and cooled in a desiccator for 30 minutes, then weighed. The procedure was repeated until a constant weight (two readings $\pm$.003 grams) had been recorded.

A conditioned specimen of approximately five grams was placed in the bottle, covered and weighed. The weight of the bottle was subtracted to obtain the air-dry weight of the specimen. This weight was known as A.

The sample was then dried uncovered in the oven for at least 1 1/2 hours. The bottle was then covered, placed in the desiccator, and uncovered. After 30 minutes the dried sample in covered bottle was weighed. This procedure was repeated until a constant weight (two readings $\pm$.003 grams) had been recorded. The weight of the bottle was subtracted from this weight to obtain oven-dry weight, which was known as B.

Moisture regain was calculated according to the following formula:

$$\text{Percent moisture regain} = \frac{A - B}{B} \times 100$$

Thickness

The thickness of the fabric was determined with the Schiefer Compressometer. The sample was placed on the anvil of the instrument smooth but without tension. The one-inch foot was used and lowered upon the specimen and the pressure gradually increased. When the pressure reached 0.1 lb./in.², the lower dial reading was recorded. Similar observations were made and recorded at seven other pressures up to 2 lb./in.². The standard thickness was recorded as the difference between the zero reading of the instrument and the reading at 1 lb./in.²

The series of readings were taken at three different areas of the fabric specimen and the average of the three determinations recorded as the standard thickness.

Weight per Square Yard

Five specimens two square inches in size were taken from the specimen in such a manner as not to include the same warp or filling yarns in any two of the specimens. Each square was weighed and the weight per square yard of the blanket was calculated according to the following formula:

$$\frac{\text{total wt. in gms. of 5 squares} \times 1296. \text{ in.}}{\text{total sq. in.} \times 28.35 \text{ gms.}} = \text{wt./sq. yd. in oz.}$$

Length and Width Measurements

Length: Each blanket was laid out smooth, without tension, on a horizontal surface, and the length measured from bound edge to bound edge parallel to the selvage. Five measurements were recorded and the average of these was known as the length.

Width: The width was measured with the fabric laid out smoothly on a horizontal surface but without tension in either direction. The average of five measurements uniformly distributed along the full length of the blanket were reported as the width.

Tensile Strength

The cut strip method was used for this test as the blankets were not large enough to permit cutting specimens for the grab method. Five specimens each in warp and filling directions, respectively, measuring 1 1/2" x 12" were prepared for each fabric to be tested. The specimens for each test were numbered from one to five and the specimens cut so that the number one sample in every test had the same warp or filling yarns as every other number one, etc. Likewise, each sample was numbered at either end with the same number and the sample cut in half lengthwise, one-half of the sample for dry and the other half for wet determination.

Each sample was clamped vertically in the jaws of the Scott Tester and broken. Average breaking strength was calculated for both warp and filling yarns, wet and dry.

Test samples for wet breaking strength were immersed in distilled water for at least one hour at room temperature before testing.

✓ Elongation

The elongation was obtained when the breaking strength was determined by means of an autographic recording device on the Scott Tester. The recorded elongation was the average of the results for five specimens and was expressed as a

percentage increase in length from application of stress to rupture of yarns.

Abrasion Resistance

The Taber Abraser was used for this test. This machine subjects a specimen to rotary rubbing action under controlled conditions of pressure and abrasive action. Although the test does not imitate actual wear it provides a standard for comparison of resistance to abrasion.

An end point approximating the complete breakdown of the fabric was established. This was defined as loss of nap and a broken warp and filling yarn.

Samples of each group type to be tested were abraded to the end point described above and the number of revolutions required to reach this point recorded. The lowest number of revolutions required to reach the end point was known as the Wear Factor which remained constant for all samples tested.

Each sample was weighed before abrasion and after it had been abraded to the Wear Factor end point. Calculated weight losses indicated the fabric's decreasing ability to resist wear by abrasion.

An average of five samples was used to calculate abrasion resistance.

Thermal Conductivity

For this test the Cenco Fitch thermal conductivity apparatus was used. The apparatus consists of a calorimeter of known weight maintained at constant temperature by means of boiling water. In the bottom of the calorimeter is a block of copper containing one thermocouple junction. In series with this is a second junction which is embedded in a block of copper of known heat capacity mounted in a receiver unit. Thermocouple pairs act to produce a weak electric current in their circuit when the two members of the pair differ in temperature. The strength of the current is proportional to the difference in temperature. Therefore, the strength of the current is measured on a galvanometer which is connected in the circuit. The rate of change in current is measured with a stop watch.

A conditioned sample was placed on the receiver and the calorimeter weighing two pounds was lowered onto the sample. Galvanometer readings were taken every minute for a period of ten minutes and the readings plotted on semilogarithmic graph paper. An average of three determinations was taken and the thermal conductivity calculated by the following formulas:

$$k = CL \qquad C = \frac{2.303 Mc}{AS}$$

k = thermal conductivity

C = conductance in cal./cm.²/°C./minute

M = mass of copper in the receiver

c = specific heat of copper (.093 cal./gm.)

S = slope resulting from plot of readings at one minute intervals on semi-logarithmic paper

L = thickness of the fabric in centimeters at 2 lb./in.² pressure

A = area of the receiver

Flammability

The apparatus and method of test recommended by the American Association of Textile Chemists and Colorists was used. Pretests were made to determine in which direction the fabric burned most rapidly.

The specimen holder rack was adjusted so that the tip of the gas nozzle was 5/16" from the specimen when released. The flame was adjusted to 5/8" in length.

The sample was brushed once against the nap, clamped in the specimen holder and dried in an oven at 105° C. for 30 minutes. After cooling in a desiccator for 15 minutes the specimen was mounted in the rack of the apparatus and subjected to burning within 45 seconds of removal from the desiccator.

Time of flame spread from the moment of ignition was recorded and flammability was rated according to AATCC standards.

An average of five samples were used to determine flammability of each blanket.

Compressional Resilience

The compressibility and compressional resilience of the fabric were calculated from the data recorded when the thickness of the fabric was measured. Compressibility was recorded as the ratio of the rate of decrease in thickness at a pressure of one pound per square inch to the standard thickness and was computed by the following formula:

$$\frac{\Delta t}{t} = C$$

C = compressibility

Δt = thickness at 1 lb./in.²

t = standard thickness

The compressional resilience of the specimen is the amount of work recovered when the pressure is decreased from 2 lbs./in.² to 0.1 lb./in.² expressed as a percentage of the work done on the specimen when the pressure is increased to 2 lbs./in.² The reported compressional resilience was calculated by the following formula:

$$\frac{R}{C} = \%CR$$

R = the amount of work recovered

C = the total compression

CR = compressional resilience

DISCUSSION OF RESULTS

In the organization of this study the eight blankets were classified in four groups according to retail price and fiber content. Upon analysis so many differences in structure and fiber content were found that it was necessary to compare the blankets individually rather than by groups. Consequently, in the discussion of the specifications the group classification was used, but was discarded for the discussion of performance characteristics.

The performance tests were analyzed statistically when it was possible. Differences between means exceeding the 1% level of significance were reported as highly significant. Those exceeding the 5% level of significance were reported as significant differences. In tests where the significant differences were too numerous to include in the discussion the least significant difference at the 1% and 5% levels of significance appear with the table of means.

Throughout the discussion the following code was used:

<u>Code</u>	<u>Blanket</u>
Oa	100% Orlon
Ob	100% Orlon
ORa	30% Orlon, 70% rayon
ORb	7.9% Orlon , 92.1% rayon
ROa	7.9% Orlon, 92.3% rayon
ROb	13% Orlon, 87% rayon
RNa	8.2% nylon, 91.8% rayon
RNb	7.0% nylon, 93% rayon

A. Specification Tests

The eight blankets studied were analyzed to determine initial specifications of fiber content, yarn number and twist, yarn count, weave construction, moisture regain, thickness, weight/square yard, and width and length measurements.

Fiber Content

Qualitative Analysis

Microscopic, burning, stain, and chemical tests were used to analyze fiber content.

The blankets in Group I were found to be 100% Orlon. Group II blankets were viscose in the warp and filling core and blends of Orlon and viscose in the napped portion of the filling. The viscose staple in the nap was not all of the same denier. Greenwood (13) states denier of two sizes may be used in fabrics with raised surfaces. The coarser ones give resilience; the finer ones add depth to the pile.

Both blankets in Group III had viscose warps. Blanket ROa in Group III had a viscose filling core; the napped portion of the filling being of viscose and Orlon. ROb had delustered viscose warp; the filling being of bright and delustered viscose and Orlon. Group IV blankets had viscose warps. RNa warp was bright and RNb was delustered. The filling yarns of both were blends of viscose and nylon. RNb filling had both bright and delustered viscose yarns.

Quantitative Analysis

To determine the percentage of Orlon in the Orlon-rayon blends, a solvency test of dimethyl formamide was used. For rayon-nylon blends, HCl (sp. gr. 1.139) was used as a nylon solvent. The results are summarized below:

	<u>Fiber Content as Labelled</u>	<u>Fiber Content as Analyzed</u>
Group II		
ORa	25% Orlon	30.4% Orlon
ORb	"Rayon and Orlon"	7.89% Orlon
Group III		
ROa	10% Orlon	7.69% Orlon
ROb	"Rayon and Orlon"	13.01% Orlon
Group IV		
RNa	10% nylon	8.22% nylon
RNb	"Rayon and nylon"	7.08% nylon

Weave

All blankets in the study were of double face twill weave construction; that is, one set of warp yarns to two sets of filling. With the exception of one 100% Orlon blanket (Oa), all were woven with a one to three right hand twill on one face and a one to three left hand twill on the other. Oa had a one to two twill weave.

Yarn Number and Twist

All blankets were napped in the filling only. The filling yarns ranged from 2's to 3's. In all cases the twists

per inch were so few it was impossible to remove the yarns for testing without distorting them.

Both blankets in Group II and one in Group III (ORa, ORb, and ROa), had core yarns in the filling. The cores were much finer (26's) and of much higher twist than the napped portions. Core and napped yarns were bound together with approximately 6 t.p.i. The other 5 blankets had 2's and 3's filling yarns of low twist.

Warp yarns in all of the blankets were similar in structure. All were of "S" twist staple viscose. They ranged in size from 15's to 22's. The twist was quite high ranging from 9.2 to 14.7 t.p.i. None of the warp yarns were napped.

Yarn Count

All fabrics were constructed so that the filling count was the same on both faces of the fabric. A blanket reported as having $3\frac{1}{4}$ filling yarns per inch had 17 yarns per inch on one face and 17 yarns per inch on the other face.

Oa in Group I had a balanced count of 32 warps and $3\frac{1}{4}$ filling yarns per inch. Ob was less well-balanced with a count of 40 warpwise and 30 fillingwise. ORa in Group II was well-balanced with 31 warps and 32 filling yarns. ORb was less balanced with 42 warps and $3\frac{1}{4}$ fillings. Both blankets in Group III had $3\frac{1}{4}$ filling yarns per inch but ROa and ROb had 40 and 46 warps, respectively. Blankets RNa and RNb in

Group IV were nearly alike with 28 filling yarns and 40 and 41 warp yarns, respectively.

The changes in yarn count in laundering and dry cleaning related directly to dimensional change. In instances where warp shrinkage had occurred, the filling yarn count increased. In instances of filling stretch, the warp count decreased.

Moisture Regain

Hartsuch (15) lists the moisture regains for Orlon, viscose, and nylon as 1%, 11% and 4.2%, respectively, at standard conditions. Regain values found for blanket fabrics of these fibers in this study compare favorably with his report.

<u>Blanket</u>	<u>Fiber Content</u>	<u>% Regain at Standard Conditions</u>
Oa	100% Orlon	.87
Ob	100% Orlon	1.27
ORa	30% Orlon, 70% rayon	9.91
ORb	8% Orlon, 92% rayon	13.22
ROa	7.7% Orlon, 92.3% rayon	12.24
ROb	13% Orlon, 87% rayon	11.7
RNa	8.2% nylon, 91.8% rayon	12.24
RNb	7% nylon, 93% rayon	11.79

Thickness

There was a 34% range in standard thickness among the eight blankets studied. All were less than .200 in. in thickness at 1 lb./sq. in. pressure which is less than L-24 American Standards Minimum Performance Requirements for Woven Blankets of comparable weights.

Blankets in Groups I and IV were of similar thicknesses within the group. Group I (Oa and Ob), were .157 in. and .167 in., respectively. Both blankets in Group IV were .130 in. In Group II, ORa was .197 in. and ORb .166 in. thick. In Group III, ROa was .133 in. and ROb .184 in. thick.

Change in thickness after launderings and dry cleanings, in general was minor. Changes of less than .01 in. were considered insignificant and not reported.

The 30% Orlon blanket lost .02 in. after one laundering and .03 in. after five launderings. Although it shrank appreciably in the warp, its weight gain was not as great as other blankets which shrank similar amounts. Such findings may indicate fiber loss.

Similarly, the 13% Orlon blanket (ORa) lost .01 inch after one laundering and .044 in. in five launderings. Its shrinkage was appreciable after one laundering and its weight gain was 0.7 oz./sq. yd. However, after five launderings, its shrinkage was less than after one laundering but there was a weight loss as well as thickness loss which would indicate progressive fiber loss.

Loss in thickness in the rayon-nylon blankets would indicate fiber loss also.

One 100% Orlon blanket (Ob) increased .02 in. in thickness in one dry cleaning but its increase in five dry cleanings was only .01 inch. The 30% Orlon blend (ORa) lost

.01 in. in five dry cleanings as compared to a .005 in. increase in the first dry cleaning. The 13% Orlon blend increased .014 in. in thickness in one dry cleaning but lost .003 in. in five dry cleanings. The 7% nylon blend (RNb) increased in thickness in one dry cleaning but decreased .01 in. in five. When change in thickness is related to shrinkage and weight per square yard, the changes seemed, again, to indicate loss of fiber in the cleaning processes.

Weight per Square Yard

Hartsuch (15) lists the following specific gravities for fibers: nylon-1.14, Orlon-1.18, and viscose-1.52. For this reason, the 100% Orlon blankets would be lighter in weight than blankets which are largely viscose. It must be noted that yarn size, yarn count, and thickness also determine weight.

As an example, ROa (largely rayon) had yarns of similar size, and had lesser thickness than Oa (100% Orlon), but it also had more warp yarns. However, Oa was lighter in weight than the rayon blend.

Weights per square yard were similar within Groups II (ORa-12.96 oz. and ORb-12.81 oz.) and Group IV, (RNa-11.51 oz. and RNb-10.17 oz.). However, there was variation in Group I, (Oa-9.43 oz. and Ob-12.50 oz.) and in Group III, (ROa-11.20 oz. and ROb-14.15 oz.).

Weight difference, then, is related to yarn number, count, and fabric thickness as well as fiber content.

All of the blankets gained weight after one laundering. Those which gained from 0.8 oz. to 2.61 oz./sq. yd. are, in general, those which showed appreciable shrinkage. However, one of the 100% Orlon blankets (Ob) showed a gain of 0.8 oz. with only 1% shrinkage. Such a weight gain may be a result of soap or lint deposit in the fabric. The 13% Orlon blend gained only 0.7% in weight but shrank 5% in the warp and 4.1% in the filling which, again, may indicate some fiber loss in laundering. It also lost .01 in. in thickness.

After five launderings, each of the blankets weighed more than originally but five weighed less than recorded after one laundering. Three of these (7.7% Orlon and both nylon-rayon blends) showed increased shrinkage and slight loss of thickness at five launderings which indicated the weight loss might be due to fiber loss in the laundering process. The 13% Orlon blend weighed less after five launderings but it also showed less shrinkage after five launderings than after one laundering. The 100% Orlon which showed weight loss after five launderings may have lost fiber in laundering because it was dimensionally quite stable.

The 100% Orlon blankets gained more weight after one dry cleaning than after one laundering which relates to greater shrinkage in one dry cleaning than in one laundering.

The 30% Orlon blanket gained more in weight in one dry cleaning than in one laundering. Although warp shrinkage was less after one dry cleaning, filling stretch was less which may account for the weight increase.

The other five blankets gained less weight in one dry cleaning than in one laundering but their shrinkage was also less. After five dry cleanings, one blanket (30% Orlon) weighed less than it had originally although shrinkage was progressive.

One of the 100% Orlon blankets (Ob) lost 0.7 oz./sq. yd. in five dry cleanings although its shrinkage was progressive which again may indicate loss of fiber. The other 100% Orlon blanket (Oa) reacted similarly although its shrinkage and weight loss were not as extensive as in Ob.

The three rayon-Orlon blends other than the 30% Orlon weighed slightly more after five dry cleanings than after one although dimensionally there was little change. Collection of lint from other fabrics could account for weight gain. Both of the rayon-nylon blends lost 0.8 oz. after five dry cleanings but since they were dimensionally quite stable, weight change may be due to a loss of fiber in the cleaning process.

Width and Length Measurements

All of the blankets were labelled as 72 inches in width and 90 inches in length except RNb which was labelled 72" x 84".

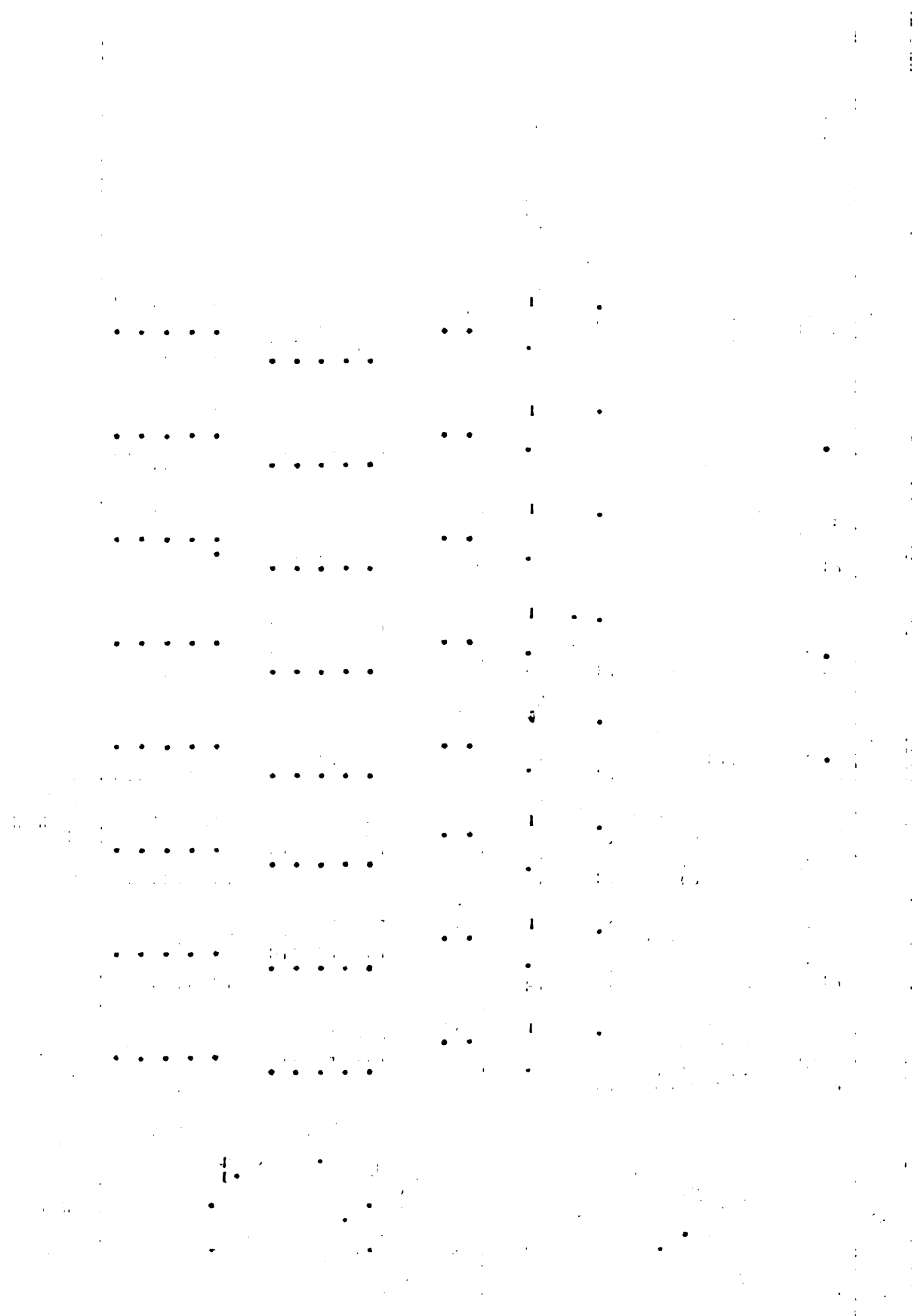
All of the blankets actually measured less than the label indicated except the length of RNb and width of Oa.

SPECIFICATIONS

Blanket	Oa	Ob	ORa	ORb	ROa	ROb	RNA	RNb	
Fiber content	100% Orlon	100% Orlon	30%* Orlon	7.9%* Orlon	7.7%* Orlon	13%* Orlon	8.2%* Nylon	7%* Nylon	*Remainder viscose
Yarn	W F	W F	W F	W F	W F	W F	W F	W F	
count 1L	32 34	42 30	31 32	42 34	40 34	46 34	40 28	41 28	
(per. 5L	30 36	42 30	29 32	41 35	37 39	43 36	38 30	41 34	
in.) 1DC	31 36	43 40	30 34	40 37	38 40	43 40	38 31	40 30	
5DC	31 38	43 32	29 33	40 34	39 38	45 36	38 29	39 29	
	31 38	44 32	29 32	40 34	38 37	46 38	40 29	41 30	
Yarn number	16 3.3	22 2.2	16 2.3	15 2.7	15 3.3	18 2.3	16 2.4	20 2.6	*Core
			26*	26*	26.7*				
Twist	10.9 -*	14.7 -*	9.3 -*	9.2 -*	10.8 -*	9.5 -*	12.5 -*	10.3 -*	*Filling twist too low to be counted.
Width	72.25	70.3	71.18	68.75	71.63	68.33	71.5	68.1	
Length	89.3	87.15	87.15	87.75	87.4	86.5	87.3	84.3	
Thickness**									
(in.in. at 0	.157	.167	.197	.166	.133	.184	.130	.130	
1 lb./in ² 1L	.150	.172	.177	.166	.132	.174	.113	.127	
pressure.) 5L	.153	.167	.165	.148	.117	.140	.108	.118	
1DC	.162	.190	.202	.169	.132	.198	.129	.133	
5DC	.158	.178	.186	.167	.131	.181	.125	.120	
Weight/yd. ²									
(in.oz.)**	0	12.50	12.96	12.81	11.20	14.15	11.51	10.17	
	1L	13.33	13.44	13.66	12.36	14.89	13.30	12.78	
	5L	10.29	13.54	14.03	12.26	14.42	12.58	12.04	
	1DC	10.48	13.47	12.60	11.66	14.51	12.53	11.01	
	5DC	10.21	12.80	13.20	11.69	14.63	11.73	10.31	

**0 = original
1L = 1 laundering

5L = 5 launderings
1DC = 1 dry cleanings
5DC = 5 dry cleanings



Discrepancies in measurement could be due to a finishing process after weaving, or to relaxation shrinkage after the fabrics are removed from the loom. Shrinkage in viscose blankets could also be due to creep.

B. Performance Tests

Dimensional Change

Government specifications (7) for blankets other than all wool allow a maximum shrinkage of 10% in both warp and filling directions after one laundering or dry cleaning.

L-24 American Standard Minimum Performance Requirements for Woven Blankets (22) permit a maximum shrinkage of 8% in both warp and filling in laundering and 2% shrinkage in warp and filling in dry cleaning.

All blankets tested met the above requirements after one laundering except the 7% nylon blanket, RNb. It shrank 12% in the warp (viscose) and 5.4% in the filling (nylon and viscose).

Warp shrinkage was progressive with five laundering for all of the blankets except the 13% Orlon blend. After five laundering, four of the blanket blends did not meet the above specifications and a fifth missed the maximum by only .05%. All of the blends had viscose warps.

Dimensional change in the filling in laundering was well within the minimum requirements. This difference in

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DIMENSIONAL CHANGE

Percent Change from the Original

Code	Blanket							
	<u>Oa</u>		<u>Ob</u>		<u>ORa</u>		<u>ORb</u>	
	Warp	Fill.	W.	F.	W.	F.	W.	F.
1 Laund.	-0.2	+0.5	+0.7	-1.0	-4.2	+2.5	-5.8	+2.5
5 Laund.	-0.9	+0.1	-0.8	-	-7.5	+5.1	-8.5	+2.9
1 Dry Clean.	-2.2	-1.6	-1.1	-1.5	-1.0	+0.5	-2.3	-4.3
5 Dry Clean.	-3.3	-2.6	-4.2	-3.1	-3.3	+1.0	-3.1	-4.4
- - - - -								
	<u>ROa</u>		<u>ROb</u>		<u>RNA</u>		<u>RNb</u>	
	W.	F.	W.	F.	W.	F.	W.	F.
1 Laund.	-5.4	+0.75	-5.0	-4.1	-4.7	+1.4	-12.0	-5.4
5 Laund.	-10.1	+2.3	-1.78	-3.0	-8.6	+2.0	-15.9	-1.5
1 Dry Clean.	+2.3	-0.5	-1.7	-2.1	-0.5	-0.6	-0.9	-1.15
5 Dry Clean.	+0.45	+0.5	-1.8	-2.3	-1.9	-0.9	-0.9	-1.9

performance between the warp and filling yarns may have been due to variation in yarn structure, manufacture, or to the fact that in all of the blends, the Orlon or nylon was found only in the filling yarns.

Four rayon-Orlon blends and one rayon-nylon blend showed stretching in the direction of the filling. There seemed to be no direct relationship to fiber content in this case. The 30% Orlon blanket showed the greatest stretch; the 13% Orlon blanket showed shrinkage, and those blankets with less than 10% Orlon stretched slightly. However, three of the rayon-Orlon blends which stretched had viscose core filling yarns and the 13% Orlon blend which showed shrinkage had no core.

In laundering, both of the 100% Orlons were very stable; changing no more than 1% in either the warp or filling.

All of the blended blankets were considerably more stable in dry cleaning than in laundering. All of the blankets, however, met the Federal Specifications of 10% maximum shrinkage. The L-24 American Standards maximum of 2% was exceeded in these blankets. The 30% Orlon shrank 3.3% in the warp after five dry cleanings. The 13% Orlon blend which had no filling core shrank approximately 2% in dry cleaning. The 7.9% Orlon blanket shrank more than 2% in both warp and filling in dry cleanings.

It is noteworthy that the warp of the 7% nylon blend which shrank 12% and 15.9% after one and five launderings,

respectively, shrank only 1.15% and 1.9% in one and five dry cleanings.

The 100% Orlon blankets were less stable in dry cleaning than in laundering. Shrinkage progressed until in five dry cleanings, both warp and filling for each of these blankets had exceeded the 2% maximum.

Johnson (19) reports that Orlon fabrics may shrink as a result of tumble drying in heated dryers. The commercial dry cleaner tumble-dried the blankets in this study for 30 minutes at 110° F. after each dry cleaning.

Tensile Strength

Tensile strength is a function of yarn count, yarn number and twist, weave construction and fiber content. The fibers in the blankets studied varied in initial strength; both nylon and Orlon being stronger than viscose. Viscose loses about one-half of its strength when wet.

Analysis of Variance Among Treatments

Dry warp. The warp yarns of all the blended blankets were 100% viscose. However, there was a variation among the blends in yarn count, number and amount of twist.

Both of the 100% Orlon blankets lost strength when cleaned; a greater loss occurring in dry cleaning.

All of the rayon blends lost strength after both cleaning methods, many at the 1% level of significance.

TENSILE STRENGTH

Tensile Strength in Pounds per Inch

WARP

Code	Original		After 1 Laund.		After 5 Laund.		After 1 D. Clean.		After 5 D. Clean.	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Oa	35.1	34.1	30.6	28.6	30.7	27.2	29.8	28.4	27.9	28.3
Ob	42.6	38.4	40.4	31.8	40.9	35.6	37.6	33.3	35.7	35.5
ORa	34.3	17.2	29.2	11.8	30.6	11.4	28.6	10.0	27.7	10.6
ORb	43.6	19.0	37.3	15.8	32.3	14.8	37.2	16.8	36.5	15.8
ROa	46.7	25.2	41.3	20.4	37.5	17.4	41.6	20.6	41.1	20.8
ROb	34.4	10.1	28.0	8.6	27.2	8.8	30.4	9.6	28.8	9.8
RNa	37.0	16.4	31.5	13.0	31.2	12.4	32.3	13.9	32.1	12.8
RNb	34.1	13.3	26.3	9.7	22.0	13.3	26.8	9.6	29.4	10.7

*L.S.D. at the 5% level of significance is 4.38.

*L.S.D. at the 1% level of significance is 5.8.

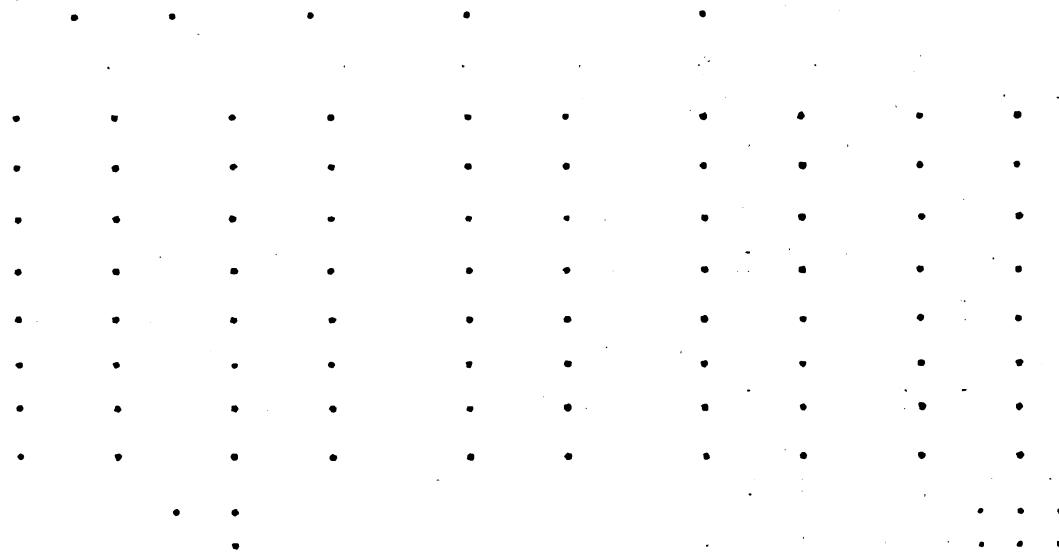
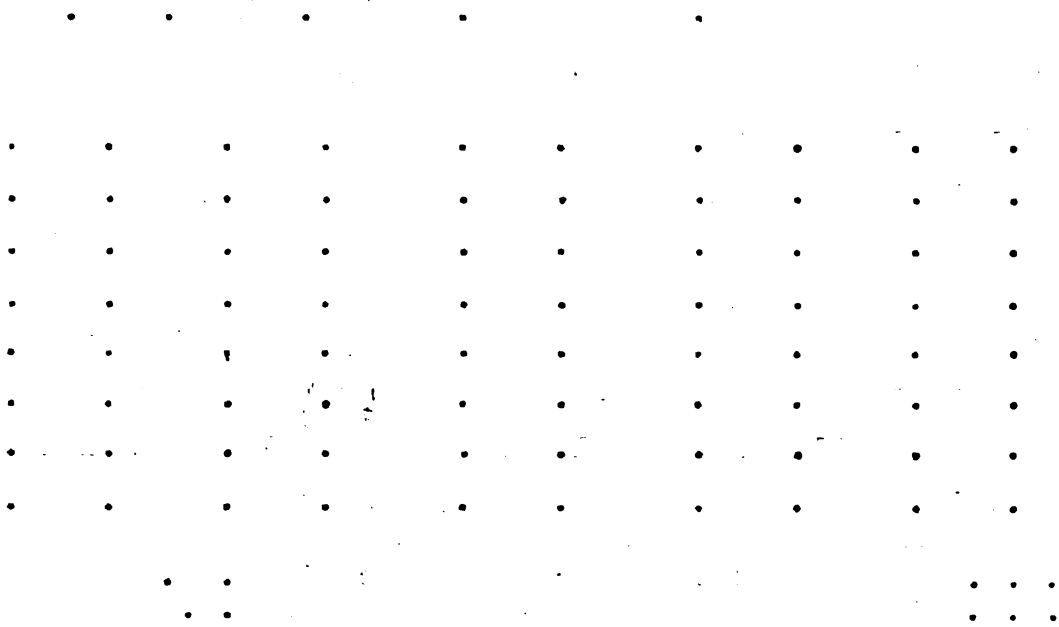
FILLING

Code	Original		After 1 Laund.		After 5 Laund.		After 1 D. Clean.		After 5 D. Clean.	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Oa	17.4	19.3	20.0	21.4	27.4	26.0	23.0	23.6	25.0	25.6
Ob	23.8	34.8	43.7	43.6	50.0	44.8	35.7	31.8	30.5	30.0
ORa	25.2	16.4	24.4	14.6	27.6	15.2	24.2	14.6	22.3	14.4
ORb	29.2	20.6	26.4	17.6	26.9	16.2	22.5	16.2	20.4	14.6
ROa	19.2	16.0	27.0	19.2	27.7	17.8	14.0	14.4	16.0	11.4
ROb	6.5	6.2	5.4	4.3	15.2	8.6	3.2	4.3	6.6	6.1
RNa	20.4	17.2	19.6	17.4	30.3	22.5	15.9	17.3	21.8	18.4
RNb	4.6	5.3	7.9	7.5	9.0	8.3	4.9	5.2	8.0	5.4

*L.S.D. at the 5% level of significance is 4.98.

*L.S.D. at the 1% level of significance is 6.6

*The above least significant differences for comparison of two means refer only to variance among blankets at a given treatment level and not to variance among treatments for one single blanket.



Generally, the greatest loss occurred in five launderings even though there was significant shrinkage. The 30% Orlon blend, however, lost more strength after five dry cleanings.

Wet warp. Both of the 100% Orlon blankets showed a highly significant loss in strength after all cleaning treatments. Ob lost the greatest amount after one laundering and one dry cleaning.

All of the rayon blends lost strength at the 1% level of significance with the exception of the 13% rayon-Orlon blend (ROb). In general, the rayon blends lost more strength in laundering than in dry cleaning. However, two blankets (ORa and RNb) which shrank considerably did not lose as much strength in laundering.

Dry filling. The 100% Orlon blankets were highly significant in strength after launderings and dry cleanings than originally; the greatest strength gains occurring in the fifth cleanings. The filling strength of Ob nearly doubled at five launderings. As there was no shrinkage or increase in yarn count further research would be necessary to attempt to account for this increase. For both of the 100% Orlon blankets the strength gain after one and five launderings was significantly higher than after one and five dry cleanings.

The rayon blends, in general, were stronger after laundering than after dry cleaning. It must be noted that

shrinkage was also greater, in general, after laundering than dry cleaning.

Two of the blankets lost strength in cleanings. The 13% Orlon blend which had no filling core lost approximately 50% of its strength in one dry cleaning. The 7.9% Orlon blend which did have a filling core also showed a highly significant strength loss after both dry cleanings and one laundering.

Wet filling. Neither of the 100% Orlon blankets showed any significant wet strength loss after either method of cleaning. As in dry filling strength there was a greater gain in strength in laundering than in dry cleaning.

Two rayon-Orlon blends (ORa and ORb) showed significant strength loss after all cleaning treatments. Both of these blankets had filling core yarns. The third blanket with a core yarn (ROa) showed a significant loss only after five dry cleanings but a gain in strength after other cleanings. The rayon-Orlon blend which had no filling core (ROb) showed a highly significant gain in strength after five laundering but a loss after one laundering and one dry cleaning. In this blanket the relationship of strength increase is not correlated with shrinkage.

The rayon-nylon blend RNa was highly significantly stronger after all cleanings. Rayon-nylon blend RNb gained considerably more strength in laundering than in dry cleaning.

Significant gains in strength in this latter case relate directly to shrinkage.

Analysis of Variance Among Blankets

Dry warp. Initial tensile strength of the warp yarns was directly related to yarn number and twist, and yarn count. The strongest blankets, rayon-Orlon blends ROa and ORb, had the heaviest yarns (15's) and relatively high yarn counts (40 and 42 yarns per inch). The stronger of the two 100% Orlon blankets (Ob) had the finest yarns (22's) but also the highest amount of twist (14.7 t.p.i.) and a high count (42 yarns per inch).

The Orlon blanket (Oa) which ranked among the lowest of the eight blankets in tensile strength also had a low yarn count (32 yarns per inch), relatively heavy yarns (16's), and average twist (10.9 t.p.i.). The rayon-Orlon blend (ROb) which had the highest yarn count (46 yarns per inch), relatively fine yarns (18's), and twist comparable to the blend ORb, was not as strong as either ROa and ORb. Evidently the four additional yarns per inch in ROb did not compensate for the fineness of the yarns and the lower twist.

In laundering the rayon-Orlon blends (viscose warps) lost more strength than the 100% Orlon blanket (Ob). However, in the other Orlon blanket (Oa), strength change was comparable to that in the strongest viscose blends.

When laundered, the rayon-nylon blends lost significantly more warp strength than either the Orlon or Orlon blends. Blanket RNb lost considerably more strength than any of the others even though its shrinkage was much greater than RNa or any of the Orlon blends.

Orlon blanket Ob lost relatively more strength in five dry cleanings than any of the other blankets. The rayon-nylon blend RNb by contrast gained strength in five dry cleanings.

In general, the 100% Orlon blankets lost more strength when dry cleaned while the viscose blends lost more when laundered.

Wet warp. The Orlon warps were highly significantly stronger than the viscose warp yarns when wet.

When laundered the viscose warps showed greater loss in wet strength than the Orlon warps. ROa lost relatively more wet strength in laundering than any of the other viscose blends.

After one dry cleaning, the 100% Orlon blankets were highly significantly stronger than any of the rayon blends. However, the two rayon blends (ROa and ORb) having the heaviest warp yarns were highly significantly stronger than any of the other blends.

After five dry cleanings both of the 100% Orlon blankets were superior in strength to all of the blankets in the study. However, Ob was highly significantly stronger than Oa. Although Oa had a lower yarn count and yarn twist than Ob, it shrank more

than Oa in five dry cleanings. These differences may account for the strength variation in these two blankets.

After five dry cleanings the relative strengths of the rayon blends were unchanged except for the one rayon-nylon blend (RNb) which showed a significant gain in strength.

Dry filling. There was no direct relationship, initially, between fiber content and dry filling strength. There was an interrelationship of yarn number and amount of twist, yarn count, and fiber content. The blankets with filling core yarns were significantly stronger than those without. The 100% Orlon blanket (Ob) which had heavier yarns (2's) was not significantly different from one of the blends (ORa) which had a core filling yarn. The 8% nylon blend (RNa) was comparable in strength to both of the 100% Orlon blankets. Although blanket RNa had heavier yarns its yarn count was lower than that in either of the Orlon blankets.

After one laundering the 100% Orlon blanket (Ob) was highly significantly stronger than all of the other blankets. The blankets with core yarns were significantly stronger than the other blends. The rayon-nylon blend RNa and Orlon blanket Oa were similar in strength. Both were comparable to blanket ORa. Although ORa had a core yarn it was not as strong as the other two blankets with cores.

After five launderings all of the blankets were highly significantly stronger than either the rayon-nylon blend RNb

or the 13% Orlon blend ROb. The latter had no core in the filling yarns. Since both of these blankets shrank it was evidently the low twist and other yarn properties which impaired their strength in laundering.

Blankets ROa and RNa lost considerably more strength in dry cleaning than in laundering. The Orlon blanket Ob, however, was highly significantly stronger in dry cleaning than any of the other blankets. Except for blanket ROa, those blankets with core fillings and the 100% Orlon blanket Oa were highly significantly stronger than the others. In dry cleaning as in laundering, blankets ROb and RNb were consistently weak. The two 100% Orlon blankets were more comparable in strength but stronger than the blends after five dry cleanings. Blanket RNa gained in strength so that it was comparable to the 100% Orlon blanket Oa and the blends with core filling yarns.

Wet filling. The strength relationship among the blankets was nearly the same wet and dry. The wet filling strength of blanket Ob was significantly greater than any of the other blankets. Blanket Oa, the blends (ORa, ORb and ROa) with filling cores, and RNa were all similar in initial wet strength. All of the blankets were highly significantly stronger than blankets ROb and RNb, initially, as well as throughout both types of cleanings.

After five launderings and all dry cleanings, blanket 0a had gained in strength so that it was comparable to the other Orlon blanket and superior to all of the blends.

Summary of Tensile Strength

In summary, the 100% Orlon blankets were initially superior in strength to all of the blends and maintained that superior strength in cleaning. One Orlon blanket (Ob), however, was superior in strength to the other (0a). However, tests showed that they differed in both yarn and fabric structure and probably they differed in fiber denier as well.

Both of the 100% Orlon blankets were stronger after laundering than dry cleaning, whereas, the rayon blends, in general, were stronger after dry cleaning.

In wet and dry strength relationships, the two 100% Orlons were again superior to the blends. The viscose warps in the blends lost one-half or more of their strength when wet. However, the addition of Orlon or nylon to the viscose filling yarns greatly improved their wet strength. Analysis of test data did not reveal that a 30% addition of Orlon improved wet strength more than 7% or 8%, or that nylon was significantly different from Orlon in improving wet strength.

Dry filling strengths seemed to relate more closely to yarn structure and count than to fiber content. The presence of a high twist core yarn in the filling significantly increased its strength.

In general, the filling strengths of all of the blankets were lower than their warp strengths. This was to be expected because of the napping and very low twist in the filling yarns. Fillingwise strength in rayon-Orlon blend ROb and rayon-nylon blend RNb were so low that their potential serviceability would be doubtful particularly when laundering was the necessary cleaning method.

Elongation

In staple yarns, elongation is a function of yarn structure and the cohesive qualities of the fibers as well as inherent fiber elongation properties.

Cassie (11) states that fibers spiral around one another in the yarn; each fiber being shaped like an open spring. When stretched, the yarn may elongate by uncoiling or twisting about its own axis. In the former case the fiber surfaces separate, and in the latter any elongating of the yarn packs the fibers more closely. Viscose and nylon fibers tend to pack when elongated. Reaction of Orlon in yarns was not available.

Analysis of Variance Among Treatments

All the blended blankets had viscose warp yarns. However all did not react similarly because their yarn structures were not alike. The 100% Orlon warps showed some differences for the same reason.

ELONGATION
Elongation in Percent
WARP

Code	Original		After 1 Laund.		After 5 Laund.		After 1 D. Clean.		After 5 D. Clean.	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Oa	22.3	26.1	20.8	22.3	21.3	21.5	18.9	21.1	19.5	23.2
Ob	29.7	31.1	30.4	34.0	29.3	33.8	29.3	33.5	27.0	34.2
ORa	17.5	11.9	17.5	11.6	15.3	10.5	15.8	10.2	17.7	10.3
ORb	15.5	12.9	18.0	11.5	18.3	11.2	16.1	11.1	17.8	11.2
ROa	15.8	13.9	18.4	13.4	18.1	11.9	16.3	13.2	16.2	14.1
ROb	14.9	7.7	19.1	8.5	17.4	9.4	16.6	9.5	16.5	9.6
RNa	14.9	12.0	17.4	11.0	19.1	11.6	15.6	12.2	14.3	10.8
RNb	9.3	10.6	17.7	10.4	16.3	10.1	9.9	10.1	10.3	11.5

*L.S.D. at the 5% level of significance is 3.18.

*L.S.D. at the 1% level of significance is 4.22

FILLING

Code	Original		After 1 Laund.		After 5 Laund.		After 1 D. Clean.		After 5 D. Clean.	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Oa	19.9	25.3	27.7	27.3	29.8	25.2	23.5	23.4	21.5	30.1
Ob	17.8	24.1	19.9	21.3	19.0	20.2	18.4	17.4	14.4	16.7
ORa	15.7	16.2	13.9	15.3	16.1	15.0	14.3	14.0	11.9	15.3
ORb	16.9	19.5	20.3	18.3	16.3	15.0	18.5	16.9	15.5	15.1
ROa	12.5	12.2	12.5	13.8	10.9	11.9	11.9	11.5	11.1	10.8
ROb	7.6	9.4	13.9	14.4	17.1	22.2	13.0	16.7	18.1	15.4
RNa	15.9	13.8	14.5	16.3	18.8	17.7	14.7	16.6	16.9	16.6
RNb	7.7	9.0	16.5	16.5	19.0	18.8	15.8	17.3	19.9	12.1

*L.S.D. at the 5% level of significance is 5.37

*L.S.D. at the 1% level of significance is 7.31

*The above least significant differences for comparison of two means refer only to variance among blankets at a given treatment level and not to variance among treatments for one single blanket.

Dry warp. Both of the 100% Orlon blankets showed no significant decrease in elongation in launderings but decreased significantly with dry cleanings. The rayon-Orlon and rayon-nylon blends showed highly significant increases in elongation with launderings.

Two rayon-Orlon blankets (ORa and ROb) and the 7% nylon blend (RNb) decreased in elongation after one laundering but the 8% nylon blend (RNA) increased between one and five launderings.

Change in elongation in dry cleaning was not so marked as in laundering. Elongation readings for two rayon-Orlon blends (ORa and ORb) did not change significantly from the original but there was an increase between one and five dry cleanings. One rayon-Orlon blanket (ROb) increased in elongation after one dry cleaning. Although the elongation showed a decrease after five dry cleanings it was still higher than originally.

Elongation for both of the rayon-nylon blends was not changed significantly by dry cleaning although there was a decrease after one dry cleaning.

Wet warp. The 100% Orlon blankets reacted differently from each other when wet. There was a highly significant decrease in elongation after both launderings and both dry cleanings in blanket Oa. The other Orlon blanket (Ob) did not change with cleaning treatments.

The rayon-Orlon blends, however, reacted quite differently. Both ORb and ROb showed significant decreases in elongation after all cleaning treatments; ROb showing greater decrease in dry cleaning than in laundering. ORa decreased in elongation in dry cleaning. ROa showed no change after one dry cleaning but decreased significantly in five.

Neither of the rayon-nylon blends showed elongation change with any cleaning treatments.

Dry filling. There was variation in fiber content used in the filling yarns as well as variation in their yarn structures.

Changes in elongation varied between the two 100% Orlon blankets; Oa showing a highly significant increase in launderings but no significant change in dry cleanings. Conversely, Ob increased in elongation in five dry cleanings but did not change with one or five launderings.

The rayon-Orlon blends also reacted erratically in elongation in both cleaning treatments. The 30% Orlon blanket (ORa) showed a significant loss in elongation after one laundering but no significant loss at five launderings. However, the effect of five dry cleanings was the opposite, as there was a significant decrease in elongation. The 8% Orlon blend (ORb) showed a highly significant increase in elongation in one laundering but there was no significant difference between the original and after five dry cleanings. Like ORa, the 8% Orlon

1

blanket (ORb) showed a highly significant decrease in elongation in five dry cleanings.

The rayon-Orlon blanket (ROb) and both of the rayon-nylon blends showed highly significant increases in elongation in all cleaning treatments.

Wet filling. The two 100% Orlon blankets reacted differently. There was a highly significant increase in elongation in dry cleaning for blanket Oa. Blanket Ob increased highly significantly in all cleaning treatments.

Changes in wet elongation for the rayon-Orlon blends varied among the blankets. The 30% Orlon blanket (ORa) decreased in elongation in one dry cleaning but regained the loss in five dry cleanings. The 8% Orlon blanket (ORb) showed highly significant losses in five launderings as well as five dry cleanings; whereas the 7.7% Orlon blend (ROa) showed an increase in elongation only in five launderings.

The 13% Orlon blanket (ROb) and both rayon-nylon blends (RNa and RNb) showed a highly significant increase in all cleaning treatments.

Because changes in elongation varied so greatly among treatments any relationships between elongation change and laundering or dry cleaning based upon either wet or dry values were difficult to determine.

Analysis of Variance Among Blankets

Dry Warp. One Orlon blanket (Ob) had greater elongation than any of the other blankets both originally and after all cleaning treatments. The other (Oa) had highly significantly better initial elongation than any of the blends.

Initially, there were no differences among blends except that all were higher than the nylon-rayon blend RNb. The warp yarns of RNb were stiff, apparently from excessive sizing. Such stiffness would account for its low elongation because sizing reduces the extensibility of the yarn.

After one laundering, all blends showed greater elongation so that they were comparable to Oa. However, after five launderings Oa was significantly higher in elongation than any of the blends.

After one dry cleaning there was no significant difference among the blends and blanket Oa. However, all of the blankets had highly significantly greater elongation than one rayon-nylon blend (RNb). In five dry cleanings, however, two rayon-Orlon blends (ROa and ROb) showed significantly greater decrease in elongation.

Wet warp. Again the 100% Orlon blanket (Ob) had highly significantly greater elongation than any of the other blankets. Orlon blanket Oa had highly significantly greater elongation than any of the blends. Initial elongation in the blends was similar with the exceptions of rayon-Orlon blend (ROb) and

rayon-nylon blend (RNb) which were highly significantly lower in elongation.

In one laundering, the elongation of ROb has increased so that only the one rayon-Orlon blend (ROa) was greater at the 1% level of significance. After five launderings there was no significant difference in elongation among the blends.

In dry cleaning as in laundering there was little difference among the blends. Elongation in the 7.7% blend (ROa) was significantly greater than in the two lowest blends (ROb and RNb). However, in five dry cleanings ROa increased in elongation so that it was significantly greater than either the 30% Orlon blend (ORa) or the 8% nylon blend (RNb) at the same number of cleanings.

Dry filling. There was no significant difference in elongation among the two 100% Orlon blankets, two Orlon-rayon blends (ORa and ORb), and one rayon-nylon blend (RNb). All of these blankets had highly significantly greater elongation than the 13% Orlon blanket (ROb) and one of the rayon-nylon blends (RNb).

In one laundering, elongation in the 100% Orlon blanket (Oa) showed an increase which was highly significant. The other blanket (Ob) and the rayon-Orlon blend (ORb) were significantly higher in elongation than any of the other blends. In five launderings, one rayon-Orlon blend (ROa) decreased so

that all of the other blankets were significantly greater in elongation.

Changes in one dry cleaning were similar to those in one laundering. In five dry cleanings, filling elongation in 0a, ORb and RNb were highly significantly greater than in two rayon-Orlon blends (ROa and ORa) and significantly greater than in any of the other blankets.

Wet filling. There was some relationship between fiber content and elongation values although all of the findings did not indicate a direct relationship. The 100% Orlon blankets had highly significantly greater elongation than the low percentage Orlon or nylon blends. However, the 8% Orlon blend was not significantly different from the 30% Orlon blend and 100% Orlon blanket (Ob).

In one laundering, elongation decreased in blanket Ob but even so it was still significantly greater than the blends. In five laundering elongation values for both of the rayon-nylon blends and the 13% rayon-Orlon blend (ROb) were significantly higher than in one laundering.

In one dry cleaning, both of the 100% Orlon blankets and one of rayon-nylon blends (RNb) were similar and each was significantly higher in wet elongation than the other blends. In five dry cleanings elongation was similar for all of the blankets except 100% Orlon blanket, 0a, which was significantly higher at the 1% level of significance.

Summary of Elongation

In summarizing elongation change, an analysis of data showed that there was great variation in elongation both among treatments and among the eight blankets. In general, the 100% Orlon blankets had highly significantly greater elongation than the blends. There was no clear-cut difference between wet and dry values in warp or filling determination.

Resistance to Abrasion

Analysis of Variance Among Treatments

All of the blankets were significantly more resistant to abrasion damage after they were cleaned. Abrasion damage was measured in terms of weight loss after subjection to test. In the case of the new blankets, some weight loss may have been due to loose fibers from the napping process.

In five launderings, abrasion resistance had increased significantly over all of the treatments and the original for all but three of the eight blankets. For the 100% Orlon blanket, Oa, resistance was as good after five dry cleanings as after five launderings. Two of the rayon-Orlon blends (ORa and ORb) were no more resistant after five launderings than after five dry cleanings.

Dry cleaning did not significantly affect abrasion resistance for most of the blankets. Exceptions include decreased resistance to abrasion in the 30% Orlon blend after

one dry cleaning and improved resistance of blanket ROa (7.7% Orlon) after five dry cleanings.

RESISTANCE TO ABRASION

Weight loss in grams after 350 abrasion cycles

Code	Original	After 1 Laund.	After 5 Laund.	After 1 D. Clean	After 5 D. Clean
Oa	.0302	.0315	.0209	.0269	.0237
Ob	.0529	.0366	.0288	.0399	.044
ORa	.0635	.0629	.0506	.0454	.0614
ORb	.1326	.1351	.1011	.1273	.1289
ROa	.1603	.1424	.0815	.1612	.1347
ROb	.0932	.0885	.0528	.0856	.1040
RNA	.0946	.0936	.0746	.0874	.0975
RNb	.1226	.1254	.0831	.1053	.1044

Analysis of Variance Among Blankets

Analysis of test results showed that the higher the percentage of Orlon in the blanket the better its resistance to abrasion. Results also revealed that a small percentage of nylon improved abrasion resistance more than a comparable percentage of Orlon. In fact, the 8% nylon blend had as good resistance to abrasion as the 13% Orlon blend.

There were highly significant differences among the eight blankets except in the following: no significant difference between the 7.9% Orlon blend and the 7% nylon blend, and

no significant difference between the 30% Orlon blend and the 100% Orlon blanket (Ob).

There was a highly significant difference in abrasion resistance between the two 100% Orlons; Oa being better than Ob which was comparable to the 30% Orlon blend. The greater loss in Ob was probably due to loose fibers from the napping process.

The two 100% Orlon blankets were highly significantly better in resistance to abrasion than all of the others after one laundering. Although there were still highly significant differences among the blankets; those with the higher percentages of Orlon were more resistant than those with less than 10% Orlon. However, the following changes did occur in the first laundering. The 30% Orlon blend was better than the 13% Orlon blend at the 5% level of significance instead of at the 1% level. Blanket Ob showed improved resistance after one laundering so that it had highly significantly better resistance than the 30% Orlon blend and was more comparable to the other 100% Orlon blanket Oa.

Five launderings increased resistance to abrasion in all of the blankets. Those with higher percentages of Orlon were superior but there was no significant difference between the 13% and 30% Orlon blends. After five launderings there was no significant difference between the two rayon-nylon blends and the 7.7% Orlon blend. However, the 7.9% Orlon blend (ORb) was still inferior to either of the rayon-nylon blends.

Abrasion resistance after one dry cleaning was comparable to resistance after one laundering except in the 30% Orlon blend in which resistance was greater after one dry cleaning than after five launderings.

Differences after five dry cleanings were similar to those after only one dry cleaning with two exceptions. There was no significant difference between either of the nylon-rayon blends and the 13% Orlon blend although after one dry cleaning the 13% Orlon blanket had been highly significantly better than blanket RNb. Both of the 100% Orlon blankets were far superior to any of the blends, but 0a was highly significantly better than 0b. It is noteworthy that after five dry cleanings six of the eight blankets were less resistant to abrasion than they were after five launderings.

Susich (37) states that resistance to abrasion is related to the stress-strain properties of the fiber. Fibers which can bear repeated stress with good elastic recovery will recover from repeated deformations in abrasion. Nylon is superior in this respect and Orlon is better than viscose.

Test results in this study conform to the above findings. Use of Orlon in higher percentage amounts showed significantly increased abrasion resistance. The nylon-rayon blends were found to be more resistant than blends of comparable percentage amounts of Orlon and rayon.

Backer and Tannenhaus (4) state, "For good wear the tearing-out action can be reduced by a firm binding of the fibers."

After five launderings most of the blankets (except the 100% Orlons) had matted nap. Matting seemed to increase fiber cohesion so that the "tearing-out" action was reduced. After five dry cleanings a considerable degree of pilling had occurred in the rayon blends. The greater loss in abrasion resistance after dry cleanings was probably due to the removal of the pills in the cleaning process.

Thermal Conductivity

Analysis of Variance Among Treatments

The results of this test indicated that thermal conductivity did not relate directly to fiber content. There was some indication that loss of fiber in cleaning decreased the insulating properties of the blanket.

The two 100% Orlon blankets did not react similarly after cleaning treatments. Blanket 0a's thermal insulating properties did not change significantly upon cleaning. However, blanket 0b was a significantly poorer insulator after laundering. Blanket 0b also seemed to lose fiber in laundering. The 30% Orlon blanket (0Ra) and the 7.7% Orlon blend both lost thickness in laundering and decreased in insulating capacity.

One Orlon blend (ROb) and one nylon blend (RNb) decreased in insulating capacity in one dry cleaning but improved

with five dry cleanings although their thicknesses did not change correspondingly.

The insulating capacity of two blankets (ORb and RNa) were not affected by cleaning.

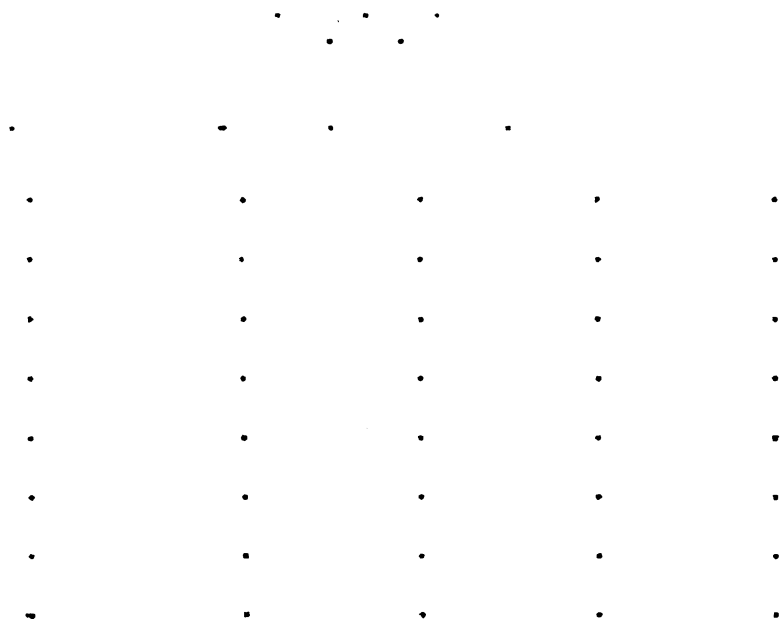
THERMAL CONDUCTIVITY

Conductance in Cal./cm.²/°C./Minute
x Thickness at 2 lb./in.² Pressure

Code	Original	After 1 Laund.	After 5 Laund.	After 1 D. Clean	After 5 D. Clean
Oa	.0196	.0211	.0214	.0185	.0204
Ob	.0176	.0192	.0212	.0184	.0168
ORa	.0211	.0264	.0255	.0233	.0230
ORb	.0235	.0254	.0262	.0260	.0251
ROa	.0210	.0266	.0272	.0276	.0253
ROb	.0245	.0263	.0262	.0279	.0248
RNa	.0254	.0269	.0274	.0293	.0255
RNb	.0237	.0249	.0278	.0284	.0226

Analysis of Variance Among Blankets

Initially, the 100% Orlon blankets were the best insulators. The rayon-nylon blends and the 13% Orlon blend were the poorest. Two Orlon blends (ORa and ROa) were highly significantly better than RNa and ROb and significantly better than RNb.



There was no direct relationship between thickness and insulating properties. Although blanket ORa was the thickest and a good insulator, blanket ROb which ranked second in thickness was one of the poorest insulators. Blankets Ob and ORb were the same in thickness but Ob was highly significantly better as an insulator.

After launderings, both of the 100% Orlon blankets were highly significantly better insulators than any of the blends. There was no significant difference in insulation values among the blends.

After one dry cleaning, both of the 100% Orlon blankets were superior in insulating properties to the other blankets. Two Orlon blends (ORa and ORb) were highly significantly better than one nylon blend (RNa). ORa was significantly better than the other Orlon blends and nylon blend RNb.

Although after five dry cleanings Ob was a better insulator than Oa, both of these 100% Orlon blankets were superior to all of the blends with one exception. One rayon-nylon blend (RNb) was as good an insulator as Oa. Blanket Ob increased in thickness in dry cleaning, the change probably being due to shrinkage. That change may account for it having better insulating properties than Oa. The improved insulating qualities of RNb after dry cleaning may have been due to change in thickness although its thickness did not increase appreciably.

In general, the 100% Orlon blanket Oa was consistently a better insulator than the other blankets and did not change

either in laundering or dry cleaning. Although blanket Ob was the best insulator initially, its insulation capacity decreased in five launderings and increased in five dry cleanings. After launderings and dry cleanings there was little difference in the insulation values among the blends except that nylon blend RNb, because of fiber loss, was significantly poorer after five launderings and one dry cleaning. Orlon blends ORa and ORb were significantly better insulators after one dry cleaning probably due to increase in thickness.

Compressional Resilience

The compressional resilience of the specimen is the amount of work recovered when the pressure is decreased from 2 lbs./in.² to 0.1 lbs./in.² expressed as a percentage of the work done on the specimen when the pressure is increased to 2 lbs./in.²

COMPRESSIONAL RESILIENCE IN PERCENT

Code	Original	After 1 Laund.	After 5 Laund.	After 1 D. Clean.	After 5 D. Clean.
Oa	26.66	30.48	31.73	22.70	23.50
Ob	26.13	33.29	30.47	26.77	29.12
ORa	25.56	21.51	32.36	29.46	27.50
ORb	26.71	26.10	31.55	27.97	28.17
ROa	28.07	31.26	31.52	28.04	29.50
ROb	27.06	27.28	29.32	25.50	26.92
RNa	23.30	29.69	34.92	23.96	27.60
RNb	23.70	31.64	33.66	24.97	27.04

There was little difference in compressional resilience among the original samples. The 100% Orlon blankets and all of the rayon-Orlon blends were in a range of 25.56% to 28.07%. The rayon-nylon blends were slightly lower being 23.3% (RNa) and 23.7% (RNb).

Schiefer, et. al. (31) reported 100% wool blankets to have a compressional resilience of 50% and blankets of 12% nylon-1% cotton-87% viscose, to have a resilience of 24%. Rogers, et. al. (29) found 100% wool blanket blends of new and reused wool to have compressional resilience of 31-33%.

Almost all of the fabrics in this study gained in compressional resilience as a result of laundering. Two exceptions were the 30% Orlon blanket which lost 4% compressional resilience and the 8% blend ORb, which lost only 0.6%.

After five dry cleanings, the increase in compressional resilience was even greater, being 10% and 12% increases for the two rayon-nylon blends. The 100% Orlon blankets gained 4% and 5%, respectively, and the rayon-Orlon blends gained from 2% to 6% in resilience.

Schiefer, et. al. (32) report that compressional resilience increased with matting because there was less motion of fibers relative to each other when a load was applied. When there is less motion of fibers relative to one another, it takes less energy to compress the fabric thus compressional resilience (the ratio of energy recovered when a compressive load is



removed to the total energy expended when the load is applied) increases.

Subjective analysis revealed there was considerable matting in the rayon-nylon and rayon-Orlon blends after launderings although the 100% Orlon blankets did not show as much change. The 13% Orlon blend showed the greatest amount of matting among the rayon-Orlon blends although its compressional resilience did not increase as much.

Change in compressional resilience after dry cleanings was not as great as after launderings. Most of the blankets increased in resiliency between 0.5% and 4% after one dry cleaning and from 1% to 5% after five dry cleanings. The 13% Orlon blend lost 1% resilience after one dry cleaning and 0.14% after five. The 100% Orlon blankets reacted differently. 0a lost 4% after one and 3% after five dry cleanings, 0b was 0.47% more resilient after one and 3% more resilient after five dry cleanings. This would indicate that yarn and fabric structure are functions of compressional resiliency as well as the fiber content of the fabric.

Maintenance of initial or an increase in compressional resilience in cleaning is highly desirable. In general, resilient fabrics have better hand, resistance to abrasion, and better insulating qualities.

Results of this test are misleading since compressional resilience values were higher for the laundered blankets which had matted appreciably. Matted fabrics, however, do not seem resilient.

Compressibility

Schiefer (31) defines compressibility as "the ratio of the rate of decrease in thickness at a pressure of 1 lb./in.² to the standard thickness." Rogers, et. al. (29) found in studying wool blankets that as felting occurred with laundering, compressibility decreased. Schiefer, et. al. (32) also found compressibility to decrease with laundering. The authors state that a high value of compressibility indicates a greater amount of napping whereas a lower value indicates felting or matting of the nap.

COMPRESSIBILITY

Ratio of the rate of decrease in thickness at 1 lb./in.²
to the Standard Thickness

Code	Original	After 1 Laund.	After 5 Laund.	After 1 D. Clean.	After 5 D. Clean.
Oa	.325	.320	.255	.296	.329
Ob	.383	.348	.401	.321	.365
ORa	.273	.237	.200	.321	.301
ORb	.265	.223	.200	.314	.311
ROa	.293	.235	.179	.318	.298
ROb	.266	.241	.207	.308	.326
RNa	.277	.221	.194	.295	.320
RNb	.358	.236	.220	.346	.367

All blankets in this study with the exception of one 100% Orlon blanket (0a) decreased in compressibility with increased launderings. Blankets which showed the greatest amount of matting also showed the greatest decrease in compressibility.

After dry cleanings, the rayon-Orlon and rayon-nylon blends increased in compressibility. These fabrics, however, showed considerable pilling after dry cleaning. Pilling, although a distortion, is a projection from the fabric surface which would permit more fiber motion when a compressing load was applied than a matted surface would permit, thus the higher compression values.

The 100% Orlon blankets showed little or no pilling after one dry cleaning, and only a slight amount after five. Both decreased in compressibility after one, but gained after five dry cleanings. Blanket 0b was still less compressible after five dry cleanings than the original fabric.

Flammability

The apparatus of the American Association of Textile Chemists and Colorists was used for testing flammability. The results were evaluated in terms of their specifications.

Classification of flammability is based on the time of flame spread from time of ignition.

Class I: Normal flammability.

Fabrics of this class are considered to have no unusual burning characteristics. The class includes napped fabrics which have a flame spread time of 7 seconds or more, or a surface flash of less than 7 seconds providing the base fabric does not ignite.

Class II: Intermediate Flammability.

Napped fabrics in this class have a time of flame spread of 4 to 7 seconds inclusive and the base of the fabric is ignited or fused.

Class III: Rapid and Intense burning.

Napped fabrics in this class have a time of flame spread of less than 4 seconds and the base fabric is ignited or fused.

The 100% Orlon fabrics fused at the point of flame contact but did not burn. These were rated as non-flammable.

The six blankets which were 70% or more viscose were rated as class III in flammability. All of them burned in two seconds or less and the base fabric was destroyed. These blankets were thus rated as highly flammable.

Federal law requires that apparel fabrics which are highly flammable be given fire retardant finishes. The law, however, does not cover household textiles which includes blankets.

C. Subjective Analysis

A group of 25 women composed of textiles and clothing instructors, instructors in other phases of home economics, extension home economists, and graduate students in home economics were asked to judge appearance and hand change after the blankets were cleaned.

Each member of the panel was given a questionnaire (see Appendix) which asked her to rate change in color, pilling, matting or flattening of nap, hand change, and loss of nap. Each was also asked to give a composite rating based on all of

the changes for each blanket. The following rating scale was used:

- (0) = No change from the original
- (1) = Slight change from the original
- (2) = Moderate change from the original
- (3) = Great change from the original
- (4) = Very great change from the original

Each person was also asked to list which change she considered the most objectionable and to make a first choice, a second choice, and last choice among the eight blankets.

An analysis of the 25 questionnaires follows:

Color Change

There was virtually no change in color either in laundering or dry cleaning. One blanket (ROa) was judged as showing a slight change after five dry cleanings but that was probably due to a difference in light reflectance caused by change in fabric surface rather than in color.

Pilling

The 100% Orlon blankets showed the least amount of pilling. They were rated as only moderately changed after five dry cleanings.

Most of the pilling occurred in the five dry cleanings with slightly less occurring in five launderings. All of the rayon blends pilled to some extent but, in general, the higher the percentage of Orlon in the blanket the lesser the degree of

pilling. The nylon blend RNb showed a greater amount of pilling than any of the other blankets.

Matting or Flattening of Nap.

The 100% Orlon blankets showed the least amount of matting. The blends matted more in five launderings than in the other cleanings. However, appreciable matting occurred in five dry cleanings. The two rayon-nylon blends showed the greatest amount of matting. RNb was rated as showing very great change after five launderings. However, the 13% Orlon blend was only slightly better than RNb.

Change in Hand

Both of the 100% Orlon blankets showed little change in hand after any of the cleanings. Oa changed moderately in five dry cleanings. Ob changed moderately in one and five launderings and similarly in five dry cleanings. Three Orlon-rayon blends (ORa, ORb, and ROa) showed great change in hand after five launderings and five dry cleanings. Blanket ROb showed very great change after five launderings but only moderate change after five dry cleanings. Both of the rayon-nylon blends changed more in laundering than in dry cleaning. Both were judged as having changed very greatly in five launderings and greatly in five dry cleanings.

Loss of Nap

The women felt that loss of nap was difficult to determine by subjective analysis. For most of the blankets the change was rated as moderate after five launderings and five dry cleanings. The 100% Orlon blanket (0a) was rated as showing less change than (0b) in laundering. Both of the rayon-nylon blends and the 13% Orlon blend showed moderate loss of nap after one laundering. In general, analysis of laboratory tests was in agreement with the subjective evaluations.

Composite Rating

All of the judges rated the 100% Orlon blankets as showing the least change in appearance and hand after repetitive cleanings. They also rated the nylon-rayon blends as having changed the most. Their evaluations did not indicate that any of the rayon-Orlon blends changed more in all respects than the others.

Summary of Subjective Analysis

When asked which specific change they considered the most objectionable, 37% of the women listed matting or flattening of nap. Pilling, hand change, and loss of nap were each listed by 21% as the most objectionable change.

When asked which blanket they preferred as their first choice, 65% chose the 100% Orlon blanket 0a, and 35% chose the

100% blanket, Ob. For their second choice 55% chose blanket Ob, 27% chose Oa, 9% chose the 30% Orlon blend (ORa), and the remainder of the judges chose one of the other rayon-Orlon blends.

When designating the blanket they liked least, 23% chose the 30% Orlon blanket, ORa; 23% chose the rayon-nylon blend, RNa; 18% chose the 7.9% Orlon blend (ORb); and 18% chose the nylon blend, RNb. The small remainder of choices were divided between the other two rayon-Orlon blends.

The photographs on page 86 show the blanket surfaces originally and after five launderings and dry cleanings.

SUBJECTIVE ANALYSIS*

Code	Change in Color				Pilling				Flattening or Matting of Nap			
	1L	5L	1DC	5DC	1L	5L	1DC	5DC	1L	5L	1DC	5DC
Oa	.04	.13	.17	.41	.08	.54	.54	1.92	.75	1.65	.65	1.90
Ob	.04	.08	.13	.21	.80	1.12	.80	2.47	1.45	2.15	1.00	2.10
ORa	.08	.46	.46	.88	.54	1.38	1.62	3.25	1.55	2.65	1.65	2.50
ORb	.17	.46	.25	.92	.54	2.38	1.42	3.62	1.40	2.50	1.30	2.30
ROa	.13	.62	.29	1.13	.80	2.25	.92	3.59	1.25	2.50	.95	2.15
ROb	.17	.57	.09	.35	1.20	2.70	1.08	2.83	2.30	3.25	1.15	2.50
RNa	.17	.96	.46	.79	1.20	2.33	1.38	3.46	2.20	3.30	1.70	2.90
RNb	.71	.88	.5	.92	2.04	2.50	1.67	3.40	3.30	3.75	1.75	2.95

	Loss of Nap				Change in Hand				Composite Rating			
	1L	5L	1DC	5DC	1L	5L	1DC	5DC	1L	5L	1DC	5DC
Oa	.03	.95	.41	1.62	.45	1.41	.62	1.83	.65	1.34	.91	2.24
Ob	1.29	1.66	.95	2.04	1.91	2.16	.75	2.04	1.43	2.10	.10	2.48
ORa	1.16	1.95	1.00	1.79	1.45	2.79	1.33	2.87	1.43	2.54	1.54	3.21
ORb	.91	2.04	.91	2.16	1.58	2.95	1.29	2.79	1.58	2.82	1.47	3.13
ROa	1.00	2.25	.83	2.33	1.45	2.87	1.25	3.12	1.36	2.76	1.21	3.13
ROb	1.50	2.45	.87	1.95	2.41	3.54	1.00	2.41	2.17	3.26	1.30	2.69
RNa	1.54	3.12	1.45	2.79	1.91	3.87	1.62	2.95	2.10	3.43	1.74	3.30
RNb	2.04	2.37	1.33	2.33	3.04	3.79	1.70	2.75	3.02	3.06	2.09	3.20

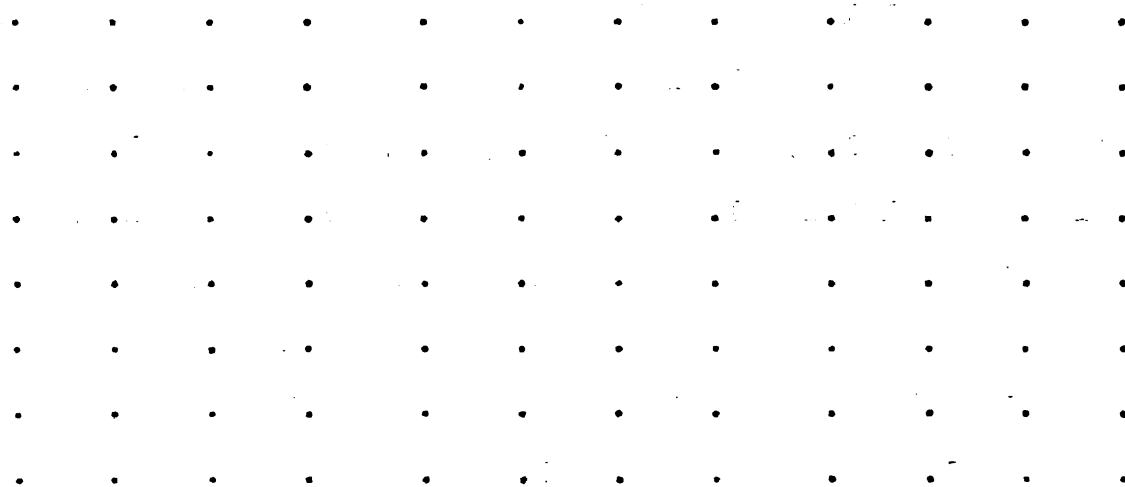
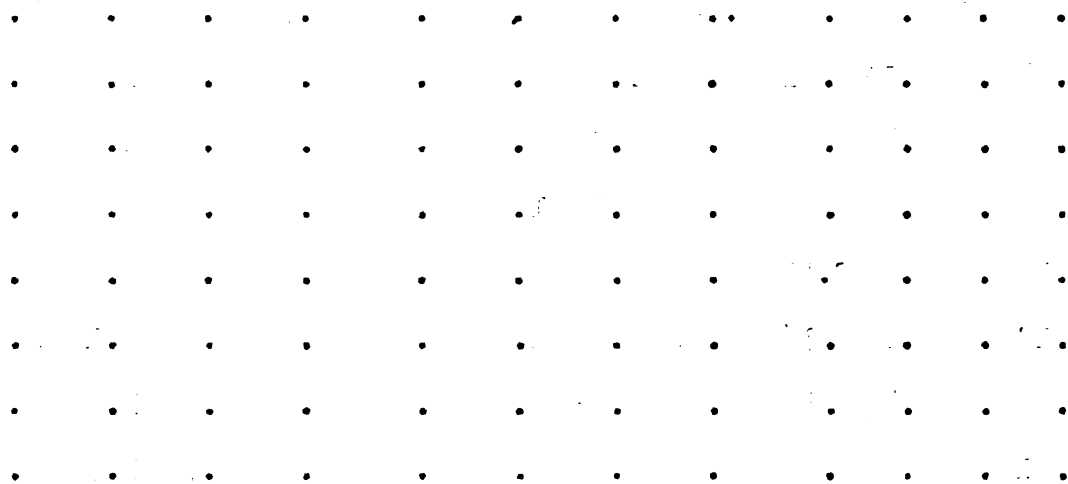
*0 = No change

1 = Slight change

2 = Moderate change

3 = Great change

4 = Very great change



CONCLUSIONS

The findings of this comparative study of 100% Orlon, rayon-Orlon, and nylon-rayon blended blankets of varying percentages showed differences in their initial performance characteristics as well as changes in laundering and dry cleaning. Conclusions relating fiber content and performance were difficult to draw because of variation among the eight blankets in their initial specifications. Performance characteristics are functions of a complexity of yarn and fabric structure and fiber content. However, on the basis of consistency of test data some conclusions are evident.

The two 100% Orlon blankets did not perform alike in all respects because of probable variation in the denier of the fibers and variation in yarn geometry. Blanket Ob, retailing at \$11.99, had consistently higher tensile strength but blanket Oa, at \$13.75, had higher resistance to abrasion. In other performance tests they rated similarly. When judged subjectively, both of these 100% Orlon blankets were ranked above all of the others; 65% of the judges listing Oa as their first choice. It would appear that if their performance did not warrant the higher price, appearance preference might.

Despite differences between the two 100% Orlon blankets both were superior in over-all performance to any of the blends.

Not only were the Orlon blankets more outstanding initially but they were also more stable in both cleaning procedures.

With one exception, there was no evidence in this study that an addition of 30% Orlon to a viscose blanket was significantly better than an addition of 13% or 8%. Resistance to abrasion, however, did seem to relate more directly to fiber content. As the percentage of Orlon was increased better resistance to abrasion was noted. However, an addition of 7% or 8% nylon to the viscose improved abrasion resistance as much as the addition of 13% Orlon; that is, 7% or 8% nylon was better than a comparable percentage of Orlon.

Small additions of Orlon and nylon seemed to improve the wet tensile strength of viscose. However, results did not reveal differences in wet tensile strength relative to percentage fiber composition.

The consumer-buyer is interested in price as it relates to performance, appearance, and hand of the fabric. In fact, price is often the criterion of selection. Findings of this study revealed that the two 100% Orlon blankets which were highest in price were consistently superior in performance. The 7% rayon-nylon blend which was consistently the poorest of the eight in performance and was ranked as the least acceptable in appearance was also the lowest in price (\$4.98).

Price-performance relationships among the six blanket blends were not so consistent. The 7.9% Orlon blanket at \$10.95

did not perform sufficiently better than the 8% nylon blend at \$5.90 or the 7.7% Orlon blend at \$7.90 to warrant the two or three dollars difference in price. No Orlon-rayon blend blanket was superior in enough performance characteristics to be ranked as a better value than the others, although they varied in price from \$6.98 to \$10.95.

The 8% nylon-rayon blend was superior in performance to the 7% nylon-rayon blend although it was only \$1.00 higher in price.

On the basis of this study it appeared that laundering was the more satisfactory cleaning procedure for the 100% Orlon blankets. There was less dimensional change in laundering than dry cleaning as well as a less significant loss in tensile strength.

Dry cleaning seemed a more satisfactory method of cleaning for the blends. There was less dimensional change, less loss of fiber, less change in appearance, and, in general, not as great a loss of thermal insulating properties in dry cleaning as in laundering.

SUMMARY

This study was composed of two 100% Orlon blankets, four rayon-Orlon blends in different percentages, and two rayon-nylon blends.

The blankets were divided into four groups of two each according to retail price and fiber composition. Group I--100% Orlon blankets at \$13.75 and \$11.99; Group II--rayon-Orlon blends of approximately 25% Orlon and 75% rayon at \$9.90 and \$10.95; Group III--rayon-Orlon blends of approximately 10% Orlon and 90% rayon at \$7.90 and \$6.98; and Group IV--rayon-nylon blends of approximately 10% nylon and 90% rayon at \$5.90 and \$4.98. Weave construction was held as constant as possible among the four groups.

The purposes of this study were to compare through a series of laboratory tests the performance of rayon-Orlon blends of different percentage compositions with 100% Orlon blankets and to compare rayon-nylon blends with rayon-Orlon blends of the same percentage composition. Other purposes were to determine any relationships of retail price to performance and fiber composition and to compare laundering and dry cleaning as procedures for these blankets.

The blankets were laundered five times in an automatic washer under home laundering conditions. Samples were withdrawn

after one and five launderings for laboratory tests. In like manner, specimens were sent to a commercial dry cleaner for five cleanings and samples were withdrawn for testing after one and five dry cleanings.

After original dimensions were determined the blankets were analyzed for initial specifications. All of the blends were found to have viscose staple warp yarns and blended staple filling yarns. Three rayon-Orlon blends had core yarns in the filling. All napping was in the filling only. Analysis revealed that both of the blankets in Group I were 100% Orlon. In Group II one blanket was 30% Orlon and the other was 7.9% Orlon. Group III blankets were 7.7% Orlon and 13% Orlon. Group IV rayon-nylon blends were 8.2% and 7% nylon.

There was variation among the eight blankets in yarn number, count, and twist. The warp yarns of all of the blankets were much higher in twist than the respective filling yarns. The warps ranged in size from 9's to 15's; the filling yarns were 2's and 3's. The core yarns were 26's. Only two of the eight blankets had a balanced yarn count. Filling counts ranged from 28 to 34 yarns per inch and the warps from 31 to 46 yarns per inch. Changes in yarn count in laundering and dry cleaning related directly to dimensional change.

Initially, all of the blankets were less than .200 inch thick at 1 lb./in.² pressure. The rayon-Orlon and rayon-nylon blends lost thickness in laundering; the rayon-nylon

blends and the 30% Orlon blend losing the most. Changes in thickness in dry cleaning were slight.

Initial weights of the blankets ranged from 9.3 oz./yd.² to 14.15 oz./yd.². All of the blankets gained in weight in laundering; those which shrank gaining the most. Five blankets (one 100% Orlon, the two rayon-nylon blends, and two Orlon blends) decreased in weight after one laundering. These blankets also lost thickness which indicated a loss of fiber in laundering. The 100% Orlon blankets gained more weight in dry cleaning than in laundering, but they also shrank some in dry cleaning. The 30% Orlon blend gained more weight in dry cleaning. The other blends showed less weight change in dry cleaning than laundering but they were also more dimensionally stable. The rayon-nylon blends and one 100% Orlon blanket seemed to lose fiber in dry cleaning as well as in laundering.

The 100% Orlon blankets were dimensionally stable in laundering but shrank slightly in dry cleaning. One rayon-nylon blend shrank more than 10% warpwise in one laundering. Warp shrinkage in laundering progressed in all blends until at five launderings four of the blends had shrunk 8% or more. Dimensional change in the filling was negligible. All of the blended blankets were considerably more stable in dry cleaning than in laundering.

The 100% Orlon blankets were initially superior in tensile strength to all of the blends and maintained superior strength in cleaning. Both of the Orlon blankets were stronger

after laundering than dry cleaning. In general, the rayon blends were stronger after dry cleaning than laundering. When wet the 100% Orlon blankets were again superior in strength to the blends. The viscose warps of the blends lost one-half or more of their strength when wet.

In dry filling strength the blends with core yarns were superior to those without a core. The presence of nylon or Orlon in the filling of the blends significantly improved their wet strength. In general, the filling strength of all of the blankets was lower than their warp strength. The filling strength of the blends without core yarns was so low that their serviceability would be questionable.

The Orlon blankets had highly significantly greater elongation than the blends both in the warp and filling. There was considerable variation in elongation among treatments and among the blends. There were no clear-cut differences, however, between wet and dry values for warp or filling.

Abrasion damage was measured by weight loss after 350 abrasion cycles. There was a direct relationship between fiber content and resistance to abrasion. The higher the percentage of Orlon the greater the resistance. The nylon blends were superior in abrasion resistance to the Orlon blends of comparable percentage fiber composition. In fact, a rayon blend with an 8% addition of nylon was as resistant as a blend with a 13% addition of Orlon. After laundering all blankets increased

in abrasion resistance, possibly because the nap had matted so that the fibers were less mobile. After dry cleaning, the blends were less resistant to abrasion than after laundering. This was probably because the blends pilled considerably in dry cleaning and abrading removed the pills.

The 100% Orlon blankets were consistently better thermal insulators than the blends. One Orlon blanket lost some insulating capacity after five launderings and five dry cleanings probably because of its loss in thickness. In the blends there was no direct relationship between fiber content and insulating capacity. In some instances there was a relationship between thickness and thermal insulation. Those blankets which lost thickness in launderings and dry cleanings showed a decrease in insulating capacity.

Originally, there was little difference in compressional resilience among the blankets. However, in laundering all of the blankets showed an increase except two of the Orlon blends. In five dry cleanings there was a greater increase than in laundering, particularly in the rayon-nylon blends. Compressional resilience findings were somewhat misleading, especially in laundering. The blankets which matted considerably showed an increase in resilience.

The blends decreased in compressibility with laundering although the Orlon blankets did not. This was to be expected because the nap of the blends matted appreciably and matting decreases compressibility. The blends were more compressible

... *... ..*

after dry cleaning than originally. This was probably because they pilled. The Orlon blankets which pilled only slightly were less compressible after one dry cleaning than originally but regained some of the loss in five dry cleanings.

All of the blends were highly flammable, but the 100% Orlon blankets did not burn.

The eight blankets were judged subjectively for changes in appearance and hand after cleaning treatments. There was virtually no change in color in any of the blankets. The blends showed considerable matting of nap in laundering; the rayon-nylon blends showing the greatest change. A greater change in hand occurred as a result of laundering; one rayon-Orlon blend and the two nylon blends showing the most change. The greatest amount of pilling was noticed after five dry cleanings. In general, the higher percentage of Orlon in the blend the less the degree of pilling. One of the nylon blends showed the greatest amount of pilling. The Orlon blankets changed very little in appearance and hand in cleaning and the nylon blends changed the most.

In all performance tests the 100% Orlon blankets were superior to the blends but they were also the most expensive. The nylon blend which gave the poorest performance was also the least expensive blanket in the study. No rayon-Orlon blend performed sufficiently better than the others to warrant its higher price. However, prices among the Orlon blends varied considerably.

This study did not reveal that the addition of 30% Orlon to a viscose blanket was any better than the addition of 8% except for improving resistance to abrasion. Differences in performance were due to variations in yarn and fabric geometry rather than fiber content.

On the basis of this study it appeared that laundering was a more satisfactory cleaning procedure for 100% Orlon blankets and dry cleaning was more satisfactory for rayon-Orlon and rayon-nylon blends.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. The text notes that without reliable records, it is difficult to track progress, identify issues, and make informed decisions.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It mentions the use of surveys, interviews, and focus groups to gather qualitative information, as well as statistical analysis and data visualization techniques to process quantitative data. The document stresses the need for a systematic approach to data collection and analysis to ensure the validity and reliability of the findings.

3. The third part of the document describes the process of interpreting the results and drawing conclusions. It highlights the importance of comparing the findings with existing literature and theoretical frameworks to provide context and meaning to the data. The text also discusses the potential limitations of the study and the need for further research to address these limitations.

4. The fourth part of the document provides a summary of the key findings and conclusions. It states that the study has identified several important factors that influence the outcomes of the research, and it offers practical recommendations based on these findings. The document concludes by emphasizing the value of the research and the potential for future studies to build upon the current work.

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24. Mauersburger, H. R., "Here's What is Happening in Synthetic Staple," Rayon and Synthetic Textiles, 31: 74, (Sept. 1950).

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the financial aspects of the organization. It provides a detailed overview of the budget, including the projected income and expenses for the upcoming year. This section also discusses the various financial risks and how they are being managed to ensure the organization's financial stability.

3. The third part of the document addresses the operational aspects of the organization. It describes the various processes and procedures that are in place to ensure the efficient and effective delivery of services. This section also discusses the various challenges that the organization is facing and how they are being addressed.

4. The fourth part of the document discusses the human resources of the organization. It provides a detailed overview of the current staff levels and the various roles and responsibilities of the different departments. This section also discusses the various training and development programs that are in place to ensure that the staff is equipped with the necessary skills and knowledge to perform their duties effectively.

5. The fifth part of the document discusses the legal and regulatory aspects of the organization. It provides a detailed overview of the various laws and regulations that the organization is subject to and how they are being complied with. This section also discusses the various legal risks and how they are being managed to ensure the organization's legal compliance.

6. The sixth part of the document discusses the environmental aspects of the organization. It provides a detailed overview of the various environmental risks and how they are being managed to ensure the organization's environmental sustainability. This section also discusses the various environmental programs that are in place to reduce the organization's carbon footprint and promote environmental conservation.

7. The seventh part of the document discusses the social aspects of the organization. It provides a detailed overview of the various social risks and how they are being managed to ensure the organization's social responsibility. This section also discusses the various social programs that are in place to support the community and promote social development.

8. The eighth part of the document discusses the overall performance of the organization. It provides a detailed overview of the various performance indicators and how they are being used to measure the organization's progress. This section also discusses the various challenges that the organization is facing and how they are being addressed.

9. The ninth part of the document discusses the future of the organization. It provides a detailed overview of the various strategic initiatives that are in place to ensure the organization's long-term success. This section also discusses the various risks and opportunities that the organization is facing and how they are being managed to ensure the organization's future growth and development.

10. The tenth part of the document discusses the conclusion of the report. It provides a detailed overview of the various findings and recommendations of the report. This section also discusses the various actions that are being taken to implement the recommendations and ensure the organization's continued success.

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[illegible]

QUESTIONNAIRE

Homemaker _____ Resident Staff _____ Extension Staff _____ Student _____

Your cooperation is being asked to help make an evaluation of change in appearance in eight blankets which have either been laundered or dry cleaned. This is a phase of my investigation of blankets made of synthetic fibers and blends. Although the comparisons in performance can be made by physical laboratory tests, appearance and hand are best evaluated subjectively. For this reason your assistance will be most helpful.

Following are definitions of terms as they pertain to this evaluation.

Color Change -- any variation from the original. This may be change in hue, fading, darkening, or streaking.

Pilling-- "balls" or "pills" on the surface of the fabric due to a collection of loose fibers.

Matting or Flattening of Nap -- loss of fluffiness or resilience of the nap causing it to lie close to the base weave. Loose fibers are entangled but without forming pills.

Hand -- the "feel" of the fabric. Look for softness, resilience, warmth to the touch, and pliability without limpness.

Loss of Nap -- a visible loss of the surface fibers. The blanket may seem to have lost thickness. (This is not to be confused with flattened nap.)

Each group of five samples represents one blanket. Sample O is the original untreated specimen. Samples A, B, C, and D have been subjected to cleaning treatments. Please make your evaluation by comparing the samples (A,B,C,D) to the original Sample O.

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Arar and Collins (1987). The *Chlorophyll a* and *Chlorophyll b* contents were expressed as $\mu\text{g g}^{-1}$ of dry weight.

1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 26

$$S_k = \{i \in \{1, \dots, n\} : \text{rank}(A_{i, :}) \leq k\} \quad \text{for } k = 1, \dots, n.$$

Figure 1. The effect of the concentration of the Ca^{2+} solution on the Ca^{2+} concentration in the Ca^{2+} solution. The concentration of the Ca^{2+} solution was 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 6.0, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 7.0, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.0, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 10.0, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, 11.0, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 12.0, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 13.0, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 14.0, 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 15.0, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.8, 15.9, 16.0, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 17.0, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 18.0, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 19.0, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, 19.9, 20.0, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 21.0, 21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 21.7, 21.8, 21.9, 22.0, 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9, 23.0, 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7, 23.8, 23.9, 24.0, 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, 24.9, 25.0, 25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7, 25.8, 25.9, 26.0, 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 27.0, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.0, 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 29.0, 29.1, 29.2, 29.3, 29.4, 29.5, 29.6, 29.7, 29.8, 29.9, 30.0, 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, 30.9, 31.0, 31.1, 31.2, 31.3, 31.4, 31.5, 31.6, 31.7, 31.8, 31.9, 32.0, 32.1, 32.2, 32.3, 32.4, 32.5, 32.6, 32.7, 32.8, 32.9, 33.0, 33.1, 33.2, 33.3, 33.4, 33.5, 33.6, 33.7, 33.8, 33.9, 34.0, 34.1, 34.2, 34.3, 34.4, 34.5, 34.6, 34.7, 34.8, 34.9, 35.0, 35.1, 35.2, 35.3, 35.4, 35.5, 35.6, 35.7, 35.8, 35.9, 36.0, 36.1, 36.2, 36.3, 36.4, 36.5, 36.6, 36.7, 36.8, 36.9, 37.0, 37.1, 37.2, 37.3, 37.4, 37.5, 37.6, 37.7, 37.8, 37.9, 38.0, 38.1, 38.2, 38.3, 38.4, 38.5, 38.6, 38.7, 38.8, 38.9, 39.0, 39.1, 39.2, 39.3, 39.4, 39.5, 39.6, 39.7, 39.8, 39.9, 40.0, 40.1, 40.2, 40.3, 40.4, 40.5, 40.6, 40.7, 40.8, 40.9, 41.0, 41.1, 41.2, 41.3, 41.4, 41.5, 41.6, 41.7, 41.8, 41.9, 42.0, 42.1, 42.2, 42.3, 42.4, 42.5, 42.6, 42.7, 42.8, 42.9, 43.0, 43.1, 43.2, 43.3, 43.4, 43.5, 43.6, 43.7, 43.8, 43.9, 44.0, 44.1, 44.2, 44.3, 44.4, 44.5, 44.6, 44.7, 44.8, 44.9, 45.0, 45.1, 45.2, 45.3, 45.4, 45.5, 45.6, 45.7, 45.8, 45.9, 46.0, 46.1, 46.2, 46.3, 46.4, 46.5, 46.6, 46.7, 46.8, 46.9, 47.0, 47.1, 47.2, 47.3, 47.4, 47.5, 47.6, 47.7, 47.8, 47.9, 48.0, 48.1, 48.2, 48.3, 48.4, 48.5, 48.6, 48.7, 48.8, 48.9, 49.0, 49.1, 49.2, 49.3, 49.4, 49.5, 49.6, 49.7, 49.8, 49.9, 50.0, 50.1, 50.2, 50.3, 50.4, 50.5, 50.6, 50.7, 50.8, 50.9, 51.0, 51.1, 51.2, 51.3, 51.4, 51.5, 51.6, 51.7, 51.8, 51.9, 52.0, 52.1, 52.2, 52.3, 52.4, 52.5, 52.6, 52.7, 52.8, 52.9, 53.0, 53.1, 53.2, 53.3, 53.4, 53.5, 53.6, 53.7, 53.8, 53.9, 54.0, 54.1, 54.2, 54.3, 54.4, 54.5, 54.6, 54.7, 54.8, 54.9, 55.0, 55.1, 55.2, 55.3, 55.4, 55.5, 55.6, 55.7, 55.8, 55.9, 56.0, 56.1, 56.2, 56.3, 56.4, 56.5, 56.6, 56.7, 56.8, 56.9, 57.0, 57.1, 57.2, 57.3, 57.4, 57.5, 57.6, 57.7, 57.8, 57.9, 58.0, 58.1, 58.2, 58.3, 58.4, 58.5, 58.6, 58.7, 58.8, 58.9, 59.0, 59.1, 59.2, 59.3, 59.4, 59.5, 59.6, 59.7, 59.8, 59.9, 60.0, 60.1, 60.2, 60.3, 60.4, 60.5, 60.6, 60.7, 60.8, 60.9, 61.0, 61.1, 61.2, 61.3, 61.4, 61.5, 61.6, 61.7, 61.8, 61.9, 62.0, 62.1, 62.2, 62.3, 62.4, 62.5, 62.6, 62.7, 62.8, 62.9, 63.0, 63.1, 63.2, 63.3, 63.4, 63.5, 63.6, 63.7, 63.8, 63.9, 64.0, 64.1, 64.2, 64.3, 64.4, 64.5, 64.6, 64.7, 64.8, 64.9, 65.0, 65.1, 65.2, 65.3, 65.4, 65.5, 65.6, 65.7, 65.8, 65.9, 66.0, 66.1, 66.2, 66.3, 66.4, 66.5, 66.6, 66.7, 66.8, 66.9, 67.0, 67.1, 67.2, 67.3, 67.4, 67.5, 67.6, 67.7, 67.8, 67.9, 68.0, 68.1, 68.2, 68.3, 68.4, 68.5, 68.6,

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1. *Environ. Biol. Fish.* 1997, 48: 171-180.

• *Journal of the American Medical Association*, 2000; 284: 2559-2562

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1. *Pharmaceutical industry* – The pharmaceutical industry is a major contributor to the economy of the United States. It is a highly competitive industry with a high barrier to entry. The industry is characterized by a high level of research and development (R&D) spending, which is necessary to develop new drugs. The industry is also characterized by a high level of marketing spending, which is necessary to promote new drugs. The industry is a major source of employment in the United States.

[illegible]

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The concentration of the *Agrobacterium* suspension was 10⁶ cells/ml (○), 10⁷ cells/ml (□), 10⁸ cells/ml (△), 10⁹ cells/ml (◇), and 10¹⁰ cells/ml (●). The error bars represent the standard deviation of three independent experiments.

• *Chlorophyll a* (Chl *a*) is the primary photosynthetic pigment in all photosynthetic organisms. It is a green pigment that absorbs light energy in the blue and red regions of the visible spectrum. Chl *a* is the most abundant pigment in the chloroplasts of green plants and algae.

[illegible]

In each space place the number of the phrase which best describes the degree of change. In the last column please give an over-all or composite rating of the sample as a whole, In this last column use a number score but do not average the numbers you have marked in each column.

- (0) No change
- (1) Slight change
- (2) Moderate change
- (3) Great change
- (4) Very great change

Blanket No. _____

	Color Change	Pilling	Flattening or matting of Nap	Loss of Nap	Hand	Composite Rating
Sample A						
Sample B						
Sample C						
Sample D						

Blanket No. _____

	Color Change	Pilling	Flattening or Matting of Nap	Loss of Nap	Hand	Composite Rating
Sample A						
Sample B						
Sample C						
Sample D						

-2-

1. During the use of a blanket which of these changes would you consider most objectionable. (Encircle your answer).

Color Change	Pilling	Matting or Flattening of Nap	Change in Hand	Loss of Nap
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2. Suppose you were buying one of the blankets you just evaluated. If price were no object on the basis of your observations which would be your:

First choice No. _____

Second choice No. _____

Last choice No. _____

Please state briefly why you made the above choices.

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